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Constraints in the market chains for export of Sudanese sheep and sheep meat to the Middle East

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Omar Hassan el Dirani, Mohammad A Jabbar and Babiker Idris Babiker

Ministry of Animal Resources and Fisheries

ILRI
INTERNATIONAL LIVESTOCK RESEARCH INSTITUTE

International Livestock Research Institute

Authors' affiliations

Omar Hassan el Dirani, Ministry of Animal Resources and Fisheries, Government of Sudan, Khartoum, the Sudan
Mohammad A Jabbar, International Livestock Research Institute (ILRI), Nairobi, Kenya
Babiker Idris Babiker, Department of Agricultural Economics, University of Khartoum, Khartoum, the Sudan

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Table of Contents

List of Tables

List of Figures

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A note on the Sudanese unit of currency

Until 1997, the Sudanese unit of currency was the pound (USD 1.00 = 2600 pounds). In January 1998 it was changed to the dinar (USD 1.00 = 260 dinars) and in June 2007 it reverted to the pound (USD 1.00 = 2 pounds), the unit that is currently in use. There are ready references for conversion between the old pound and the dinar, and the new pound. The dinar was the unit of currency during the time the surveys for this study were conducted (2005–06) so this report presents price figures in dinar.

Executive summary

Before oil was discovered in Sudan, export of livestock and livestock products was the country's most important foreign exchange earner; it is currently the second most important source of foreign exchange after oil. The Middle East, especially Saudi Arabia, has been the traditional export destination for livestock and livestock products. Export occurs throughout the year, but volumes peak during the two months prior to the annual Hajj festival.

However, the pattern of demand in the Middle East has been changing in recent years. Increases in incomes and urban population, combined with a growing immigrant worker population, have contributed to a rapidly increasing demand for meat. Demand for food quality and safety assurance has also been increasing, and these countries are increasingly implementing sanitary and phytosanitary (SPS) regulations.

One consequence of these changes is that new suppliers like Australia, Brazil and New Zealand that are able to comply with new standards have entered the market and the volume of Sudanese exports has been on a downward trend. For example, live sheep export from Sudan decreased from 1.6 million animals in 2002 to 1.4 million in 2006 and lamb and mutton exports decreased from 8620 t to 2264 t during the same period. Moreover, there have been bans on imports from Sudan in the past due to outbreaks of transboundary animal diseases such as Rift Valley fever.

While there is some preference for Sudanese breeds of sheep in the Middle East markets, there are specific quality, health and safety requirements in addition to preferences for age, weight and other physical characteristics. Sudan's declining and fluctuating market share is partly because of competition from alternative suppliers but mainly from Sudan's own problems within the supply chains for sheep and sheep meat.

This study characterized the nature of some of these problems by using a market chain framework and collecting data on several components of the framework from three states (Gedarif, Blue Nile and West Kordofan) which are important supply hinterlands for sheep for both export and domestic markets. Sample data were collected from 360 households/flocks, 56 traders and several quarantine centres and export slaughterhouses in these states. Data analysis focused on how producers are linked with the terminal domestic or export markets through various actors and institutions along the market chains, and the constraints at different stages of the market chain. The main marketing constraints are summarized below.

The supply hinterlands of West and North Kordofan, Blue Nile and Gedarif states are located far away (an average of 1500 km) from export ports and Khartoum, the largest domestic market. Furthermore, poor quality roads link the supply hinterlands, particularly those in the

western part of the country, to the main seaports of Port Sudan and Sawakin. Consequently, trekking takes a long time, with negative consequences for the health and quality of the animals. Overloaded trucking to reduce transport costs also has similar consequences.

In the three states, market offtake rates for flocks range from 16–22% which are considered to be very low by the standard of commercially oriented flocks. With this level of offtake, sustained supply of export quality animals is bound to be difficult as no more than 40% of the animals sold by producers are of export quality; the remainder is absorbed in the domestic market. In the commercial herds/flocks in the developed countries, offtake rates of 40–50% are considered optimal. The number of animals sold is significantly higher among households whose main or sole source of livelihood is livestock, and for nomadic/semi-nomadic sheep producers compared to their sedentary counterparts. The actual number of animals sold per producer increases with flock size while offtake rate declines, because owners of larger flocks need not sell too many animals. Such flock owners are mostly nomadic or semi-nomadic and depend almost entirely on livestock for their livelihoods. Therefore, increased offtake has to be encouraged among this group of producers in order to sustain supply for export.

Health problems at the household and flock levels reduce the seasonal and overall supply of export quality animals to market. The household/flock-level survey in the three states showed a high incidence of heartwater, *peste des petits ruminants* (PPR), and sheep pox. For example, in 2006, 57% of flocks in Gedarif had heartwater, 64% in Blue Nile had PPR and in West Kordofan, the incidence of both heartwater and sheep pox was about 30%. Incidences were generally higher in the dry season. Since high incidence of PPR was not expected by the veterinary staff in the survey states, blood samples were collected for serological analysis to validate producer responses. The serological tests confirmed the high prevalence of PPR in the survey states.

Overall mortality was 6% in Gedarif and West Kordofan and 11% in Blue Nile but crude case fatality rates (CCFRs)[1] for the major diseases were very high. During 2003–05, the CCFR was 34–48% for PPR, 24–40% for sheep pox and 34–42% for heartwater. One of the reasons for the observed high morbidity and mortality is poor access to health facilities. For example, the nearest veterinary health facility is over 40 km away from 33% of households in West Kordofan, 29% in Blue Nile and 52% in Gedarif. These health facilities are poorly staffed and lack adequate equipment and chemicals for diagnostic tests. Consequently, only about 44% of the sampled households used any professional veterinary service during the year prior to the survey. Of these, 37% used public or private veterinary services, 17% consulted paraveterinarians (drug sellers and community animal health workers) and 10%

1. Crude case fatality rate is the number of deaths divided by the number of cases.

used traditional medicine. About 92% of the households used self-prescription to treat their animals and 65% felt confident that they had enough knowledge and experience to do so.

The consequences of high disease incidence, morbidity and mortality are heavy losses for the flock owners and limited market supply of export quality animals. In 2005, the average economic loss per household due to diseases was 176,276 dinars (USD 766), 74% of which was due to loss of animals, 18% due to cost of drugs and services for preventive and curative treatment and 8% due to loss of output. Some of the important factors that affect the level of expenditure on veterinary services and drugs include flock size, distance to drug stores, veterinary clinics and laboratories, and the number of times a professional veterinarian was consulted or self-prescribed drugs were used.

Figure 1 summarizes the main constraints along the market chains for live animals and meat and the key activities that relate to quality and safety assurance. Traders use physical characteristics and some well-known symptoms of diseases like sheep pox, pneumonia, heartwater and PPR to screen animals before purchase at the market or in the village. Inspectors at the livestock markets also certify animals based on visual examination or observation of physical characteristics and symptoms of certain diseases such as sheep pox, pneumonia and heartwater. There is an elaborate system of inspection and certification for live animals and meat involving quarantine, testing and screening for specific transboundary or trade-related diseases. There is also strict screening at the port of arrival in Saudi Arabia, where a whole vessel is usually rejected if only one or two animals with unacceptable symptoms are detected. Such action provides a good signal and an incentive to undertake inspection and screening in a serious manner. However, there are either procedural or technical deficiencies in the implementation of the quality and safety regulations and tests, resulting in high rates of rejection of animals along the export chains. For example, during 1997–2005, 31% of the animals offered for export were rejected within the domestic sections of the chains and another 2% were rejected between the export and import ports. Such high rejection rates increase costs and reduce competitiveness.

One of the challenges in addressing the problem of animal rejection is that, except for brucellosis, causes of rejection are not recorded for individual animals. Analysis of records at inspection and vaccination centres showed that brucellosis, lymph node, abscesses and mange were the main reasons for rejection. Although one major laboratory and several primary and terminal quarantine centres were well organized and conducted standard tests, it was unclear if this was the case for all laboratories and quarantine centres. One reason for rejection at the higher end of the chain is that symptoms of trade-related diseases may appear after the animals have left the primary quarantines. This indicates a need for a high degree of rigour to be applied during screening and testing animals at the primary inspection stages.

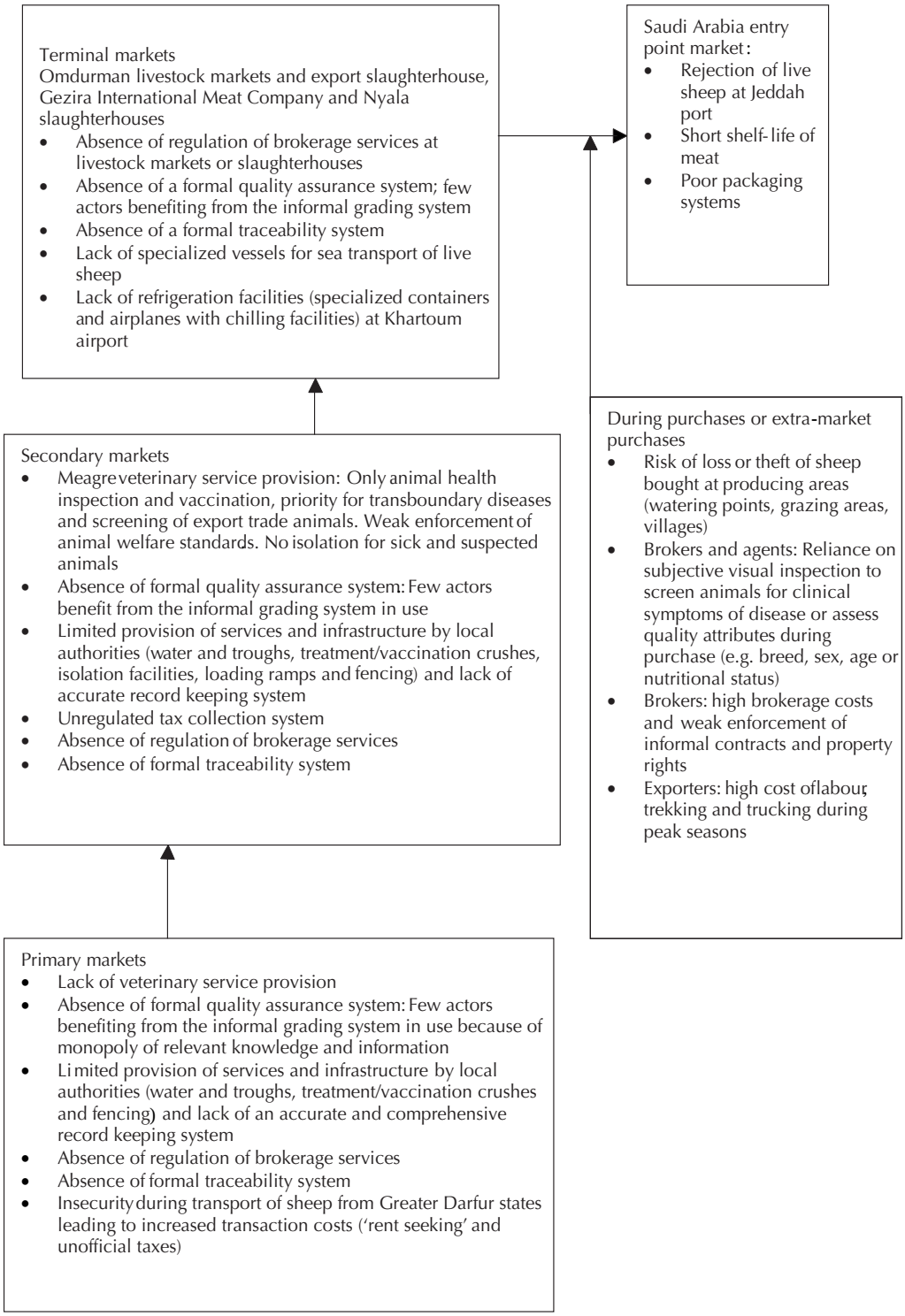


Figure 1. *Major constraints along the Sudanese sheep and sheep meat marketing chain.*

The market chain comprises several intermediaries along the supply chains and multiple local government taxes en route to the ports; this results in high marketing and transactions costs. The estimated producer price of export quality sheep in the three states is 65–77% of the free on board (FOB) price at Port Sudan or Sawakin, which is quite high. Consequently, the competitiveness of Sudanese sheep is low. However, the weighted average producer price of all animals sold is much lower because no more than 40% of the animals sold are high-grade animals suitable for export at a premium price. The remaining animals are sold on the domestic markets where prices have increased due to appreciation of the value of the dinar, propelled by oil revenues. Another reason for the high producer price of export-quality sheep is that the trade is largely financed by producers who accept deferred payment due to traders' lack of access to formal credit; the producers factor in the time value of money and demand premium price for export quality animals.

Major supply markets in the hinterlands are integrated with the terminal market in Khartoum as indicated by price co-integration. However, responses to price shocks are variable between markets. Some markets are more responsive than others and supply markets respond more quickly and intensely to shocks than terminal markets. Also due to inadequate mobility between the supply markets in different states, responses in these markets to shocks in other similar markets are fairly low. Major marketing problems mentioned by domestic traders include multiple taxes, unstable price, lack of infrastructure/facilities at the markets, unauthorized road taxes, low demand for animals, low price in import market and limited or no access to formal credit. The main problems that export traders face are lack of adequate high-quality animals in the dry season and competition from alternative suppliers in the Saudi market.

Recommendations

On the basis of the above findings, the following recommendations are made for actions to improve the functioning and efficiency of the market chain and for approaches to future studies and research.

1. Branding and promotion of Sudanese sheep, highlighting its natural grass-fed character, quality and safety assurance and certification, and reliable supply will help to capture a niche market within the overall expanding market demand for animals from a variety of suppliers. MARF (2008) produced a promotional video as a campaign tool to promote Sudanese sheep, though it needs to be refined, expanded and updated. Sudan is facing a declining market share of the rapidly expanding market for live animals and meat in the Middle East, especially the Saudi Arabia. The current marketing system is based on extraction of animals of relatively homogeneous traits from diverse natural production

systems rather than improving production systems to respond to emerging market demand for more uniform and better quality animals. This system works because of preferences among Saudi consumers for some Sudanese breeds of sheep which are grass-fed and whose meat has a distinct taste. It is unlikely that this advantage will be adequate to maintain a long-term market share of Sudanese sheep in the Saudi market.

2. Efforts should be made to increase commercial offtake rate, especially given that flock sizes are quite large, especially among the nomadic/semi-nomadic households, but offtake rates are quite low and majority of the animals supplied to the market are not of export standard. Sudan's market share in the Middle East cannot be sustained or increased without a significant increase in the offtake rate.

3. Inspection and certification systems should be applied more rigorously to reduce rejection rates at higher levels of the export chains. Since high incidence of some diseases and high rate of rejection of animals affect the supply of good quality meat and animals in the market, the following steps need to be taken on a priority basis to reduce rejection rates and overall costs of marketing per animal:
   - Inspection and certification of animals at primary and tertiary quarantine centres should be enforced and quarantine record keeping improved to enable accurate identification of the causes of rejection of animals and assure proper health certification along the market chain.
   - Better clinical capacity and records at every step in the chain are required to develop long-term predictive disease statistics.
   - Regular and periodic complementary serological studies and examination of clinical records for validation are required to build a reliable system for disease diagnosis, reporting and control.
   - Strategies are needed to improve veterinary service delivery by field staff and laboratories. Improved veterinary health services will reduce disease incidence, mortality and morbidity and improve the quality of marketed animals. In the medium to long term, health facilities and laboratories need to be better equipped and the number of veterinary staff in the public and private sectors increased.

4. Taxes by local and provincial governments should be harmonized and lowered to reduce overall transaction costs and improve competitiveness. The state and local governments should not only consider livestock as a source of revenue but should reinvest tax revenues for the benefit of the livestock sector and consider alternative options for revenue generation. Agricultural and rural development activities should be promoted and more remunerative jobs created so that fewer people will need to operate as intermediaries in the livestock trade.

5. Increased access to credit is required to improve producer competitiveness. Long-term sustained access to Saudi markets for Sudanese sheep will require investment towards improved animal productivity and quality through dissemination of improved management and technology, disease control measures and extension services. Providing producers, traders and exporters with access to formal institutional credit will help to induce adoption of new technologies by producers and better trading practices by traders, provided the cost of formal credit is balanced by better market prices for quality and safety.

6. An integrated systems approach using value chain analysis should be applied to research, extension, technology dissemination and marketing to improve the effectiveness of the supply chains. To accomplish this, multidisciplinary approaches involving epidemiology, economics, animal production and other relevant disciplines will be required. Given that multiple institutions are involved in the livestock industry, coordinated efforts will also be needed to identify and implement institutional options for animal health delivery and livestock market improvement. This effort should be led by MARF and involve other public, private and non-governmental partners engaged in agriculture and rural development because livestock is only one component of the rural economy.

1 Introduction

Sudan's land mass spans over 2.5 million square kilometres and the country has one of the harshest climates in the world, with one-third of the total land area being desert, about 40% suitable for grazing and less than one-quarter potentially arable (FAO 1997). Sudan has a large livestock population, estimated in 2006 at 41 million head of cattle, 50.1 million sheep, 42.1 million goats and 4 million camels. Of the total livestock population of the Arab world—the main market for Sudanese livestock—Sudan accounts for about 70% of cattle, 31% of sheep, 49% of goats and 25% of camels. Sudan also accounts for some 43% of the Arab world's red meat production. The main livestock production sites are located far from the major consumption centres and export outlets. Economically valuable livestock populations are concentrated in northern, western and southern Kordofan and Darfur accounting for 36% of cattle, 40% of sheep, 36% of goats and 33% of camel populations. Blue Nile and Gedarif states are also important supply hinterlands for export sheep (Figure 2).

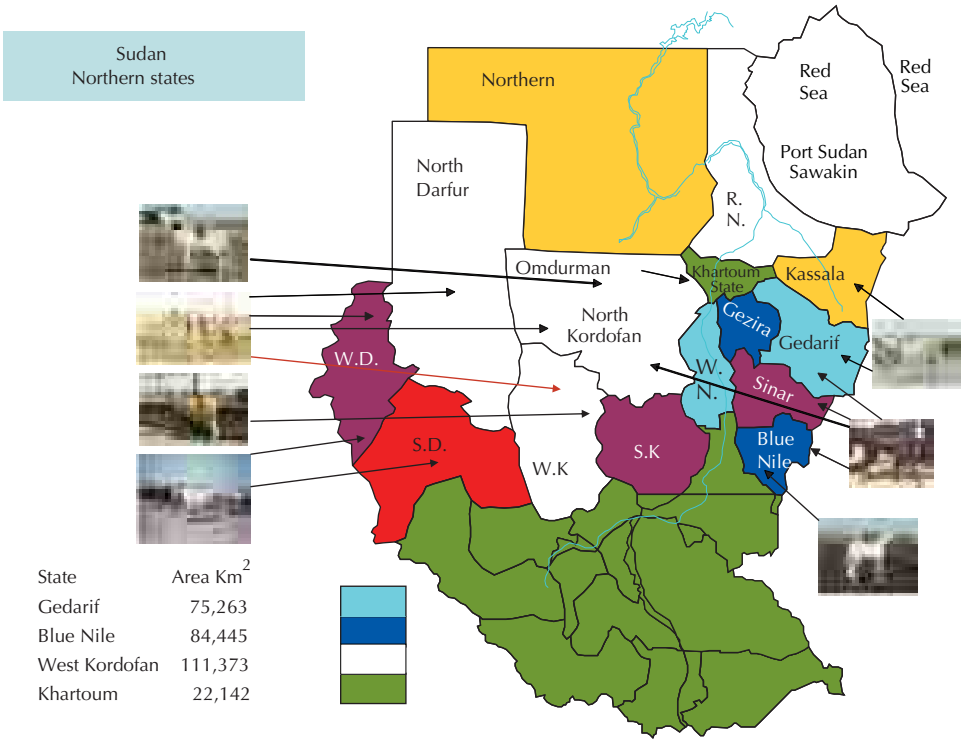


Figure 2. *Major breeds of sheep for export and their production areas in Sudan.*

The livestock sector in Sudan is an important contributor to the national economy, accounting for 25% of the gross domestic product (GDP) and employing 40% of the country's population. Before 1999, livestock exports generated 20–25% of the national

foreign exchange earnings (second to oil). However, oil is now the primary foreign exchange earner (accounting for 82.1% of the total value of Sudanese exports in 2004) while agriculture ranks second (Central Bank of Sudan 2004). The contribution of livestock to export earnings has declined to below 8% (MARF 2005). Nearly all Sudanese exports of live sheep and sheep meat are to Saudi Arabia (Table 1). This lack of diversified export destinations for Sudanese sheep and sheep meat export has been a long term characteristic of the sector (FAO 1997).

Table 1. *Sudanese exports of live sheep, mutton and lamb between 2002 and 2006*

Year	Live sheep ('000 head)	% to Saudi Arabia	Mutton and lamb (tonnes)	% to Saudi Arabia
2002	1603	99.9	8620	83
2003	1315	99.6	9700	81
2004	1704	99.8	5565	88
2005	1272	99.7	4710	92
2006	1422	99.8	2264	98

Source: MARF (unpublished data).

Demand for meat in the Middle East—especially in the Saudi market—has increased rapidly, propelled by rising income levels, population growth, urbanization and growth in the food service sector from increased investment in tourism. However, Sudan's market share and absolute exports to the Saudi market have declined in recent years. This decline was exacerbated by a ban on imports from Sudan in 2000–01 following an outbreak of Rift Valley fever in the Horn of Africa. Although the ban was later lifted, the process of regaining the export market share has been slow, resulting in other countries like Australia and New Zealand increasing their share of the Middle East market. In the export market for live sheep, Australia has the advantage of lower prices compared to Sudan although Syria seems to benefit from non-price factors which account for its slightly higher market share compared to Sudan despite relatively higher prices (Table 2). Sudan's relatively lower market share of fresh and frozen sheep meat is primarily due to differences in product characteristics, namely, shelf life, packaging, taste and average carcass weight.

Thus, although Sudan has the advantage of being near the Gulf markets for sheep and sheep meat, it faces competition from Australia and New Zealand in terms of price, reliability of supply and terms of trade, and from Syria in terms of product quality and other non-price factors.

International meat trade is mainly in cuts or parts, not in the form of live animals or carcasses. The slaughter of a meat animal automatically generates a full set of muscle meat cuts, as well as trimmings, offal and other by-products. The value of a carcass is the composite value of the cuts and by-products while the derived value of a meat animal is the

composite value of the carcass and by-products, less processing and transaction costs (Dyck and Nelson 2003). However, Sudan's level of livestock product processing falls below the industry threshold level, compared to actual demand and the country's livestock resource potential. For instance, in 2004, New Zealand exported 442,200 t carcass weight equivalent (CWE) out of 39.6 million head of sheep (i.e. 55.8% offtake rate) while Sudan exported 40,400 t (CWE) out of 48.9 million head of sheep (0.8% offtake rate).[2] Low quantities of meat exports from Sudan are due to lack of expertise in meat processing, handling and packing. Building capacity in meat processing technology would contribute towards the future growth of the meat industry (Ibrahim 2004).

Table 2. *Average prices of live sheep and sheep meat and market shares of selected exporting countries in 2004*

Exporting country	Live sheep		Young sheep meat (fresh or frozen)		Sheep meat (whole fresh carcasses)	
	Price USD/t	Market share (%)	Price USD/t	Market share (%)	Price USD/t	Market share (%)
Sudan	1771	29	3043	na	4243	69.3
Syria	3054	31	na	na	na	na
Jordan	2696	1	na	na	na	na
Yemen	na		na	na	1473	0.13
Egypt	na		3202	1	3149	0.06
Pakistan	na		1908	32	2175	5
Australia	1107	38	4100	36	2254	3
New Zealand	na	na	4429	22	2884	20.4
Average price c.i.f. Jeddah	2382		3336		2696	

na: Not applicable.
Source: AAAID (2005).

Sudanese live sheep and sheep meat is recognized in Saudi Arabia markets as '*Swakni*'; except for removable stickers on meat carcasses, there is no formal branding or labelling. Sudanese meat is not promoted in domestic or international markets and there are currently no programs aimed at stimulating demand in Middle East countries through influencing consumer attitudes, building confidence in the quality and integrity of the product and enhancing the appeal of Sudanese meat.

The problem faced by Sudan is thus one of enhancing its competitiveness in the Middle East markets for sheep and sheep meat in order to increase and maintain its market share. This would entail improving the efficiency of internal marketing systems and livestock export procedures, and improving product quality. With regard to quality, serious attention needs to be given to grades, standards and SPS measures, in compliance with international agreements.

2. Calculated from export figures in 2004 by adding the quantities of mutton and lamb meat export to live sheep export then converting the figure into tonnes (conversion rate: 20 kg carcass weight per head).

The objective of this paper is to analyse the causes of declining market share of Sudanese sheep and sheep meat in the Middle East market, especially in the Saudi market, by examining the constraints in the export supply chains. The following major factors are hypothesized to explain constraints limiting export to Saudi Arabia:

- There are specific export requirements for quality assurance and safety of Sudanese sheep and sheep meat, and there are rules and procedures in place in Sudan to test, certify and assure supply of quality and safe animals and meat to the Saudi importers. However, these are inadequate and inefficient to match the SPS standards of the importing country.
- Multiple intermediaries are involved along the market chains resulting in several points of taxation along the value chains; this leads to increased transaction costs which lower competitiveness.
- Domestic livestock markets are spatially integrated and therefore can respond quickly to varying import demand requirements.

A market chain framework linking producers and importers through the intermediate markets and actors was used to analyse these factors. Both secondary and primary survey data were used to generate evidence on these factors.

2 Methodology

2.1 Study framework and sources of data

A supply chain framework was used to represent the nature of import and domestic demand and requirements as the driver of the livestock trade (Figure 3). The framework also shows the role of animal health and marketing institutions and services at various points along the supply chains.

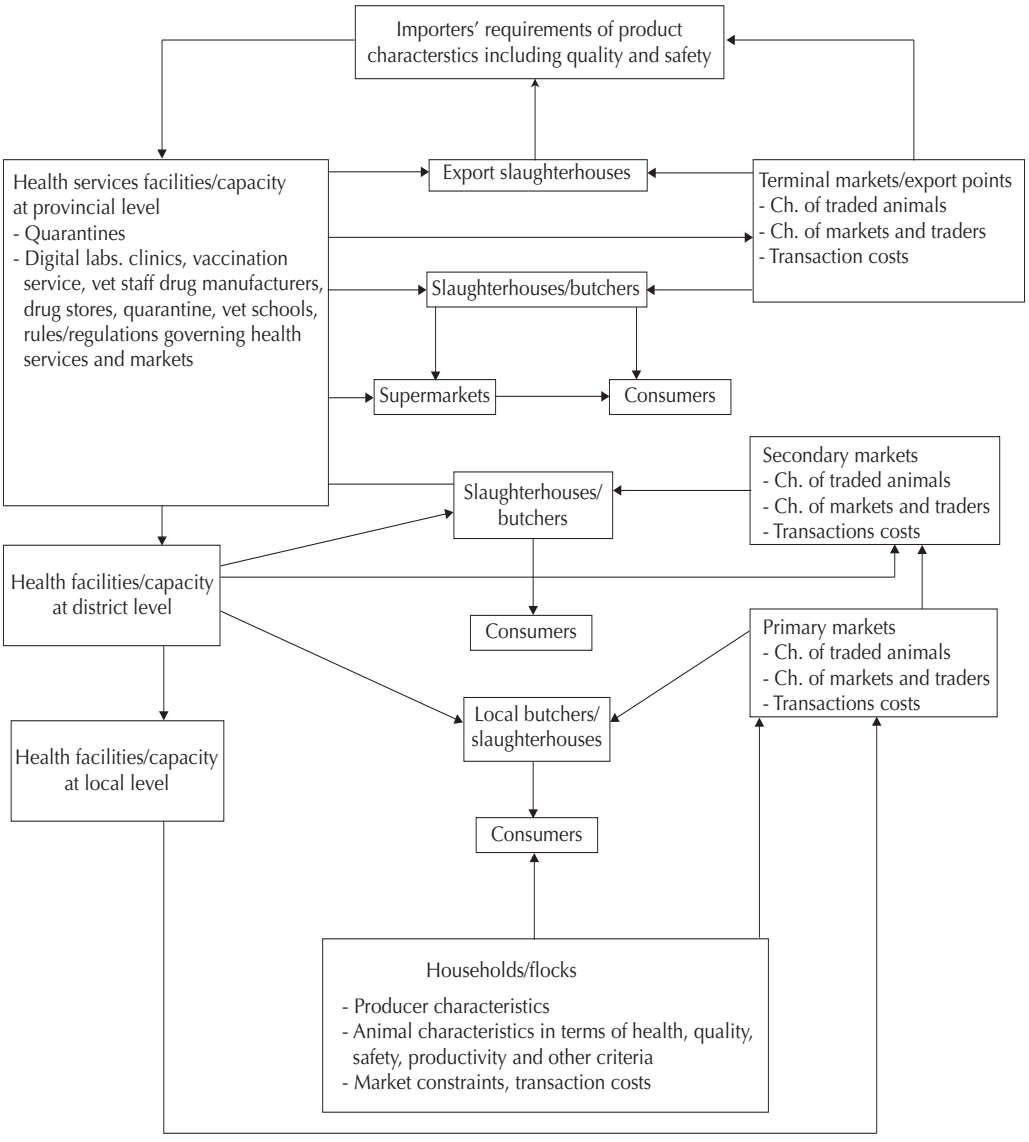


Figure 3. *Market chain framework to analyse constraints for sheep export.*

The aim was to identify the main market activities that could either promote or constrain market access by characterizing the sheep markets in Sudan and identifying the sequence of primary and supporting activities that would lead to increased exports and better quality products for local consumers and importing countries.

Marketing institutions and transaction costs are key elements of this framework. Institutions include public and private sector business firms of various sizes and types and the services they provide, as well as rules, regulations, norms, practices and facilities that govern the functions of the business enterprises (Padberg et al. 1997). Marketing failure or faulty performance may be traced to many causes, including imperfect information, high transaction cost, lags in adjustment to change and inadequate infrastructure.

According to the new institutional economics approach, the unit of analysis is the transaction rather than the price. Exchange itself is costly. Transaction costs, which are distinct from physical marketing costs such as those for transport and storage, arise from the coordination of exchange among market actors. They include the costs of obtaining and processing market information, negotiating contracts, monitoring agents and enforcing contracts (Williamson 1985; Hoff and Stiglitz 1990; North 1990; Gabre-Madhin 2001). However, it is widely recognized that market transactions, particularly in developing countries like Sudan, are often embedded in long-term, personalized relationships.

Personalized exchange emerges in response to commitment failure, in which the risk of breach of contract or opportunism is high, resulting from lack of market information, inadequate regulation and the absence of legal enforcement mechanisms. Institutions that build trust and promote reputation and social capital, such as trade associations, solidarity networks and groups that enhance ethnic or religious ties, emerge to circumvent commitment failure (Gabre-Madhin 2001). Individual effort to minimize transaction costs leads to the emergence of alternative institutional arrangements. The link between transaction costs and the emergence of institutions has long been recognized in institutional economics theory.

In Sudanese livestock markets, transaction costs include costs of:

- transportation
- feeding and grazing
- marketing levies and taxes imposed by local and national authorities
- mortality or loss of animals during transit
- slaughtering and processing
- capital (interest on the money tied up in the livestock from the point of purchase to the point of sale)

- opportunity cost or salary of the trader or butcher.

In order to characterize the health- and market-related constraints that limit the ability of exporters to satisfy importers' needs, the following levels of the supply chain were analysed:

- village-level livestock resources, services and marketing infrastructure
- households and flocks
- primary, secondary and tertiary livestock markets, and marketing institutions
- livestock traders and exporters
- local- and district-level veterinary service providers
- veterinary quarantine stations for export markets and
- slaughterhouses for domestic and export markets.

Livestock production in Sudan is predominantly pastoral. There are three systems of animal production: traditional low-input-low-output system, modern or intensive system, and feedlot. The traditional system has three subsystems: (1) pastoral nomadism and transhumance system, (2) sedentary and semi-sedentary agro-pastoralism and (3) urban and peri-urban scavenging system. A pastoral system is one in which over 50% of the total household revenue (the value of home consumption plus income) or more than 20% of human food energy is derived from livestock or livestock products. There is little integration of livestock and crops in this system. An agro-pastoral system is one in which 10–50% of total household revenue is derived from livestock or livestock products (FAO 1997). Livestock migration has been recently constrained following the tribal conflict of 2000 between the Meidob and Berti of Northern Darfur (Young 2005). The conflicts in Darfur have reduced the level of supplies from primary to secondary markets thus raising the price of meat and livestock in the latter. Livestock prices are also on the decline in some primary markets that are cut off from secondary markets.

The modern or intensive system is mainly for milk and poultry production and is based on irrigated fodder and agro-industrial by-products. The feedlot system is centred on livestock markets (with seasonal activity during summer) to support domestic consumption and export. Conflicts in North Darfur have made grazing areas and their migratory and commercial stock routes inaccessible; this has led to remote routes being used to transfer animals to the main urban and export markets, resulting in high marketing costs.

Sudan's Central Bank, Ministry of Foreign Trade, Live Animals and Meat Export Promotion Council and the Livestock and Meat Marketing Corporation (LMMC) play complementary roles in livestock and meat export. Before livestock marketing was liberalized in 2002, the LMMC was the only government-sanctioned institution authorized to facilitate livestock trade and export marketing activities. It was financed through a fee levied on all sales of livestock in markets that it operated. The main objective of establishing the LMMC was to stabilize producer prices, particularly of livestock and meat destined for export markets. The

corporation was dissolved in April 2002 following the liberalization of livestock marketing which saw the entry of the private sector.

In order to characterize the supply chains and their inter-linkages, secondary data were collected from relevant departments at national, state, local authority and administration unit levels. Structured and non-structured questionnaires were also used to collect primary data from market chain actors in Blue Nile, Gedarif and West Kordofan states. The criteria used to select these three states were: the relative importance of export quality sheep; the diversity of production systems; relative importance of domestic vs. export market outlets; and the prevalence of poverty.

In order to conduct surveys on various actors described in the supply chain framework, stratified multistage random sampling was proposed to sample one local authority in each state, and one administrative authority within each sampled local authority. From each of the selected administrative units, 10% of the villages were randomly sampled. Household lists were obtained from local veterinary authorities, administrative units and local tax offices. Households where small ruminants were not kept were excluded.

In Western Kordofan state, only one local authority—el Nihood—was sampled because of insecurity in the other local authorities situated adjacent to Southern Darfur state. Within el Nihood local authority, el Khowei administrative unit was sampled and villages within this administrative unit were randomly sampled.

There were some problems in applying the stratified sampling frame in Gedarif and Blue Nile because of the nomadic nature of the households and the absence of clearly defined villages in the Blue Nile state as a result of conflict in the region. Thus, purposive sampling was used to select local authorities from Gedarif state (Abu Rukhum, Bazoora, el Hawata, Elmagata and Gedarif local authorities) and Blue Nile state (Aboghmy, Badows, Boought, Midiem, Ofod, Wadabook and el Damazeen local authorities) after discussions with producers, traders and local experts, and officials from veterinary authorities, ministries of finance, livestock taxation units and local producer associations. The breakdown of the sample sizes of units in the surveyed states is summarized in Table 3.

2.2. Description of the study areas

Gedarif has a higher human population density and lower livestock density than compared to Blue Nile and West Kordofan states (Table 4). Each of the three states has a distinct comparative advantage in sheep production.

Table 3. *Breakdown of sample sizes of units in the three surveyed states*

Survey unit	Gedarif	Blue Nile	West Kordofan	Total
Village level rapid appraisal	8	5	6	19
Households	46	108	106	260
Livestock traders	16	21	19	56
Livestock markets	6	7	8	21
Veterinary services	5	4	1	10
Veterinary quarantines	1	0	2	3
Slaughterhouses	3	3	2	8

Table 4. *Human population and livestock densities in three states of Sudan*

	Gedarif[a]	Blue Nile[b]	West Kordofan[c]
Area (km^2)	75,263	84,445	111,373
Human population density per km^2	15	10	9
Sheep density per km^2	16	43	34
Goat density per km^2	16	3	18
Cattle density per km^2	2	35	30
Camel density per km^2	2	<0.5	4
Number of sheep and goats per capita	2.0	4.6	5.8

Sources: a. State Ministry of Finance, Economy and Labour Force. Livestock Taxation Administration, Gedarif (2005); b. Veterinary Authority, Blue Nile State, Damazeen (2005); and c. General Planning and Animal Resources Economics Administration, MARF, Khartoum.

Gedarif state is rich in fodder, grazing areas and by-products of sorghum and sesame. It is also situated close to Port Sudan, the main point for export of livestock and livestock products. During the rainy season, the state has abundant fodder and water in the northern Butana area. In the summer when water is scarce, sheep populations are concentrated around the Blue Nile River in large sorghum and sesame agricultural schemes[3] and around *hafeers* (artificial water reservoirs) and deep-bore wells. Mixed crop–livestock systems predominate and the sheep produced in the state are destined for both domestic and export markets.

Blue Nile state is rich in water resources. Besides the Blue Nile River and its tributaries (Dindir and el Rahad), this state has 750 hand pumps, 58 boreholes, 21 deep wells and 3 *sudd* (small dams). For this reason, the livestock population in Blue Nile state increases during the dry season due to in-migration from neighbouring states. The livestock production systems are mainly nomadic and semi-nomadic. Watiesh desert sheep are reared for export production of prime quality lamb with an average carcass weight of 12 kg.

3. The standard area of a scheme is 1000 *feddans* (one *feddan* is approximately one acre or 0.417 hectare). Some farmers may have up to 10 schemes in a given area. There are also small schemes with areas ranging from 10 to a few hundred *feddans*.

West Kordofan state has a mixture of nomadic, sedentary and semi-sedentary production systems. Hamari desert sheep, the main breed reared in the state, are the highest quality for live sheep and the second-best breed for meat. The bulk of Sudan's live sheep exports and meat for local consumption are from this state. In addition, most of the large sheep (average 35–45 kg live weight) and high-quality lambs purchased during the annual Hajj and Ramadan religious festivals originate from West Kordofan state.

2.3. Data collection and analysis

Survey data for Gedarif, Blue Nile and Kordofan states were collected by questionnaires in March, May and June 2005, respectively. Surveys of markets, traders and exporters were conducted in the terminal market during June 2006. The main problems encountered in conducting the surveys were related to the dry season: where surveys were conducted, it was difficult to find flock owners in the vicinity as they often moved long distances in search of feed and water.

Questionnaires were developed for household/flock, market, trader, quarantine and slaughterhouse surveys and pretested before use. Data were collected on the profiles of the respective target, their assets or inventories, functions, functional mechanisms, productivity, costs and margins, and related problems. Discussion groups were conducted during the same periods at livestock markets, government offices (local councils, taxation and *zakat*, and veterinary authorities) and nomadic camps. The collected data were analysed using SPSS software.

3 Quality assurance system for export of live sheep and sheep meat

3.1 Quality requirements of importing countries

Several countries in the Middle East, the main destination of Sudanese export sheep and sheep meat, are upgrading their SPS standards for import of live animals and animal products to international standards. Saudi Arabia has preference for Sudanese sheep and sheep meat because the products meet specific quality and safety characteristics. Enforcement of quality regulations is the responsibility of the Saudi Ministry of Agriculture and Water. Quality requirements of Egypt and Jordan, although not major importers, are also discussed as these two countries are potential export destinations for Sudan. Mariner (2007) gave a more detailed account of the dynamics of demand for meat and live animals and SPS requirements in selected importing countries in the Middle East.

3.1.1 Saudi Arabia

Imported animals are inspected at the major ports of entry; both physical and laboratory tests are performed.

Exporters of live animals to Saudi Arabia must provide the following documents:

- Veterinary health certificate declaring the animals to be free from epidemic or contagious diseases. The certificate is signed by a qualified veterinary officer from the Federal Ministry of Animal Resources and endorsed by a senior veterinarian.
- Certificate of origin authorized by the Sudan Chamber of Commerce
- Commercial invoice giving details of the shipment
- Bill of lading

Importers of meat in Saudi Arabia require the following documents:

- Health certificate from the federal veterinary authorities indicating the results of ante- and post-mortem examinations and certifying the meat to as originating from disease-free animals and fit for human consumption.
- Certificate of origin authorized by the Sudan Chamber of Commerce and counter-signed by the Saudi Embassy in Khartoum
- Commercial invoice giving details of the shipment
- Bill of lading
- Carcass label that indicates: names and addresses of the exporting and importing companies; date of slaughter; types of meat and carcass temperature
- Certificate ratified by the Saudi Consulate or its authorized representative, or issued by a recognized Islamic centre or organization declaring that the animals were

slaughtered in a licensed abattoir in accordance with Islamic procedures; each carcass must bear a stamp indicating that it was slaughtered under the supervision of the centre or organization.

The veterinary health certificate, certificate of origin and commercial invoice are countersigned by the Saudi Embassy in Khartoum. Table 5 summarizes the regulations governing the maximum allowable interval between slaughter of the animals and arrival of the meat products in Saudi Arabia, the recommended storage temperatures and the shelf life of the chilled and frozen meat products.

Table 5. *Regulations governing the duration between slaughter and import, storage temperatures and shelf life for meat exported to Saudi Arabia*

Product	Type	Maximum allowable interval between slaughter and arrival	Shelf life	Storage temperature (°C)
Chilled meat	Carcasses	10 days	4 weeks	–2 to 0
	Vacuum packed	40 days	10 weeks	–2 to 0
Frozen meat		4 months	10 months	Below –18

Source: Ibrahim (2004).

3.1.2. Egypt

The Egyptian market stipulates the following regulations and requirements for imports of live animals (cattle and sheep) and chilled bone-in-beef from Sudan.

Requirements for import of live sheep

- Only male sheep shall be imported.
- Animals shall be quarantined at the shipping port in Sudan for not less than 30 days.
- Serological testing for foot-and-mouth disease (FMD) should be carried out during the quarantine period.

Requirements for import of live cattle

- Only male animals younger than three years old and over 300 kg live weight shall be imported.
- Animals shall be free from contagious diseases, particularly FMD, rinderpest and contagious bovine pleuropneumonia (CBPP).
- Animals shall be quarantined at the shipping port in Sudan for not less than 30 days.
- Animals shall be drenched, injected and sprayed against internal and external parasites.
- Serological testing for FMD, rinderpest and CBPP shall be carried out during the quarantine period.
- Dung shall be disposed of by fermentation as organic fertilizer.

Requirements for import of chilled bone-in-beef

- Animals intended for slaughter should be quarantined for 21 days and tested for contagious diseases from the 16th day.
- Animals testing negative should be slaughtered in approved facilities.
- Only the fore and hind quarters shall be exported; the quarters shall be packaged in labelled cartons and stored at 0–2°C.
- Chilled bone-in-beef shall be deboned immediately upon arrival at the Cairo airport in one of the government deboning halls under supervision of veterinarians from the Public Corporation for Veterinary Services.
- A certificate of origin and copy of pro-forma invoice shall accompany the shipment.

3.1.3 Jordan

Jordan is both an importer and exporter of live sheep and sheep meat. It is currently seeking to access markets in the First World and is adopting SPS and World Trade Organization standards to process imported products for re-export to terminal markets. Jordan imports processed sheep meat and beef from Sudan but not live sheep. It recently began importing live cattle from Sudan; following are the import regulations stipulated by the Jordanian Ministry of Agriculture:

- The shipment should be accompanied by a veterinary health certificate that certifies the cattle as free from infectious diseases and a certificate of origin stating that the animals are from a disease-free zone. The animals should not have suffered from FMD during the previous three months.
- The cattle should be kept in official veterinary quarantine for 30 days prior to shipment, during which time serological testing for brucellosis and laboratory examination for FMD strain 3ABC should be carried out. The animals should also be dipped or sprayed to ensure that they are free from external parasites.
- The cattle should not be vaccinated against FMD, lumpy skin disease or CBPP but should be vaccinated against haemorrhagic septicaemia (HS)
- The animals should be quarantined upon arrival in Jordan for at least 14 days.
- Transportation, loading and unloading of animals should be carried out according to Jordanian standards.

3.2 Institutional infrastructure supporting livestock production and trade

Following the liberalization of livestock marketing in Sudan, the private sector is playing the lead role in production and marketing services needed to support livestock exports. Nearly all slaughterhouses and tanneries have been privatized. The responsibilities of the public sector are now limited to regulation, research, planning and investment promotion. The government also has a role to play in fostering a supportive policy and infrastructure

environment by overseeing activities such as public health and food safety in relation to hygiene and sanitation of meat slaughtering and processing facilities for exports; monitoring and control of animal diseases; and documentation. In addition, new federal policies that encourage the export of livestock are being developed. One such policy allows traders to have unrestricted access to their foreign exchange earnings, whether to use it for importation of goods, sell it to the bank or to a third party (Aklilu 2002).

Limited credit is available and most working capital is generated within the industry. Financial resources are fully extended and are a major constraint to export expansion (FAO 1997). The main inputs are veterinary products, which are now imported, distributed and retailed entirely by the private sector.

The other important input for the livestock industry is feed, which is a major constraint that the government is making only limited efforts to overcome through research on cultivated and irrigated fodder and pilot projects on range management (Ibrahim 2004). Liberalization of markets has not delivered the expected results because markets do not function smoothly or, in some cases, even exist. Access to assets such as land and water is unequal and often reflects intractable patterns of inequality. Poor people's decisions are geared to avoiding risk and vulnerability rather than optimizing investment returns (Brückner 2004). In fact, the livestock sector in Sudan has suffered from negligence compared to the strong development-oriented policies in irrigation and mechanized farming. Development spending has hovered around 1% of public investment in spite of livestock's 10–20% contribution to GDP. Some reasons for the neglect include production largely to satisfy domestic needs, exports dominated by trade in live animals and the difficulties of investing in nomadic and agro-pastoral systems (FAO 1997).

The main development policies formulated during the last 15 years include The Economic Salvation Program (1990–92) and the Comprehensive National Strategy (1992–2002), but neither of these made any significant impact in the livestock sector. A more recent policy document is the Millennium Strategy for the Development of the Agricultural Sector (2003–27) which adopts a five-year development plan (2007 to 2011). Policy priorities for livestock sector development under the five-year development plan include:

- Expansion of manufacturing of veterinary drugs and vaccines
- Provision of veterinary services to nomads
- Research, capacity building and genetic improvement of livestock
- Rehabilitation of veterinary quarantines, slaughterhouses and tanneries
- Production of baled dry fodder to ensure availability of feed during summer
- Establishment of dams, *hafeers* and other water reservoirs for livestock
- Provision of credit facilities for the public and private livestock sectors. The cost of finance (equivalent to rate of interest) will be 5% annually instead of the present 12%,

and the difference will be paid by the Ministry of Finance and National Economy. Credit facilities will have longer grace periods and four-year payback period.
- Establishment of specialized livestock industry institutes.
- Promotion of modern dairy and beef production (both for milk and meat production).
- Establishment of programs to promote and develop livestock production and export.
- Designing programs to develop livestock production exports.

As this policy has only just been implemented, its outcomes are yet to be seen. However, at present, the performance of all public sector institutions is severely limited by lack of operating funds. At the federal level, public sector activities are confined to MARF's seven general administration and training institutes and the Ministry of Science and Technology. At the state level, each of the 26 states has a Department of Animal Resources which fall under the State Ministry of Agriculture and Livestock.

Other government institutions that are important in the livestock export sector include the Ministry of Foreign Trade (MFT) and the Central Bank of Sudan. The MFT acts as a moderator between the private business and the government. It issues export licences and sets minimum indicative prices for export (Aklilu 2002). In 2006, the minimum export prices were USD 1400/t for beef, USD 700/t for live cattle, USD 1665/t for live sheep, USD 3750/t for mutton and lamb meat, USD 25 per head of for live goats, and USD 175 per head for live camels (meat type).

The MFT has formed export promotion councils for major export commodity groups. The Live Animals and Meat Export Promotion Council (LAMEPC), chaired by the MFT, consists of exporters, members of other relevant institutions, and randomly selected pastoralists. The council's most important function is to enable exporters to make use of their foreign exchange earnings to import commodities or sell their hard currencies to third parties. The MFT appoints commercial attachés to key foreign trade missions to create market opportunities for Sudanese exports. In another development, the MFT, in collaboration with the Khartoum State (Ministry of Agriculture), has set up a separate livestock market in Omdurman for sheep exports. In addition, the Animal Resources Company set up el Salam market in Omdurman in 2001 under an arrangement where market fees are shared by the company (75%) and Khartoum State represented by State Ministry of Agriculture (25%).

Private sector marketing of live animals and meat is organized through a network of traders, corporate entities, brokers, agents and subagents throughout the country whose activities are guided as much by rules and regulations as by their own norms, practices and customs derived from tradition. Small public slaughterhouses cater for much of the domestic market. Two large public slaughterhouses—Kadaro and Sabalowka (at Omdurman)—and four private abattoirs—Ghanawa, Gezira International Meat Company (GIMCO), Port Sudan and Nyala—cater for the export market. Export trade is dominated by individual traders, family companies

and shareholding companies. Many of these have some vertical integration, with livestock buying as the first step in a business chain that includes ranching, fattening, feed milling, slaughtering and meat processing (FAO 1997).

Banking services are provided by commercial banks, which include the Animal Resources Bank that has 22.71% government shareholding but is managed as a private enterprise. The Sudanese Standards and Metrology Organization (SSMO) in collaboration with MARF issues standard specifications for meat and meat products.

3.3 Supply chains for live sheep and sheep meat

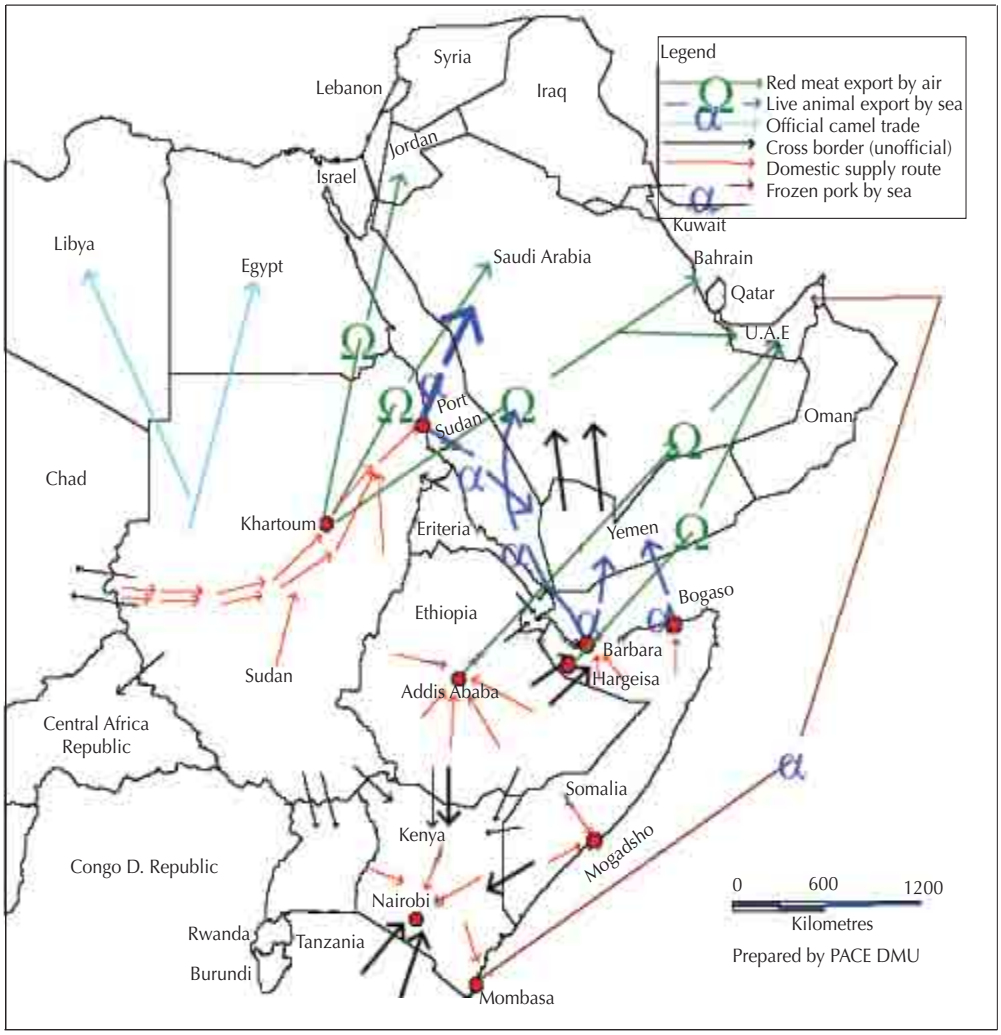
Marketing is a social and managerial function associated with the process of researching, developing, promoting, selling, and distributing a product, service, or intellectual property (Kotler and Keller 2006). A market chain is the sequence of actions necessary to take a product from raw material to a deliverable customer item. The supply chain in Sudan's sheep subsector comprises six functional stages:

- input supply
- livestock production
- livestock marketing
- primary processing (abattoirs, minced meat and meat preparation plants).
- secondary processing
- distribution

Most of the production areas for sheep and other livestock species in Sudan are located far from the main consumption or export centres. Production areas and seasonal migration patterns significantly influence domestic, cross-border and formal export trade routes for livestock (Figure 4). These two factors have also led to the development of a unique internal livestock market system in Sudan (Aklilu 2002). This has resulted in a marketing chain that comprises four tiers:

- Direct sales from the farm or pastoral herd
- Primary markets that handle individual or small groups of animals
- Secondary markets that handle larger groups of animals
- Terminal markets in large cities that represent the final point of sale for domestic consumption or export.

Thus, the supply chains for live sheep and meat link producers and consumers through a series of institutions (organizations, rules and regulations) and related actors. Up to a point, elements of the chains for domestic and export markets overlap, beyond which they take different shapes and routes and involve additional actors and institutions. These are discussed below.



Source: Aklilu (2002).

Figure 4. *Domestic, cross-border and official export trade routes for Sudanese livestock.*

3.3.1 Producers

This analysis is based on a survey of 260 households/flocks in Blue Nile, Gedarif and West Kordofan states. Table 6 summarizes the main characteristics of households and flocks in the three states.

The market offtake rates are quite low for commercially oriented production systems, indicating that the production systems in the three states are not sufficiently commercially oriented despite the fact that flock sizes are relatively large and export of sheep and goats is a major source of foreign exchange. In this study, only 11% of the sampled households bought

some animals, accounting for only 2% of the overall average stock. Therefore, further analysis focused on the gross offtake rate.

Table 6. *Household and flock characteristics in Blue Nile, Gedarif and West Kordofan states*

	Gedarif	Blue Nile	West Kordofan
% of households by source of income			
Only livestock	29	52	15
Mainly livestock, minor crop	33	38	64
Mainly crop, minor livestock	18	4	14
Livestock and crop equally important	20	6	6
% of households by livestock management type			
Sedentary	29	28	64
Semi-nomadic	64	67	32
Nomadic	7	4	3
Average number of sheep and goats per household	152 (207)	111 (94)	77 (66)
Goats as % of small ruminants	13	17	9
Inventory change for sheep and goats during the year (%)			
Market offtake rate	22.4 (12.4)	15.7 (9.2)	19.2 (12.2)
Non-market offtake (home consumption, gift out, lost/stolen)	5.1 (5.7)	6.0 (8.0)	9.2 (9.4)
Mortality	6.8 (6.5)	10.1 (7.1)	8.7 (7.0)

Note: Following Negassa and Jabbar (2008) market offtake rate is defined as (sales – purchases)/average stock during a year * 100; Non-market offtake rate is defined as (slaughter + gift out – gift in + lost or stolen)/average stock * 100; Mortality is defined as the number of deaths as a percentage of the average stock.
Standard deviations in parentheses.
Source: Household survey data (2005).

In order to identify factors related to variation in market offtake rate, two regressions were run: the first used market offtake rate as the dependent variable while the second used the number of animals sold. The results are presented in Table 7.

The explanatory power of the variables in the offtake rate equation was quite low and only a few variables were found to have a statistically significant effect on offtake rate. Conversely, the coefficients of the several independent variables in the equation for number of animals sold were statistically significant and accounted for 74% of the variation (Table 7).

Mortality rate might, in theory, influence the number of animals sold; a lower mortality rate may imply enhanced supply while a higher mortality may result in a decrease in supply, with consequences on market offtake rate or number of animals sold from a given stock. However, neither offtake rate nor the number of animals sold was found to be influenced by mortality rate. Although mortality rate varied between households/flocks (Table 6), a regression with several combinations of factors showed that only distance to nearest clinic had a significant negative effect on mortality rate (a perverse relationship, as this would not normally be

expected) and no other factors, including level of expenditure on veterinary services and drugs, appeared to influence variation in mortality rate.

Table 7. *Estimated coefficients and related statistics for equations explaining sales of sheep and goats*

Independent variables	Market offtake rate	Number of animals sold
Intercept	26.822*** (4.103)	6.09 (20.67)
State dummy (W Kordofan = 0)		
Gedarif	–0.766 (2.601)	–12.213 (13.867)
Blue Nile	–6.031*** (2.070)	17.181 (11.055)
Livestock only or main source of livelihood (yes = 1, no = 0)	2.661 (2.385)	27.162** (12.725)
Production system (nomadic/semi-nomadic = 1, sedentary = 0)	4.439** (1.971)	17.8109* (10.491)
Flock size (number of sheep and goats)	–0.046** (0.018)	0.628*** (0.053)
(Flock size)^2	5.0E–0005* (0.000)	na
Number of cattle and/or camels in herd	–0.008 (0.022)	–0.224* (0.119)
Mortality rate for sheep and goats	0.083 (0.132)	0.618 (0.702)
Non-market offtake rate for sheep and goats (consumption, gift etc.)	0.024 (0.101)	0.177 (0.533)
Total family size	0.155 (0.165)	–0.561 (0.880)
Amount of crop land owned (*feddan*)	0.004 (0.003)	0.092 (0.015)
Age of the household head	0.097 (0.112)	–1.314** (0.597)
Number of years of schooling	–1.423 (2.475)	4.475 (13.224)
Distance to nearest market	–0.199 (0.395)	–2.973 (2.109)
R^2	0.18	0.74
Adjusted R^2	0.16	0.71

Standard errors in parentheses.
***, ** and * indicate significance at 1%, 5% and 10% respectively.

Distance to the nearest market was not found to have a significant influence on offtake rate or actual number of animals sold. Producers sold their animals at their own premises, grazing sites (sometimes referred to as 'bush market') or established market places (primary, secondary or terminal markets). Theoretically, several factors could explain the choice of sales outlet. These factors include age and level of education of household head, number of adult males in the family, relative importance of livestock to the household livelihood, and the system of livestock management. A logistic regression model with these and other variables gave a poor fit. However, pairwise cross tabulations and Chi square tests revealed that only household type and buyer type had a significant effect on the choice of sales outlet. Households in which livestock are the main source of livelihood are more likely to sell their animals at markets than households that mainly depend on crops. Similarly, traders and butchers are more likely to purchase animals at markets compared to herders, farmers, consumers and bush traders.

3.3.2 Livestock markets

There are three types of formal livestock markets: primary, secondary and terminal/export markets. Other institutions that facilitate live animal and meat marketing are quarantines, slaughterhouses and airports facilities. However, the discussion in this section is limited to a sample of rural and urban livestock markets in the three surveyed states: 18 primary markets, 3 secondary markets and 2 terminal markets. The characteristics of the three categories of livestock markets are discussed below.

Primary markets

- Usually located within a village market or near a livestock-producing village.
- Have no physical infrastructure (such as fencing, water and feed for animals) or market information.
- Animals are not kept in the market overnight.
- Market days are variable with some markets open once or twice a week and others operating daily. Some primary markets operate only during the wet or dry season.
- Trading may be by direct negotiation between sellers and buyers or sometimes through a broker.
- Except in el Showak (Gedarif State) and el Khowei (West Kordofan State) where vaccination and inspection centres are present, veterinary certificates are not issued for movement of purchased animals.

Secondary markets

- May or may not have facilities and infrastructure, such as fencing, water and feed for animals. For example, these facilities are present in Gedarif and el Nihood markets but absent in el Damazeen market.
- Animals are inspected by a veterinary officer and veterinary health certificates are issued.
- Animals may be kept overnight in the market in holding facilities (*mannama*) or fenced areas.
- More secure and better managed than the primary markets.

Terminal markets

- Infrastructure facilities (e.g. fencing, water and feed, veterinary clinic and pharmacy, loading ramps) are in place.
- Officials from the federal veterinary authority and market management are present at the market.
- Some primary markets, (e.g. el Khowei in West Kordofan State and el Showak in Gedarif) also serve as terminal markets, due to the recent setting up of veterinary quarantines for export.

- Live sheep destined for export are inspected, vaccinated and health certificates are issued by federal veterinary authorities. Ante- and post-mortem inspections are carried out on sheep intended for slaughter.
- Some terminal markets for meat are located next to export abattoirs that receive live animals directly from production areas; where live animals are supplied directly from production areas.

In the three states, 40% of the primary markets open once a week, 33% daily and 12% twice a week. Secondary and terminal markets are open every day except on Fridays. Of 21 primary and secondary markets surveyed, none had holding facilities, only two secondary markets were fenced, and veterinary clinics or outposts with minimal facilities were present in five primary markets and one secondary market. The number of animals traded varies seasonally (Table 8). At el Salam terminal market, trade peaks from July to August and drops during summer (February to May).

Table 8. *Number of animals traded and specialization of traders in the primary and secondary markets in three states of Sudan*

State	Market type	Number of sheep and goats supplied/market day		Average number of traders handling		
		Peak period	Lean period	Only sheep	Sheep and goats	Sheep, goats and cattle
Gedarif	Primary	1142	287	0	20	18
	Secondary	1950	550	0	40	30
Blue Nile	Primary	232	217	0	0	18
	Secondary	300	50	0	0	92
West Kordofan	Primary	2205	2205	18	0	48
	Secondary	5000	1950	0	0	40

Source: Livestock market survey (2005).

Sudan is currently expanding the number of its terminal markets. Livestock are now exported directly from el Muwelih in Omdurman, el Khowei, el Rahad in North Kordofan and el Showak through Port Sudan. El Muwelih in west Omdurman is the largest terminal market in Khartoum State operating on Wednesdays and Saturdays and serving both the domestic and the export markets.

3.3.3 Market actors

In general, the market chains are dominated by livestock traders and exporters who operate through a network of agents (*wakil*), subagents, small traders and brokers. Figure 5 illustrates a schematic diagram of the movement of sheep and goats along various market chains. Figures 6, 7 and 8 illustrate the market chains for sheep in Gedarif, Blue Nile and West Kordofan, respectively.

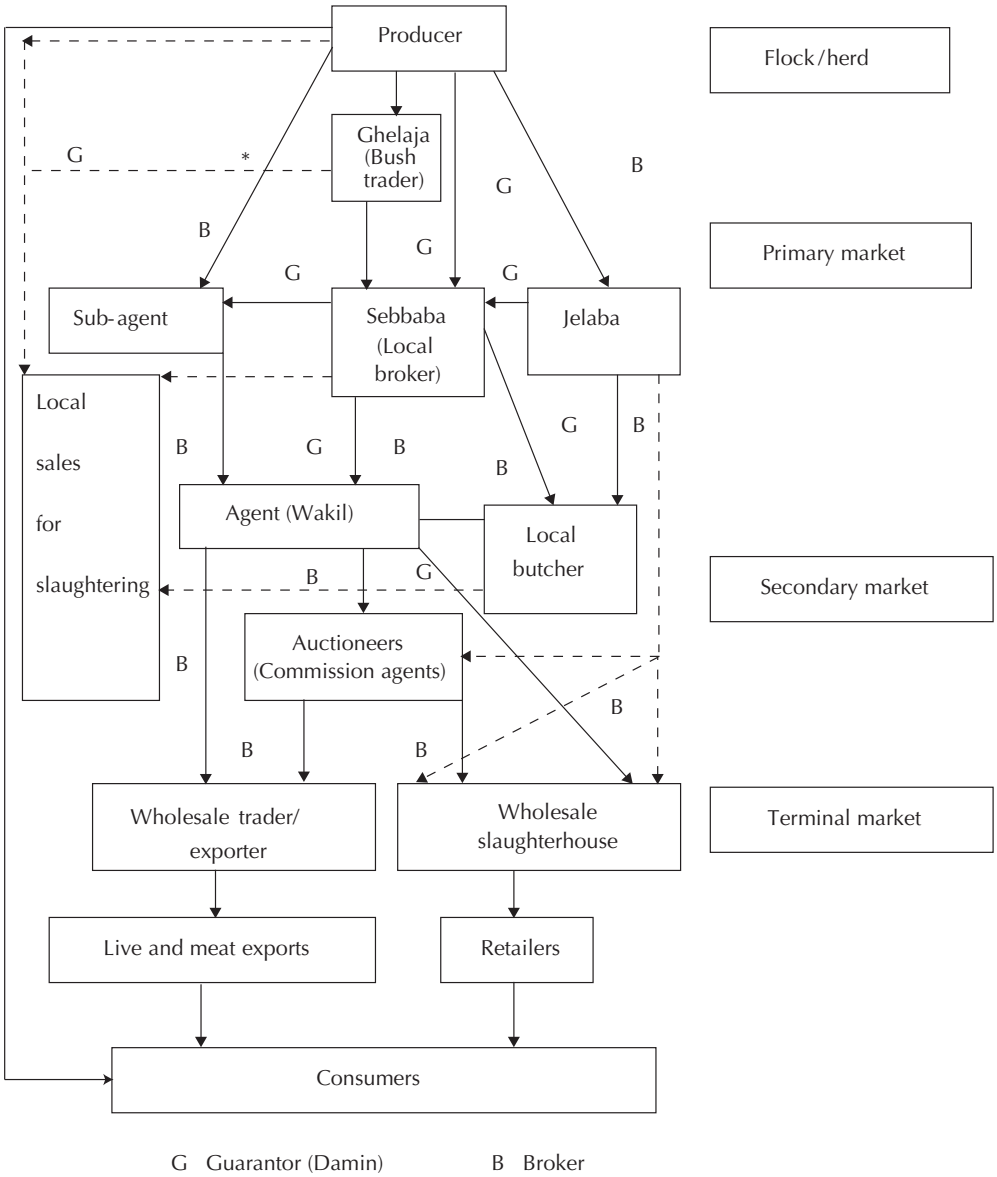


Figure 5. *A general schematic diagram of the sheep and goat market chain in Sudan.*

The supply chain is characterized by many intermediate stages, with transaction costs being taken up mostly by intermediary traders and brokers (FAO 1997). Most trading is done by private treaty, with the exception of large numbers of sheep intended for export which are sold by private auction at primary, secondary or terminal markets. Resale in the same market on the same day is common, and animals may be fattened or reconditioned before resale. The following descriptions of the various market intermediaries are based on surveys carried out in 2005–06 and personal observations. For more details, see el Dirani (2007).

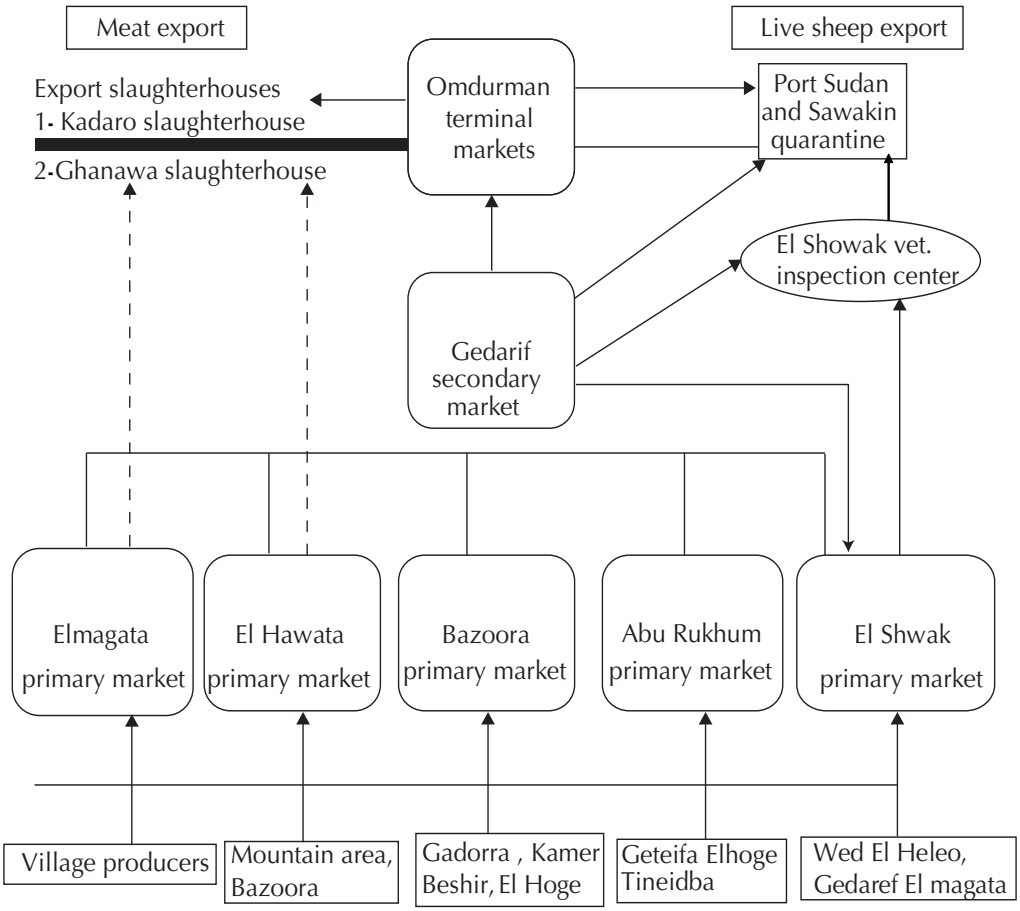


Figure 6. *Sheep marketing channels in Gedarif state.*

Ghelaja (bush traders): These agents purchase animals directly from producers at grazing areas, villages or primary markets and sell the animals to local brokers (*sebbaba*) at primary markets. Their revolving funds for purchases do not normally exceed SD 100,000 (USD 435), enough to buy only about 10 sheep.

Sebbaba (local brokers): There are three categories of sheep *sebbaba* in Sudanese livestock markets, according to the roles they play in the transaction. The first category of *sebbaba* purchases sheep either from *ghelaja* or directly from producers at the primary market. They then sell the animals either at another primary market or at a secondary market. Their capital is about SD 500,000 (USD 2174). Although they are called 'local brokers', they are also traders in the sense that they purchase animals from one market and sell in another market or in the same primary market. However, at the primary markets they are called *sebbaba* because they mostly act as brokers and act as a link between buyers and sellers.

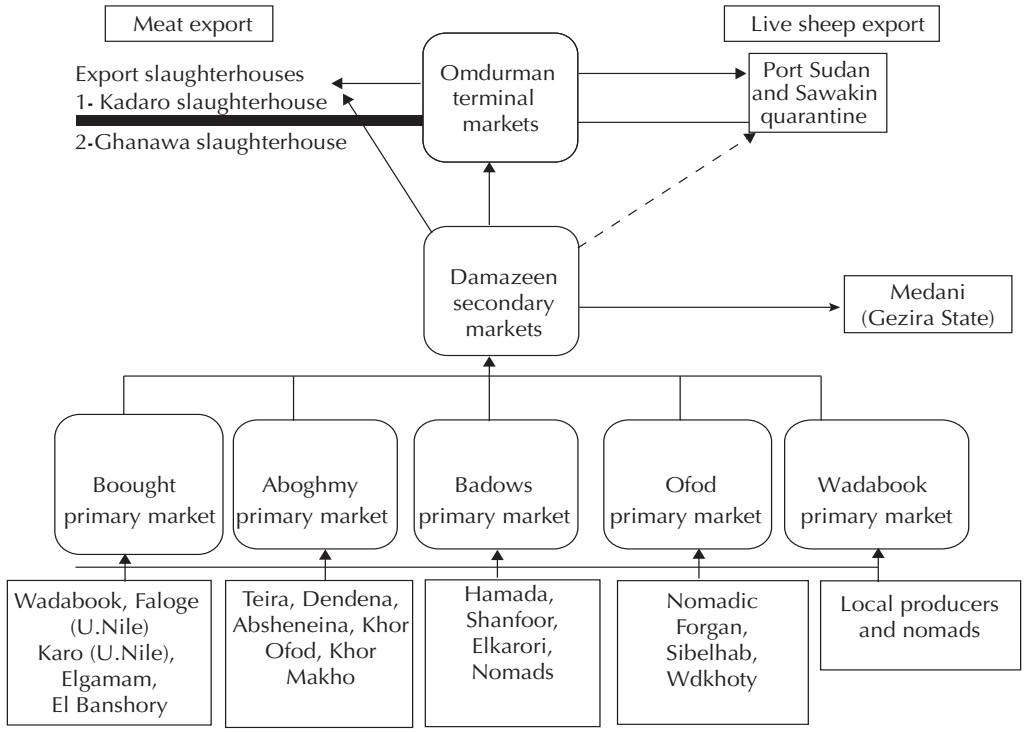


Figure 7. *Sheep marketing channels in Blue Nile state.*

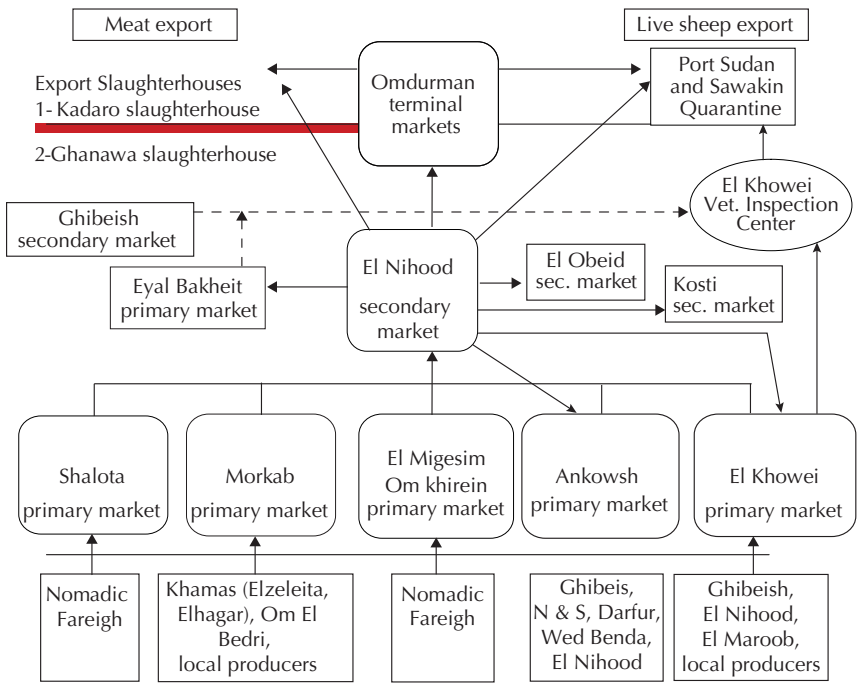


Figure 8. *Sheep marketing channels in West Kordofan state.*

The second category of *sebbaba* operates at primary, secondary or terminal markets. They are classical brokers or typical middlemen involved in all transactions between sellers and buyers along the market chain. The majority do not have working capital and are paid a commission based on the number of animals or herds handled.

The third category of *sebbaba* is also called *kaggir*. These brokers buy animals at a nominal fee or acquire the animals without paying a fee. Transactions by this category of brokers are relatively fewer and account mostly for domestic demand.

Jellaba (suppliers): They purchase animals from remote production areas and bring them to the terminal markets for live sheep export. They may work in partnership with sheep exporters and wholesalers. They are speculative traders who buy and sell livestock with the main aim of profiting from price fluctuations.

Damin (guarantor): The *damin* provides a guarantee to the buyer that animals offered for sale are not stolen and that the seller is known by tribe. Each tribe has a guarantor. They are present in all livestock markets in the Sudan with high concentration in production areas. They also provide services for livestock owners, providing credit for managing and accommodating animals, and sometimes advice producers as to whom they can sell on credit basis. To operate in the market, they must have a valid licence from local authority. They charge a fee of SD 100 per head (USD 0.4).

Wakil (agent): Agents act only as representatives of their clients; they do not own the animals they handle. They receive their income in the form of fees and commissions and provide services to buyers and sellers. Often, the main service they provide is market information and the linking of buyers and sellers.

Dallallein (auctioneers): They arrange for terms of sale of the animals, receive the payments, deduct their fees and transfer the balance to the owners. They influence the supply of sheep to Omdurman terminal market and the price determination. At secondary markets, they have the same function, but with relatively less influence. The role of the different actors in the livestock market chain is summarized in Table 9.

Table 9. *Livestock market actors and functions by type of market in the Sudan*

Type of market	Market actors	Function
Primary	Producers	Sell, purchase and resell
	Ghelaja (bush traders)	Sell, purchase and resell
	Local butchers	Purchase for local slaughter
	Wakil (agent/subagent)	Purchase for export
	Jellaba (suppliers)	Purchase and assemble
	Sebbaba (local broker)	Purchase, sell or mediate
	Brokers (*semsar*)	Commissioned middlemen
Secondary	Local butchers	Purchase for local slaughter
	Wakil (agent/subagent)	Purchase for local slaughter and/or export
	Jellaba (suppliers)	Sell/or purchase and assemble
	Sebbaba (local broker)	Purchase, sell or mediate
	Brokers (*semsar*)	Commissioned middlemen
Terminal	Local butchers	Purchase for local slaughter
	Wakil (agent/subagent)	Purchase for sheep export
	Jellaba (suppliers)	Sell for domestic consumption export
	Brokers (*semsar*)	Commissioned middlemen
	Sebbaba (local broker)	Purchase, sell or mediate
	Small traders	Purchase and sell to big traders/consumers
	Big traders	Purchase and sell to live sheep exporters
	Big auctioneers	Sell to live sheep exporters

Source: Adapted and modified from Solomon and Nigussie (www.fao.org/wairdocs/ilri/) by el Dirani (2007).

3.4 Physical movement of traded sheep from producers to market outlets

The pattern and mode of movement of sheep from production areas to domestic or export market outlets depends on the season and the age, sex and condition, and quality of the animals. In the Sudan, livestock are mostly transported by road in trucks, rail, trekking on hoof or by boat. The road and railway networks are relatively well established throughout the country. The paved road from el Nihood through el Khowei to el Obeid is connected to Omdurman and Port Sudan and Sawakin (export outlets). However, the high cost of transporting animals from production to consumption areas by road or rail is still one of the major constraints facing the sheep industry, occasioned by the high cost of fuel. The lowest cost option for livestock transport is by trekking the animals during winter or the rainy season, but not in the dry season when there is high mortality and weight loss. Improving the railway infrastructure by introducing additional power locomotives and double deck wagons would help to enhance the supply of animals from production areas to markets.

3.5. Quality and safety assurance system for export trade

The quality assurance activities in the export chains for live sheep and lamb are shown in Figures 9 and 10, respectively.

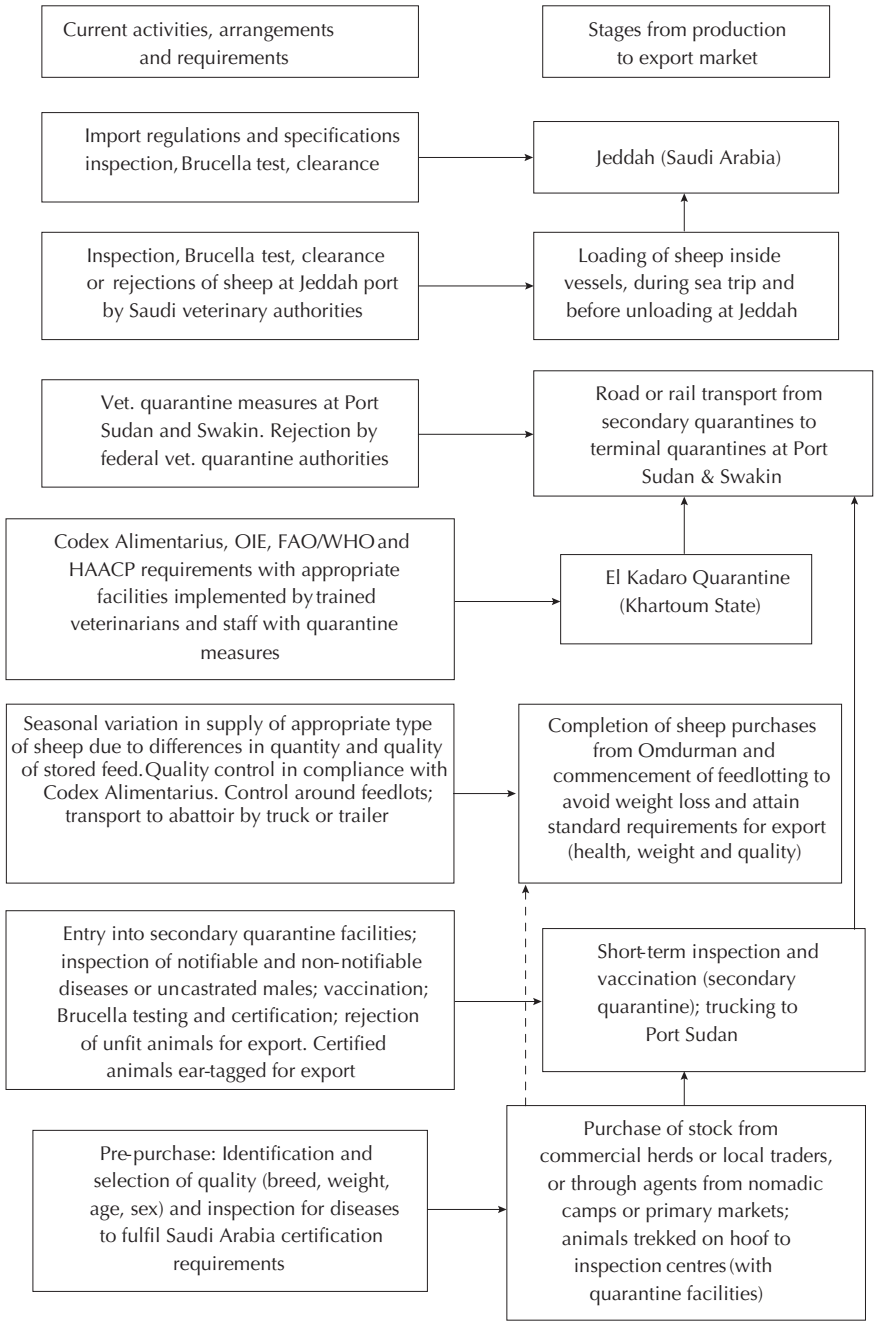


Figure 9. *Quality assurance activities in the Sudanese live sheep export chain.*

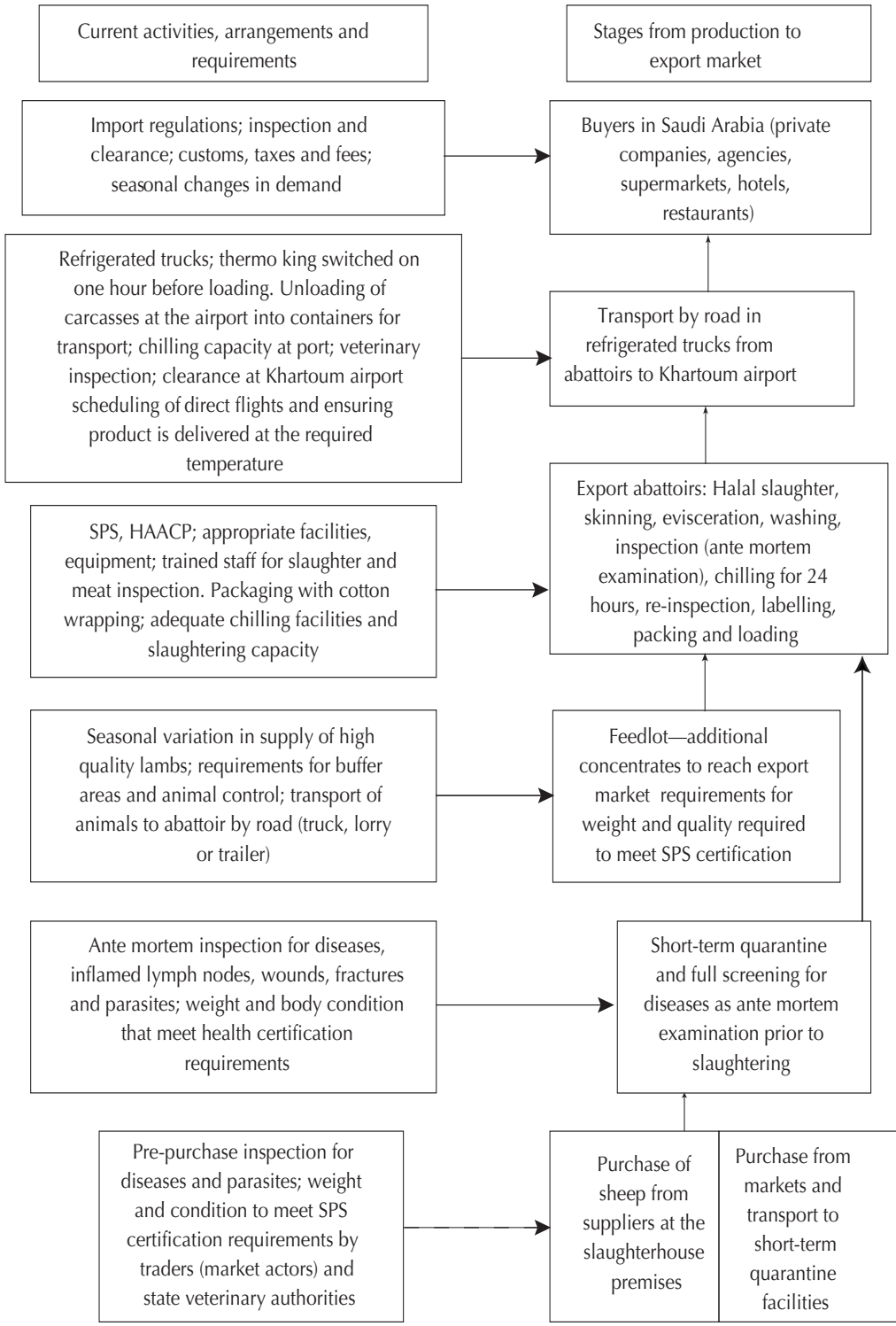


Figure 10. *Quality assurance activities in the Sudanese lamb export chain.*

3.5.1 Quality indicators at producer level

Most producers offer sheep for sale to meet their urgent needs at any time during the year. Some producers have started to supply sheep according to seasonal variation in demand and select the appropriate type of sheep according to function (Hajj, Ramadan or vacations). Although they are not market oriented and do not produce for the market, yet they select from their herds based on their need for money, and the type of demanded animal. Recently, some producers of sheep in Kordofan have developed the system of purchasing small lambs (50–100 animals at a time), maintaining them for 2–4 months within the breeding herd and offering them for sale. Some of them are self-financed (usually by selling culled stocks), others by obtaining loans from traders (and sharing 50% of the profits).

Animal characteristics in terms of health, quality, safety, productivity and other criteria required by importers are well known to traders and exporters and less so to producers, who get information on demand characteristics from the traders. Sheep meat exports to the Middle East from different countries, except Sudan, have historically been in the form of frozen carcasses. With improvements in technology, the market now expects chilled lamb cuts and carcasses for the growing food industry, restaurants, and retail sectors. The Middle East markets have a preference for sheep carcasses in the range of 8 to 12 kg carcass weight, because of a perception that the smaller the lamb, the younger the animal. As for live sheep, the local sheep breeds in Saudi Arabia—the 'fat tail' Harri, Nagdi and Awassi sheep—produce light and lean lamb carcasses that are considered to be of highest quality and so receive the highest prices in the market. Saudi market has a preference for Sudanese live sheep within the range of 35 to 45 kg live weight. The best quality is demanded mainly during Hajj and for religious purposes and the second-best quality is demanded throughout the year. The animals should be no more than three years of age (three pairs of permanent incisor teeth) unless otherwise specified in the import permit.

Exporters reported that lamb meat quality indicators preferred by Saudi importers are age from 4–6 months and up to 12 months, weight range between 9–12 kg carcass weight, wide chest and fat. Sometimes, importers request heavier weight range of 18–21 kg carcass weight. The carcass should not have contusions or spots, should be white (marbling appearance), labelled with date of slaughtering, stamped and wrapped in light cotton cloth.

Against the above requirements and preferences in the Saudi market, the type of sheep and sheep meat available and supplied by producers and traders in the Sudanese market are described in Table 10. There are three different qualities of live sheep differentiated by breed (or type, as scientific classification of breed is often absent but animals have local names recognized in the Saudi market), live and carcass weight, and best quality sheep meat is defined by carcass weight, fatness and compulsory halal slaughter.

Table 10. *Quality indicators of Sudanese live sheep and sheep meat for export*

Products	Quality indicators
High quality live sheep	1. (a) Desert or pure breed animal (Hammari, Kabashi, Zaghawi, Meidoub, Wateish, Rofa'a, Ashgar, Butana, Dubasi)
	(b) Heavy weight (45 kg live weight, 17 kg and above carcass weight)
Medium quality live sheep	2. (a) Cross breeds (Desert × Nilotic) × Desert = Shawrani; Desert × Zaghawi = Shawrani)
	(b) Medium weight (35 kg live weight, 13–16 kg carcass weight)
Low quality live sheep	3. (a) Cross breed (Garage : Baggara type)
	(b) Light weight (25 kg live weight)
High quality lamb meat	4. Halal meat, fat carcass, 11.5–12.5 kg carcass weight, removal of specific parts. Three types are identified: i) fat and lean; ii) freshly killed and chilled; iii) importing country consumers' preference demand

Source: Traders survey data (2005).

The three states surveyed in this study supply several breeds preferred in the Saudi market as described above. For example, Hamari is the most common breed in West Kordofan, White is the dominant breed in Blue Nile, and Abrag and Ahmar are the dominant breeds in Gedarif (Table 11). It should be recognized, however, that some breeds or types of sheep may be found in more than one state and some breeds/types move across states due to seasonal migration or due to location of a major primary/secondary market whose supply hinterland goes beyond state boundary. Therefore, absolute dominance of a breed in a state may not be permanent during the whole year, though a breed /type might have originated in a specific state. For example, Ghebeish livestock market in West Kordofan is considered to be number one and most famous primary market in the Sudan for Hamari sheep, dominant breed in the state, but the market also receives other breeds or types such as Zaghawa sheep, called locally as Showrani from East and North Darfur States.

Table 11. *Dominant sheep breeds (or types) in three states of Sudan*

Local name of breed	Rank of available sheep breeds in each state		
	Gedarif	Blue Nile	West Kordofan
Hamari	–	–	1
Abrag	1	3	–
White	2	1	5
Ashgar	2	4	3
Ahmar	1	2	–
Kabashi	–	–	2
Asfar	3	4	–
Zaghawa	–	–	4
Garage	–	–	4

Note: White is also called Wateish, Rofa'a, Shebeilat, Kenana; Abrag is also called Musalami, Dubasi; and Ahmar is also called Kenana.
Source: Traders survey data (2005).

Apart from breed, sex, weight, and colour, the other most important quality criteria are related to health and diseases. Although Sudan has a disease free zone in the north of the country, incidences of some diseases, especially trade related (transboundary) diseases are high in some production areas that supply export animals. Village and household/flock level surveys in the three states provided data for incidences of diseases and mortality for 2003–05. The following patterns in disease incidence emerged from responses of sample producers.

First, in group interviews in village level surveys, sheep pox, PPR and heartwater and poisoning were reported as the most important diseases in the past three years (2003–05) prior to the survey (Mohammed 2006).[4]

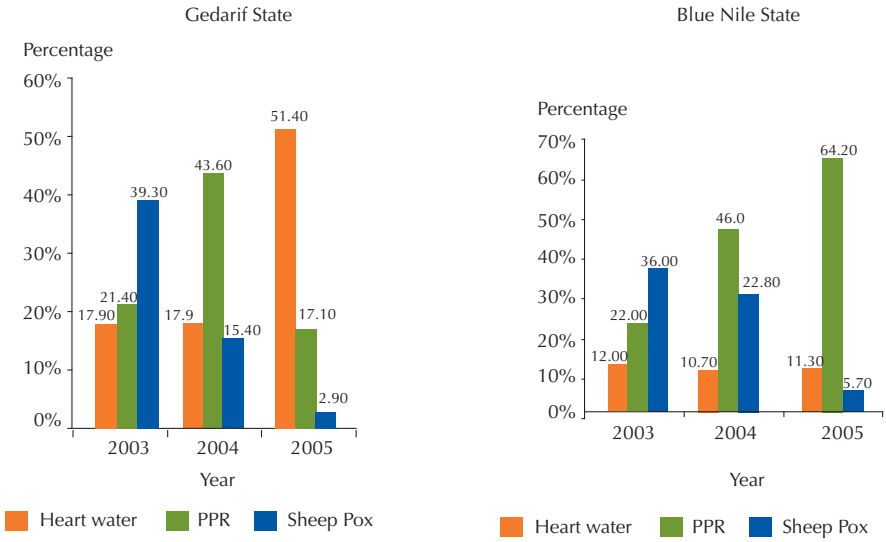
Second, flock/household level surveys showed that in each state, predominance of diseases varied between years (Figure 11). In Gedarif state, sheep pox, PPR and heartwater were the most important diseases in 2003, 2004 and 2005 respectively. Incidence of sheep pox declined but that of heartwater increased over time, while incidence of PPR increased in 2004 then decreased in 2005. In Blue Nile, incidence of sheep pox declined over time and that of PPR increased, but incidence of heartwater remained stable at a lower level in all the years. In West Kordofan, incidence of sheep pox declined slightly over time from a high level, while the incidence of poisoning was very important and incidence of pneumonia increased in 2004 and 2005. The incidence of major diseases was higher in the dry season (Figure 12). Also there was difference in the incidence of diseases according to system of management of flocks. Among the sedentary flocks, incidence of major diseases was evenly distributed. Among seasonally migrant flocks, PPR was the most important disease, followed by heartwater, then sheep pox. Among nomadic flocks, sheep pox, PPR and poisoning were major diseases.

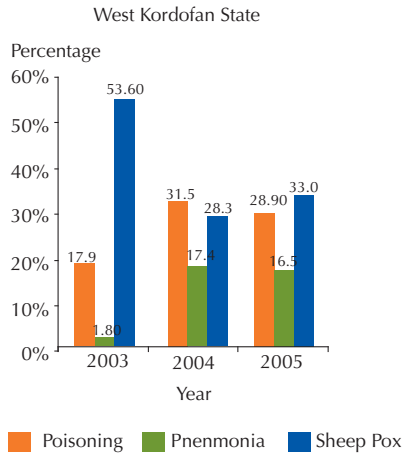
Third, CCFR was very high in case of all the four major diseases—sheep pox, heartwater, PPR and poisoning—and they varied between the years (Table 12). CCFR was higher among goats than sheep in case of PPR and heartwater.

Fourth, as the reported incidences were based on local names or symptoms, so there was room for error in reporting and recording disease names. In order to validate the reported incidences, serum samples were collected from small ruminants from selected flocks in the survey areas to test incidence of heartwater and PPR. Results of serum analysis for heartwater conducted on samples from 320 animals showed that 98%, 93% and 12% of the animals tested positive in Gedarif, Bluer Nile and West Kordofan. In case of PPR, 600 serum samples were tested, and respectively 29%, 69% and 68% of samples in Gedarif, Blue Nile and West Kordofan tested positive. Sero-positve cases were higher among goats than sheep,

4. In village and flock level surveys, reported diseases were recorded on the basis of local disease names or symptoms mentioned by the respondents and later converted into standard scientific names by the survey enumerators on the basis of guidance on equivalent chart. The local names are given in Appendix 1.

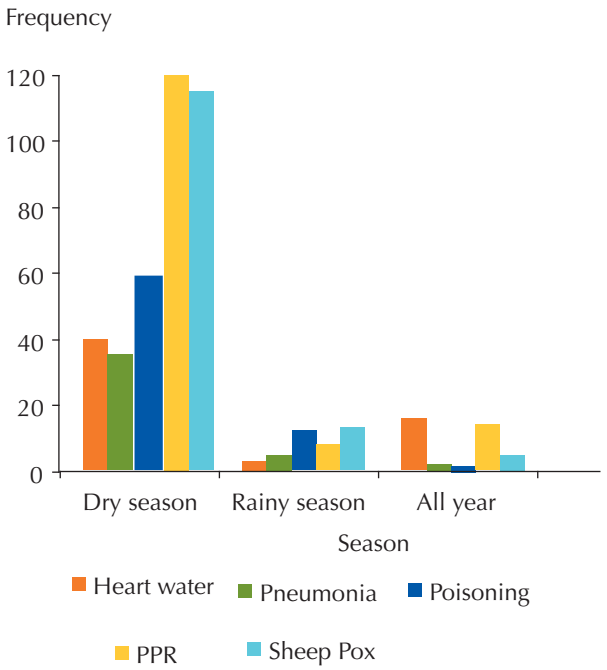
indicating that goats were more vulnerable to these two diseases than sheep. Thus, even though the reported and serum tested figures for incidences were not exactly the same, the serum tested figures are quite close to the survey results for PPR and heartwater, which confirms observation of Mariner and Paskin (2000) that farmers are a rich source of practical agricultural knowledge and the extent of knowledge is usually related to the degree of economic dependence a society has on that activity (Mohammed 2006). The validation tests also confirmed that surveys could generate fairly reliable statistics on disease incidence in a short period when lack of time and resources may not permit collection of serum samples and conduct rigorous laboratory tests.





Source: Mohammed (2006) based on producer survey 2005.

Figure 11. *Incidence of major diseases in three states of Sudan, 2003–05.*



Source: Mohammed (2006) based on producer survey 2005.

Figure 12. *Seasonal incidence of major diseases in three states of Sudan, 2006.*

Table 12. *Crude case fatality rates for diseases reported by household respondents in Sudan as important during 2003–05*

Diseases	2003		2004		2005	
	No. of animals affected	CCFR %	No. of animals affected	CCFR %	No. of animals affected	CCFR %
PPR	635	35	3160	48	4400	34
Sheep pox	2845	24	2694	26	2969	40
Heartwater	167	42	522	34	1886	40
Foreign body	31	52	0	na	22	82
HS	15	100	175	44	177	64
Botulism	40	70	75	65	20	65
Arthritis	0	na	35	63	2	0
Diarrhoea	94	96	94	96	108	57
Poisoning	301	60	692	83	289	84
Mastitis	20	0	107	61	0	na
Avitaminosis	0	na	5	0	100	60
Pneumonia	63	24	59	12	222	41
Nonspecific	248	17	70	67	38	92
Total	4459	30	7688	43	10233	39

CCFR: crude case fatality rate; HS: haemorrhagic septicaemia; PPR: peste des petits ruminants.
Source: Mohammed (2006) based on producer survey 2005.

A major reason for high incidence of diseases and high mortalities, especially fatalities in case of major diseases, is poor use of veterinary services. A summary of responses of the sample producers on their felt need for veterinary services and actual use of services from various sources is given in Table 13. In all, 60% of the sample households felt the need for any veterinary services once or more times during the year prior to the survey, but only 44% actually used any services from one or more sources one or more times. Only 31% of the entire samples used government veterinary services, 10% used private veterinary services, 16% depended on the prescription or advice of drug sellers, 3% used the services of community animal health workers (CAHW), and 10% used traditional medicine. Apart from seeking the services of others, 93% of the sample households themselves prescribed drugs and bought from the market. The average frequency of self-prescription was about three times more than services sought from other sources. Sixty-two percent of the sample households felt that they had enough knowledge and experience to prescribe drugs themselves for their animals, a situation that needs careful consideration as indiscriminate and improper use of drugs may create long-term problems for overall disease management and treatment of diseased animals in the country.

Table 13. *Proportion of sample households in Sudan according to use of veterinary services from different sources during the year prior to the survey*

	% of sample households by number of times a service was used			
	0	1–3	4+	All
Felt the need for any veterinary service during the past year	40	44	16	100
Actually used veterinary service from a source	56	34	10	100
Used government veterinary service	69	29	2	100
Used private veterinary service	88	8	4	100
Subtotal government and/or private veterinary service use	63	29	8	100
Used drug sellers' advice	84	10	6	100
Used community Animal Health Workers	97	2	1	100
Subtotal paravet or dug seller use	83	10	7	100
Used traditional medicine	90	8	2	100
Used own prescription	7	24	69	100

Source: Household survey data (2005).

Among the three states, the extent of use of veterinary services was significantly higher in Gedarif and Blue Nile than in West Kordofan. The extent of use was also higher (not statistically significant) among households with mainly crop or crop and livestock as equal source of livelihood compared to households with livestock as the only or main source of livelihood. Extent of use was higher among sedentary households (not statistically significant) compared to nomadic and semi-nomadic households but there was no significant difference between households who sold animals at a market place compared to those who sold in the village or camp.

A major reason for low use of professional veterinary services is poor access to personnel and facilities as indicated by distance of facilities from households and one way travel time by the fastest or most common means of travel (Table 14). For example, the nearest veterinary health outpost or veterinary assistant is over 40 km away for about 50% of the sample households in Gedarif, 27% in Blue Nile and 33% in West Kordofan. Most of these facilities are also managed by inadequate number of staff, with poor qualifications. For example, in Gedarif, out of 150 staff, 32% have a graduate or above degree, 13% have a diploma or certificate and 55% are CAHW with short-term training. For Blue Nile, out of 76 staff, 34% have a graduate or above degree, 15% have a diploma or certificate and 51% are CAHW with short-term training. So each staff has to cover a large area and large livestock population. For example, in Gedarif, each qualified veterinarian with a diploma qualification or higher covers 1123 km^2 and 41,269 head of ruminant livestock (sheep, goats, cattle and camel). The corresponding figures are 502 km^2 and 18,433 head of animals if CAHW are also added to the staff list. In Blue Nile state, each veterinarian covers 1719 km^2 and 156,378 heads of livestock, and the figures are 1111 km^2 and 90,535 head of animals when CAHW are added to staff list. The situation in West Kordofan is even worse. These staff : animal number ratios are too unfavourable when compared to the recommended ratios of 30,000 head of animals per qualified veterinarian for developing countries (WHO/FAO 1965 quoted in Hassan 2006).

Table 14. *Average distance and travel time to neatest veterinary facilities from households/flocks in the three states of Sudan*

Nearest health facilities from household/flock	Gedarif		Blue Nile		West Kordofan	
	Distance, km	Travel time, hrs	Distance, km	Travel time, hrs	Distance, km	Travel time, hrs
Health outpost or veterinary assistant[a]	39 (23)	1.3 (0.9)	29 (40)	3.1 (6.1)	33 (27)	2.3 (3.1)
Veterinary clinic with qualified veterinarian[b]	41 (24)	1.4 (0.8)	73 (55)	3.6 (4.9)	35 (27)	2.3 (3.1)
Diagnostic laboratory[b]	67 (54)	1.8 (1.1)	98 (53)	4.1 (4.6)	134 (29)	2.9 (1.3)
Drug store	35 (25)	1.7 (2.9)	41 (51)	2.7 (4.6)	34 (26)	2.1 (2.6)

Figures in the parentheses are standard deviations.
a. Travel time is one-way.
b. Average travel times in the three states are significantly different at <10% level.
Both differences in average distances and travel times between the three states are significantly different at <2% level.
Source: Producer survey data (2005).

Estimated losses due to diseases, taking into account morbidity, mortality and cost of preventive and curative treatments of affected animals, amounted to SD 176,276 (USD 766) per household per year for the entire sample, equivalent to the market value of about 10–14 head of sheep, which is quite large for many households whose livelihood depends on such animals. Of the total loss, 74% occurred due to the loss of animals and 18% due

to cost of veterinary services and drugs (Table 15). Of the overall loss, 21% occurred due to PPR related causes, 10% due to heartwater related causes and 69% due to other diseases. The overall consequence of diseases and health costs was reduced supply of better quality animals in the export market.

Table 15. *Value of losses per household per year (2003–05) due to livestock diseases in Sudan*

Causes of loss	Loss due to all diseases	
	Value (SD)	%
Value of dead animals	129,976	74
Value of production loss (milk, weight loss, lower sale value)	14,551	8
Cost of drugs, vaccines and vet services	31,749	18
Total	176,276	100

Note: USD 1 = SD 230.
Source: Producer survey data 2005.

Results of the best-fit equation to explain variation in the level of expenditure on veterinary services and drugs are summarized in Table 16. The significant negative intercept of the equation is consistent with the fact that over 60% of the households did not use any professional veterinary service, though some of them might have incurred some cost through buying self-prescribed drugs. There was no significant difference in the average level of expenditure per household between the three states, between households with livestock as the only/major or minor source of livelihood or between systems of production. Level of expenditure increased significantly with the proportion of household income derived from livestock, with increase in the size of flock, with longer distance to the nearest drug store, with increase in the number of times drug was purchased on the basis of self-prescription, and with increase in the number of times professional veterinary service was sought. Theoretically, livestock as a source of livelihood, flock size and rank of income from livestock could be correlated, but they were not in this sample. Alternative specification of the equation excluding one or two of these three variables worsened the model fit, so the estimated coefficients in the best-fit equation are considered unbiased.

3.5.2 Quality indicators at markets

The different health, safety and quality criteria the traders consider when purchasing sheep and goats are basically to avoid diseased animals as reported by 21% of traders at primary market level and 38% at secondary market, and they select fat animals as reported by 44% at primary market level and 34% at secondary market level (Table 17). Collection of information from market managers including veterinary inspectors, revealed that most common diseases for which animals were barred from sale by veterinary inspectors at the primary and secondary markets in the three states are heartwater, PPR, jaundice, sheep pox, severe emaciation, pneumonia, generalized mange, trypanosomosis, and recently foreign

bodies in heavy export quality sheep—especially in West Kordofan State (Table 18). At el Salam terminal market in Omdurman (Khartoum State), diseased animals (such as these having emaciation, diarrhoea, pneumonia and severe cases of mange) are usually bought by specialized traders. They cure and fatten them for reselling in the terminal market. Thus major diseases for which animals are screened at various points in the market chain are also the major diseases prevailing at the producer level. In addition to diseases, other physical conditions and criteria are used to screen animals in markets to assure quality and safety.

Table 16. *Estimated coefficients of variable explaining level of expenditure on veterinary services and drugs in the three states of Sudan (using GLM procedure in SPSS)*

Independent variables	Estimated coefficients
Intercept	–66231.70** (2972.96)
State dummy (West Kordofan = 0)	
Gedarif	15740.43 (14067.66)
Blue Nile	3458.31 (11698.11)
Livestock only or main source of livelihood (yes = 1, no = 0)	16179.10 (13056.61)
Production system (nomadic/semi-nomadic = 1, sedentary = 0)	–13465.36 (11024.68)
Rank of livestock in total household income (highest score = 10 when livestock is the only source)	4447.28** (2229.684)
Flock size	198.961*** (52.882)
Distance to nearest drug store (km)	321.629* (189.273)
Have enough experience to prescribe/buy drugs yourself (yes = 1, no = 0)	18958.79 (21639.29)
Number of times drugs bought on own prescription	1578.646*** (546.143)
Number of times professional veterinary service used in the year	2932.387** (1568.059)
Number of times paravets service used in the year	–482.405 (1455.071)
Distance from household/flock to the nearest health outpost/veterinary assistant (9 km)	–113.377 (4465.475)
Distance from household/flock to the nearest veterinary clinic (9 km)	–207.980 (425.266)
Age of household head (years)	2414.314 (3815.226)
Years of schooling of household head	787.964 (12964.39)
Land ownership (*feddan*)	–14.790 (14.603
R^2	0.41
Adj R^2	0.33

Figures in the parentheses are standard errors. ***, ** and * indicate significant at less than 1, 5 and 10% level.

At all market levels, about half of the traders (43–57% in the three states) do not target any specific breed for purchases, while the other half target specific breed(s) for purchase. This is so even at terminal markets, although at that stage sufficient screening should have occurred for traders to target animals of specific characteristics for export. The reason this does not occur is explained by the fact that when traders fail to get their animals accepted by exporters, they sell them at the domestic market, primarily in Khartoum, which is quite large.

Table 17. *Distribution of traders according to health, safety and quality criteria they consider at primary and secondary markets in Sudan when purchasing sheep and goats, especially for export market*

Type of market	Safety and quality criteria used by traders in purchase decisions	% of traders reporting
Primary	Selection of fat good general health and not emaciated	44
	Avoid animals with Pox, PPR, Fascioliasis, abscesses, sheep pox, mange, heartwater	20
	Avoid unhealthy, should be disease free	13
	Avoid cough and pneumonia	10
	Avoid jaundice disease	3
	Palpation points for fatness; tail, chest, back	3
	Purchase clean smooth glistening hair not rough coat (rough coat is a sign of internal parasites)	7
	Total	100
Secondary	Disease free and eliminate diseased animals, avoid abscess	38
	Select fat and good shape animals, good general health and appearance condition (active)	34
	Avoid mange, sheep pox, free from foreign bodies (Omderradim)	11
	Export market standards, pure breed and fat sheep, red or Ashgar coloured sheep, smooth hair coat, select 12 kg carcass wt.	16
	Total	100

Source: Traders survey data (2005).

Table 18. *Rank of most common diseases for which animals were barred by veterinary inspectors from selling at the primary and secondary markets in the three states of Sudan as reported by traders*

Diseases	Rank by State		
	Gedarif	Blue Nile	West Kordofan
Heartwater	1	1	3
PPR	1	2	–
Jaundice	2	2	–
Sheep pox	–	–	1
Emaciation	–	4	1
Pneumonia	3	3	2
Foreign body	–	–	3
Trypanosomosis	–	–	3
Mange	–	4	3

Source: Livestock markets survey data (2005).

There is specialization in trade activities in the markets in three states. Some traders purchase small lamb of 11.5–12.5 kg carcass weight or the slaughter type of sheep for lamb meat export. Others specialize in live sheep for Hajj export of 13–16 kg live weight. Final category of traders is the non-specialized group; they prefer to purchase all ranges of weight (Table 19). It appears that about half of traders in West Kordofan are specialized in the 17 kg and

above (for live sheep export), Gedarif in the slaughter sheep meat export of 11.5–12.5 kg carcass weight and Blue Nile in all ranges of weight. When preferences of traders in primary and secondary markets are compared, it appears that 43% of primary market traders buy animals of all weight ranges, while 31% of secondary market traders do so; other traders buy animals of specific weight. This means that screening of animals for specific characteristics is less prevalent at the primary market and screening gets tighter at higher points in the market chain, which would be normally expected.

Table 19. *Preferred sheep weight by traders for their purchases (in kg carcass wt) in primary and secondary markets in three states of Sudan*

State	% of traders with preferred sheep weight (kg carcass weight)				
	11.5–12.5 kg	13–16 kg	17 kg and above	All ranges of weight	Total
Gedarif	50	19	19	12	100
Blue Nile	24	19	9	48	100
Western Kordofan	5	21	42	32	100

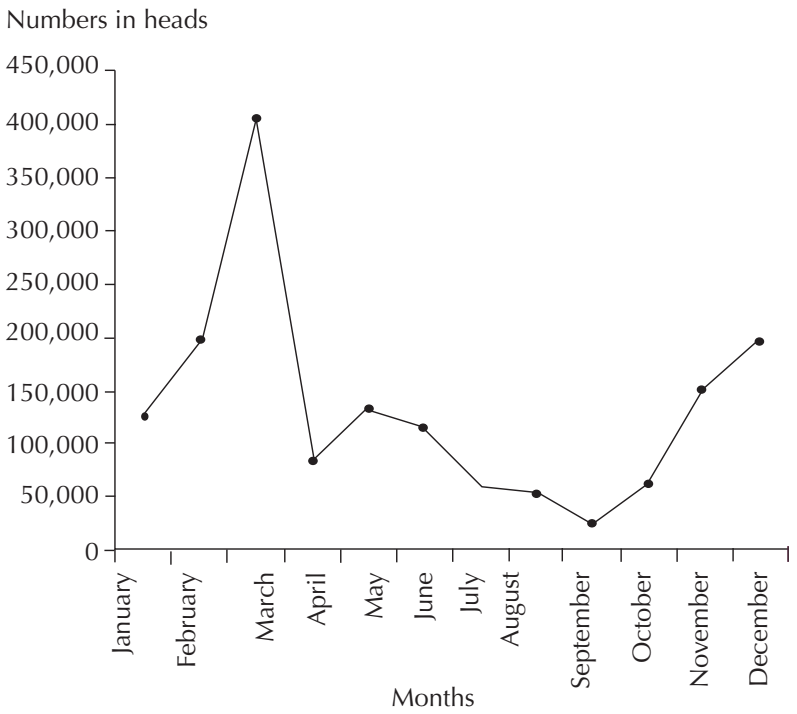
Source: Traders survey data (2005).

Well-established traditional exporters tend to purchase and manage animals through three channels. The first channel involves purchase of mature stock, either from commercial herds or from local traders or collection through agents from nomadic encampment or primary and secondary markets. The second channel involves purchase from Omdurman terminal market, either ready for shipping or needing few days for finishing. The third channel involves purchase by a system called Tabbieet (or keeping animals for more than one season). There are two categories of sheep handled by Tabbieet: the first is the purchase of young lambs (4–6 month of age) at a very low price after the rainy season and keeping them for 6 months at the natural grazing areas, then exporting them. The second type of purchase is the emaciated sheep but otherwise fulfilling other export quality criteria, during the dry season and keeping them till the rainy season. Exporters' arrangements are basically to fulfil the importers seasonal demand as shown for 2004 in Figure 13. The peak season usually occurs from December to March.

3.5.3 Inspection and certification for quality assurance

Different levels and actors are involved at various points in the export chain from primary market up to the port in Saudi Arabia for inspection and selection for quality assurance and certification for live sheep export. At each level, there is inspection and selection criteria, indicated in terms of phonotypical characteristics of sheep, diseases related requirements and regulatory requirements (Table 20). For meat export, Khartoum airport and any other export ports for meat (e.g. Nayala), export slaughterhouses, inspection and vaccination centres are involved in addition to inspection at livestock markets. There are two major bodies through which inspection and selection for quality assurance and certification of export sheep is

performed. The first is the exporter (a private sector enterprise or a company). The second is the Federal Ministry of Animal Resources and Fisheries (General Department of Quarantines and Meat Hygiene) playing its role through inspection and vaccination centres and veterinary quarantines.



Source: Ministry of Animal Resources and Fisheries.

Figure 13. *Monthly live sheep exports from Sudan (2004).*

The export enterprises or companies provide quality assurance through a number of steps and actions.

First, they screen animals at the time of purchase on the basis of a number of criteria. The purchase team observe and inspect animals individually by visual assessment (the action for inspection and individual observation is called Yarrigh) to avoid the following: *garage* (inferior quality), over aged (full permanent teeth > 4 years) or uncastrated, enlarged lymph nodes and abscesses, mange on nostrils or anywhere, infected wounds, scratches, diarrhoea, or any disease which cannot respond to fast treatment, or will leave a scar on the body, phenotypical abnormalities on sheep body or its limbs, and finally isolate females (ewes) immediately when observed.

Table 20. *Inspection and selection criteria for quality assurance and certification of Sudanese sheep exports at different points in the export chain*

Inspection/selection criteria		
Regulatory requirements	Disease related requirements	Phenotypic characteristics
Port Sudan and Sawakin Port for live sheep		
1. Veterinary inspectors issue international health certificates endorsed by higher veterinary official 2. SSMO issues quality certificates for sheep	Veterinary authority in quarantine to ensure completion of quarantine period. Veterinary inspectors with technicians perform inspection and checking four times, at entrance and departure of quarantine premises. During entrance to sea port prior to weighing and during loading inside vessels	1. Veterinary inspectors isolate emaciated and small animals 2. Exporters' agents perform their own judgment in isolating unsuitable quality
Saudi Arabia ports		
1. During Hajj a. Healthy and fat b. No abnormalities or deformities c. No tail docking d. No ear cut more than one-third e. Not less than six months old f. Average live weight 35 to 45 kg; all colours 2. Rest of the year a. Should be under 3 years of age. b. Castrated males c. Preferred colour is red or brick, but not white or black	1. Healthy and fulfilling veterinary requirements (vaccination and testing for *Brucella ovis*). This includes a list of epidemic and contagious diseases from which livestock must be free 2. Imported animals are subjected to inspection at the major ports of entry and health checks on every animal are very rigorous. Both physical and laboratory tests are performed	1. Slaughtered by Muslims and approved by accredited certifying authorities (certified Halal meat) 2. Must have the following documents: a. Authorized certificate of origin authenticated at the Saudi diplomatic mission and local chamber of commerce b. Authenticated invoice (in triplicate) stating the country of origin, name of the carrier, brand and number of goods, along with a description including weight and value; a packing list c. Bill of lading d. Documents indicating compliance with health regulations

Source: Ministry of Animal Resources and Fisheries.

Second, further screening on the basis of health specifications and indicators of good quality. The most important instruction guide here from exporter is to avoid purchases from infected areas or markets with diseases that affect the export flow. After the first visual assessment if inflamed lymph nodes exceed 5%, there should be individual checking of all animals in the flock when large numbers of sheep are offered for sale (e.g. 2000 to 5000). In inspecting inflamed lymph nodes, certain locations on the body should be considered, e.g. on the head (sub-mandibles), in front of the fore legs (supra scapular), genital organs, or any abnormal

apparent swelling on the body. The degree of good quality animals is indicated by the degree of fatness visually assessed, and a flock is usually considered of good quality if 85% or above of the flock is composed of fat animals. Another selection criterion is the colours preferred by the Saudis, which are red, brick, white and red; avoid colours which are not demanded, like black or white and black.

Third, special arrangements are made before purchases, such as the selection of a collection centre with water and pasture, away from agricultural crops and farms, to safeguard against weight loss, selection of good shepherds and drovers (honest and experienced) to take care of animals, provision of some essential veterinary drugs to deal with problems while on the road or on transit.

Fourth, use price as an indicator of quality. The purchasing team or purchasing officers should be acquainted with the cost of export quality sheep, from purchase area to export market, and the expected revenue after considering mortality and rejections. They should be acquainted with the prevailing prices in the supply hinterland, and also with supply and demand and movements of commercial flocks, the presence of other traders and their intentions and purchase policy, and to treat competitors wisely.

Fifth, accountability of the purchase team for delivery of quality animals. Purchasing team should be very strict in obeying the company instructions, especially on quantities to be purchased, prices and quality, together with keeping documents of each batch of purchases.

The Ministry of Animal Resources and Fisheries (MARF) performs several functions through the General Department of Quarantines and Meat Hygiene, Inspection and Vaccination centres and veterinary quarantines. Their role at the entry point of secondary quarantine facilities is the inspection for presence of notifiable or non-notifiable diseases, non-castrated males, emaciated and poor quality animals, and then vaccination. Finally *Brucella* testing is done, unfit animals for export are rejected, and then they issue certification. Animals are then ear tagged to identify state of origin to ensure good quality animal ready for export. In these actions, the role of appropriate agencies with appropriate facilities is to apply quarantine measures adopted from Codex Alimentarius (Sudan is a member since 1965), OIE, FAO/WHO measures and HAACP requirements. This is implemented by trained veterinarians. They continue re-inspection till the veterinary quarantine at export terminal point at Port Sudan and Sawakin. They isolate and reject animals at all levels till the point of loading vessels. Their activities are not only related to the health and veterinary requirements, but also market requirements such as the religious requirements in Saudi Arabia. During the Hajj period, animals have to meet conditions according to strict Islamic or Sharia law such as to be healthy and fat (not diseased, not emaciated, not having any abnormalities or deformities), no tail docking, ear cut no more than one-third of the ear, and not less than six months of age.

For live sheep exports, there are pre-purchase arrangements with importers, based on their requirements. The initial activity is started by a team of traders (who provide various services at cost), agents (*Wakil*) or subagents (who perform selection) and brokers (*Sebbabi*) for brokerage services and guaranteeing the animals' ownership. The team work, for the identification and selection of export quality sheep based on quality criteria (breed, sex, age, weight, and nutritional status) and exclusion of localities with disease outbreaks. Then stock is purchased, either from commercial herds or from local traders, or collected through agents from nomadic encampment or primary markets. Then they practice the visual inspection/screening of animals for diseases to fulfil the requirements of exporters and Saudi Arabia certification requirements. Animals are collected into groups and trekked on hoof by shepherds to inspection centres with quarantine facilities. This is done by traders, agents (*Wakil*) or subagents and brokers (*Sebbabi*).

The next activity is the entry of animals into the secondary quarantine facilities for inspection and certification by public veterinary services at a fee. Animals are screened for notifiable or non-notifiable diseases, non-castrated males and then they are vaccinated. Finally, testing for *Brucella ovis* and certification is done and ear tagged ready for export. At this stage, animals are kept at short-term inspection and vaccination centres (secondary quarantine) such as el Kadaro Quarantine (Khartoum State) or el Khowei (West Kordofan) or el Showak (Gedarif), then transported by road or rail transport to terminal quarantines at Port Sudan and Sawakin. During this journey, the accompanying labour (*gellab*) takes care of the animals for keeping them in the upright or standing position all the time, to avoid fractures and morbidity. At the terminal export point there is the veterinary quarantine measures at Port Sudan and Sawakin where further inspection for Brucella is done and positive cases are rejected as unfit for export.

Some exporters, in addition to purchases in the supply hinterlands, make additional efforts to purchase sheep already available at Omdurman terminal market and when required start feedlotting to avoid weight loss so as to reach requirements of standards for export (health, weight and quality). This option is prompted by seasonal variation in supply of the appropriate type of sheep to meet seasonal and functional requirement in Saudi Arabia, such as for Hajj, Ramadan or vacations, and the variation in quantity and quality of feeds available. Health control measures are adopted in compliance with Codex Alimentarius standards. During this activity, local authorities collect taxes and market fees.

Clearance of the shipment is done by presenting all the official documents of the concerned government bodies—Ministry of Foreign Trade, health certificate from veterinary quarantine, quality assurance from SSMO, certificate of origin from chamber of commerce, counting and weighting records from the Port Corporation. Apart from fees for the above documents and

certificates, other costs involved during this stage include water and feed, shipping agents for the preparation of appropriate sea transportation and preparation of loading manifest and bill of lading cost, the private clearance office fees, the drovers (*kullah*) cost to load the vessel. At this stage, there are some rejections of sheep due to observed deficiencies, such as poor health. After loading sheep inside vessels, some exporters load feed to be used during sea trip up to unloading at Jeddah to minimize weight losses, or in worst case if the entire shipment is rejected for some reason, feed will be required for the return journey.

Finally at Jeddah port in Saudi Arabia, the shipment is subjected to inspection by veterinary authorities in accordance with import regulations and specifications, including *Brucella ovis* test conducted on all animals before clearance for unloading. The Saudi Arabian Standards Organization (SASO) is responsible for establishing labelling guidance and these guidelines are strictly enforced. There are specific requirements for all exporting countries to Saudi Arabia, Jordan, Egypt and Syria. Whole shipments are sometimes rejected even though disease symptoms have been confirmed only in a few animals. A reason for this is that Jeddah port does not have quarantine holding facilities where animals can be held under observation (Ibrahim 2004). Only in 2006 Australia established quarantine in Jeddah for their animals.

As for Sudanese lamb meat export, export slaughterhouses usually purchase sheep from suppliers at the slaughterhouse premises and sometimes from markets, and transport to short-term quarantine facilities, before moving to export abattoirs. This involves shorter time and distance compared to purchases for live sheep export.

At the export abattoirs, there is halal slaughtering, then skinning, evisceration, washing, and ante-mortem examination. Then the carcass is chilled for 24 hours, re-inspected, labelled, packed and loaded inside refrigerated trucks with thermo king switched on an hour prior to loading. Carcasses are unloaded at the airport into containers for transport, then final veterinary inspection is done before clearance for shipping by air, based on schedule of direct flight from Khartoum airport to ensure that the product is delivered at the required temperature, i.e. chilled to 0ºC. Once the shipment reaches Saudi Arabian importers (private companies, agencies, private buyers for supermarkets, hotels, restaurants) at designated airport, it is subjected to import regulations, inspection and clearance.

3.5.4 Health services, facilities and delivery system

Today's primary policy focus is on livestock for trade and export—relating to a general concern to 'modernize' the sector, and boost production. This entails adopting a new approach to both livestock production and management and the delivery of animal health care and veterinary services to increase production and export. Potentially, this comes

at the expense of more simple initiatives to support productivity, breeding and disease management.

The local veterinary authority is the agency responsible for health certification at primary and secondary markets. But in 52% of the primary markets, there is no such service. The percentage of rejected animals from sale due to diseases during 2005 ranged from 1% to 5% in Gedarif and West Kordofan States and up to 10% in the Blue Nile State. These animals are sold locally at a lower price due to disease or defects. Some traders' response to the question on suggestions to improve veterinary services (inspection procedures and issuing health certificates) at the market included a need to establish veterinary clinics, drugs, inspection, and extension services. Others demanded vaccination and inspection units. In Gedarif State, they demanded that the vaccination and inspection should be done in Gedarif instead of el Showak where there is quarantine for export animals.

In terms of facilities and effectiveness of government veterinary authorities at the state level, the survey revealed that about 80% of the veterinary centres have microscopes and autoclaves, 70% have field treatment kits, 60% have stethoscopes and 20% of veterinary centres have liquid nitrogen containers (for artificial insemination). The laboratory facilities in the government veterinary centres are also deficient. Reportedly, no bacteriological, parasitological, toxicology, biochemistry or pathology tests were performed in these state laboratories during 2005.

Almost all the veterinary staff was fully aware of the rules and regulations with regard to animal health, food safety and quality, and that these rules and regulations are adequate and clear to allow proper inspection to ensure health and safety. However, only about 50% of them undertook livestock market inspections during 2005 and 90% of them issued certification for animals prior to slaughtering.

The most frequent sheep diseases outbreaks, according to veterinary centres' reports during 2005, were internal parasite, PPR and sheep pox. Suggested interventions include more vaccination cover, improved diagnostic facilities and extension services. From local veterinary authorities' point of view, improvement of veterinary services, infrastructure improvement and training were needed to better assure quality and safety of export animals. With regard to veterinary quarantine centres during 2005, the most important diseases or conditions for which animals were excluded during inspection for export certification were sheep abscess, local inflammation, mange, sheep pox and brucellosis, but these specific causes were not properly and systematically recorded in the inspection documents and only the number of animals rejected on a daily basis was recorded.

Rejected animals from the livestock markets were either sold outside markets at less than 50% of their market price, or were treated, if the cost was low, with veterinary drugs or local medicine plus additional feeding. Otherwise, they were condemned by veterinary inspectors if slaughtered.

3.5.5 Sanitary measures in export slaughterhouses

All animals need certification prior to slaughtering at the export slaughterhouses. The certificates are issued by Federal Veterinary Authorities, the Quarantine and Meat Hygiene General Department. If certified animals have health abnormality at the ante-mortem inspection, the procedure to be followed is rejection and condemnation at post-mortem inspection. The waste is managed at the slaughterhouses and drained through the drainage system. First, they are filtered to extract rumen contents and dispose them out of premises. Blood is collected in tanks and disposed of in Kadaro, Ghanawa and Sabalogha, but in GIMCO it is treated for use as poultry feed. The rest of the fluids is drained and treated in ponds (a system of water recycling) ending with clean water usable for agriculture, but usually wasted.

Health and sanitary conditions of export slaughterhouses are well looked after. Regular cleaning and flushing with water is done after each batch is slaughtered and disinfected with safe chemicals (e.g. quadrate ammonia) and, in some slaughterhouses, fumigation is a routine practice.

The reasons for rejection at ante-mortem of sheep are mainly because of the inflammation of lymph nodes, wounds, fractures and emaciation. The reason for total condemnation of sheep carcasses are mainly jaundice, generalized abscesses or spots and contusions. Recommended animal health related improvements to meet domestic market demand are the availability of water sources in some slaughterhouses and proper means of transport for live animals. For export slaughterhouses, the most important sanitary measures to be met according to importers needs are the infrastructure rehabilitation (additional cold stores and vacuum packing machines).

3.5.6 Constraints in the system of quality assurance for export

The step-by-step actions for quality assurance described above—checks and cross checks by both Sudanese authorities and exporters as well as Saudi authorities and importers—should provide adequate safeguards for delivery of good quality and safe products as required by the importers. However, in practice, there seem to be inadequacies in the system that lead to high rate of rejection of animals and meat at various stages in the export chains.

Records from primary, secondary and port quarantines and port authorities show that during 1997–2005, 30.7% of the animals offered for export were rejected at various points in the domestic portion of the export chain starting from the first quarantine'[5] and another 2.1% were rejected at the Jeddah port once the shipment was made (Table 21). At the Jeddah port, a whole vessel is rejected even when only one or two animals with unacceptable disease symptoms are detected. The rejected vessels indicated in Table 21 also had additional numbers of rejected goats and camels. Up to a maximum of 12% of goats and 3% of camels on these vessels were rejected in any one year compared to 4.6% for sheep.

Table 21. *Number of sheep rejected at various points in the export chains for Sudan, 1997–2005*

Year	No. inspected $\times 10^3$	No. exported $\times 10^3$	% rejected in-country	% rejected at Jeddah port
1997	2103	1750	16.8	na
1998	2783	2571	7.6	na
1999	3136	2133	32.0	na
2000	2057	1263	38.6	4.6
2001	400	15	*	*
2002	3517	2256	35.9	1.1
2003	3517	2016	42.7	2.2
2004	3092	2217	28.3	0.9
2005	2678	1701	36.5	3.2
Average excluding 2001			30.7	2.1

* Export ban on live sheep to Saudi Arabia and other Gulf countries.
Source: Calculated from MARF—Quarantine and Meat Hygiene General Department (monthly and annual reports) 2006.

Animals are moved from producers to the export point through inspection centres and quarantines. At each stage, animals are screened both visually and through laboratory test, especially for Brucellosis. Since specific causes of rejection are not recorded at the quarantine and inspection centres, in order to identify the specific causes of rejection, especially at quarantine centres along the market chain up to the export port, three steps were taken in this study. First, quarantine records of two primary quarantines in North Kordofan—el Khowei and el Rahad—were examined in detail, and actual veterinary inspection and tests conducted at those centres were observed on some days at random. Second, blood samples from these centres are normally analysed at the el Obeid laboratory. In order to validate the testing procedure and results of tests conducted at this laboratory, duplicate blood samples of a subset of animals tested at el Obeid on a particular day were taken for testing at the University of Khartoum Veterinary laboratory using the same reagent and technique, and the results from both laboratories were compared. Third, screened and

5. To be more accurate, any voluntary rejection by traders and producers before animals reach the first quarantine need to be added to find the final figure for rejection as a proportion of the animals offered for the export market.

certified animals from primary quarantines are transported to terminal quarantines at port Sudan and Sawakin, so quarantine records at Port Sudan quarantine centre were analysed in detail.

At the primary quarantine centres, rejection occurs at two stages. First, animals are screened based on visual assessment primarily looking for unacceptable phenotypic characteristics in the export market. Second, after initial screening, *Brucella* test is performed on all remaining animals and positive cases are rejected. Available quarantine records at el Khowei and el Rahad quarantine centres for 2002–06 are summarized in Table 22. On average, 4.3 and 3.0% of the screened/tested animals were rejected respectively at el Khowei and el Rahad centres for non-specific reasons. On average, another 0.26 and 0.36% of the animals tested respectively at el Khowei and el Rahad centres were found *Brucella* positive, and hence rejected for export.

Table 22. *Rejection rate of sheep according to cause at el Khowei and el Rahad quarantine centres in North Kordofan Sudan, 2002–05*

Year	El Khowei quarantine			El Rahad quarantine		
	No. of sheep tested	% rejected due to Brucella +ve	% rejected for non-specific reasons	No. of sheep tested	% rejected due to Brucella +ve	% rejected for non-specific reasons
2002	335,619	0.11	3.71	335,619	0.06	10.10
2003	463,445	0.12	12.66	463,445	0.06	3.25
2004	428,387	0.37	2.13	417,696	0.19	1.24
2005	504,683	0.12	5.47	476,470	0.79	0.85
2006	783,939	0.43	0.17	236,910	0.79	0.03
Total	2,516,073	0.26	4.34	1,930,140	0.36	3.02

Source: El Khowei Inspection and Vaccination Centre (North Kordofan State) 2007; and el Rahad Inspection and Vaccination Centre (North Kordofan State) 2007.

Since cause of rejection at the initial stage based on visual assessment is not recorded for individual animals or in a comprehensive manner, group discussions were held with the technical staff involved in screening and testing animals at the two centres, which provided a general pattern of causes for rejection. It appears that at the el Khowei centre, the reasons for rejection vary by type/breed of sheep. Hammari is rejected mainly for abscess, Kabashi due to abscess and mange and Zaghawa due to Mange (Table 23). On the other hand, at the el Rahad centre, noncastration and abscess are the main causes of rejection. Some of these rejected animals may also include *Brucella*-positive cases, but that is not evident at this stage as *Brucella* cannot be confirmed without laboratory test.

Table 23. *Percentage of inspected sheep rejected for various reasons by breed at the el Khowei inspection and vaccination centre in Sudan*

Reason of rejection	% of sheep rejected at el Rahad	% sheep rejected at el Khowei by type/breed		
		Hamari	Kabashi	Zaghawa
Abscess	30	85	40	2
Wounds	1	5	2	2
Mange	5	2	40	90
Diarrhoea	–	4	7	0
Emaciation	–	4	4	1
Lameness	–	–	7	–
Uncastrated	60	–	–	–
Others[a]	4	–	–	–
Total	100	100	100	100

a. Including diarrhoea, emaciation, lameness and pneumonia.
Source: El Khowei veterinary inspection and vaccination centre (2007) and el Rahad veterinary inspection and vaccination centre, North Kordofan state (2007).

The extent of *Brucella* incidence in sheep tested for the export market was further verified at the el Obeid laboratory, where blood samples from both el Khowei and el Rahad quarantine centres are tested. Test results at the laboratory for 2002–06 showed that incidence of *Brucella* in sheep intended for export varies by month or season (Table 24).

Table 24. *Number of sheep tested for Brucellosis monthly at el Obeid laboratory coming from el Khowei and el Rahad quarantine centres in Sudan, and rate of rejection, 2002 to 2006*

Month	2002		2003		2004		2005		2006	
	Number tested	% +ve	Number tested	% +ve	Number tested	% +ve	Number tested	% +ve	Number tested	% +ve
January	67048	0.28	97206	0.28	287841	0.07	115812	0.22	0.22	0.59
February	139087	0.13	19325	0.13	10551	0.05	6512	0.11	0.11	0.64
March	103734	0.01	12403	0.23	29477	0.39	40741	0.34	0.34	0.77
April	16217	0.00	37070	0.34	64144	0.64	61318	0.80	0.80	0.89
May	47592	0.50	29304	0.04	44062	0.40	77109	0.87	0.87	0.74
June	8365	0.32	53349	0.07	57584	0.30	91396	2.13	2.13	1.41
July	9003	0.24	36761	0.05	32715	0.46	21957	1.82	1.82	1.60
August	3370	0.09	106348	0.06	15432	0.19	48304	0.61	0.61	0.85
September	51956	0.15	123207	0.05	64483	0.13	99432	0.67	0.67	0.86
October	152062	0.12	157074	0.05	85830	0.18	92037	0.36	0.36	0.62
November	96331	0.31	65953	0.08	140067	0.24	17006	0.30	0.30	0.74
December	9988	0.31	138649	0.05	221596	0.31	209661	0.46	0.46	0.73

Source: Ministry of Science and Technology, Animal Resources Research Corporation, Veterinary Research Laboratory—el Obeid, North Kordofan state (2007).

In order to confirm the efficacy of the *Brucella* test at the el Obeid Laboratory, on 5 June a random visit was made to the el Khowei Quarantine Centre when a batch of 2100 sheep

were being screened and el Obeid laboratory was collecting blood samples for *Brucella* test. In addition to observing the whole procedure, duplicate blood samples were collected from a random sample of 100 sheep out of the 2100 tested, and each blood samples were given identical identification numbers. One set was tested at the el Obeid laboratory and another at the University of Khartoum Veterinary Laboratory, using Rose Bengal reagent from Soba laboratory in both cases. Out of the 100 samples taken to the University of Khartoum, 39 were spoilt for a number of reasons, so the test results for the remaining 61 were compared on one to one basis with the results from the el Obeid laboratory. And all the cases were found negative in both the laboratories. The consistency of the test results confirmed that the procedure and the reagent used at the el Obeid laboratory were of acceptable standard. The laboratory was also found well organized.

Animals cleared by el Khowei, el Rahad and similar quarantine centres are transported to Port Sudan and Sawakin port Veterinary Quarantine Centre where they are again screened visually as well as tested for *Brucella*. Records of the centre for 2002–06 are summarized in Table 25. It appears that 2.5% to 7.1% of the animals tested at this stage were rejected mainly based on visual assessment, but there were also small number of rejections due to Brucellosis. Given that these animals have gone through fairly rigorous tests at earlier stages in the market chain, the rate of rejection at the port quarantines seems fairly high. Animals come from various supply hinterlands and quarantine centres to the port and the efficacy of the el Obeid laboratory may not be equally true for others. If these rejected animals could be screened out at earlier stages in the market chain through more effective visual screening as well as laboratory tests, transportation and other transaction costs on these animals could be saved, thereby enhancing the competitiveness of the net number of exported sheep. Not only are there costs for bringing these rejected animals to the port, they have to be transported back to domestic markets for disposal, which entail additional cost and ultimately impinge on both the exported sheep as well as the domestic consumer as the consumer price could be lower than what it ultimately will be.

Table 25. *Percentage of tested sheep rejected for various reasons at the Port Sudan Veterinary Quarantine, 2002 to 2006*

Year	Inflamed lymph nodes	Mange	Emaciation	Lameness	Sheep pox	Diarrhoea	Brucella and non-castrated	Others	Total rejected
2002	4.8	0.87	0.90	0.12	0.06	0.30	0.01	0.01	7.1
2003	3.0	0.22	0.03	0.01	0.02	0.07	0.20	0.00	3.6
2004	1.2	0.34	0.65	0.00	0.13	0.40	0.02	0.00	2.7
2005	1.5	0.30	0.29	0.01	0.08	0.20	0.10	0.08	2.5
2006	1.9	0.32	0.08	0.12	0.09	0.02	0.01	0.003	2.6

Source: Calculated from Port Sudan Veterinary Quarantine figures, Ministry of Animal Resources and fisheries (2007).

4 Structure and performance of domestic and export markets for live sheep and sheep meat

4.1 Domestic markets

4.1.1 Characteristics of traders

Education and business experience: Forty-eight percent of sample traders at terminal markets were illiterate and 40% had pre-primary or primary level education compared to 38% and 36% respectively at the primary and secondary markets. On the other hand, 26% of the traders at primary and secondary markets had secondary or university education compared to 12% at terminal markets. This would not be normally expected, but this situation might have arisen due to the fact that majority of traders at the terminal markets were originally illiterate drovers from production areas, who delivered animals and stayed at the terminal markets. Initially they worked as brokers and then, with experience, gradually graduated to become traders. At the primary and secondary markets, 80% of the traders were involved in only buying and selling, and 20% were involved in buying and selling as well as served as brokers and/or guarantors for other traders. At the terminal markets, 90% were buying and selling and 10% additionally served as brokers or guarantors.

Nearly 40% of the traders at primary and secondary markets were involved in livestock trading business for over 15 years, while 80% of those at the terminal markets had similar experience. Some of the drovers turned traders might have come from families which were involved in livestock trading business. Twenty-seven percent of the traders at the terminal market reported that their fathers were livestock traders or were involved in livestock trading as drovers or guarantors; 21% of the traders at the primary and secondary markets said so. Among the sample traders in primary and secondary markets in Gedarif, Blue Nile and West Kordofan states, respectively 25%, 15% and 31% reported that their fathers were either livestock traders or were involved in livestock trade as drovers or guarantors. The rest of the traders came from families with other occupations, mostly agriculture and livestock rearing.

Physical and financial capital: The initial sources of finance of traders at all market levels are mainly own resources. The second main source is gifts from parents or family members. Traders at all levels of livestock markets start with small capital and grow slowly. Table 26 indicates sources of finance of traders at primary, secondary and terminal markets when business was started. Loan from formal sources was virtually absent for traders in primary and secondary markets. They often received deferred payments for animals sold to export traders who paid after receiving sales proceeds from Saudi Arabia, and traders in turn paid producers who supplied the animals. Such deferred payments might be more common for larger commercial producers as smaller producers usually sold animals due to need for immediate

cash and hence might not be willing to accept deferred payments. The entire chain runs on the basis of trust, and hence traders can run business with minimum cash capital.

Table 26. *Sources of finance of traders in three states of Sudan when business was started by market type*

Source of finance	% of traders by livestock markets		
	Primary	Secondary	Terminal
Own resources	77	65	79
Gift from parents/family members/relatives	10	31	14
Loan from parents/family members/relatives	13	4	0
Inherited from parents	0	0	7
Total	100	100	100

Source: Livestock traders survey (2005).

In an answer to the question about possession of a shop/house in the market (primary and secondary) where traders operated, 28.6% answered yes. At the terminal market, only 3.5% possess a house.

Social capital: Since the products exchanged in the market are not standardized, and there is no formal mechanism for contract enforcement and dispute settlement, market operators develop alternative means or institutions to facilitate transactions when various market information (price, supply, demand) are not easily and readily available in the public domain. Under such circumstances, social capital may play a critical role in facilitating market exchange. Social capital is broadly defined as a 'stock' of trust resulting from close functional or emotional attachment to a group or society that facilitates the provision of public goods (Jabbar et al. 2008).

For traders of a particular commodity, social capital may be measured by the extent of network of trading contacts available to each trader. Such network may facilitate exchange between anonymous partners, reduce transaction costs of searching for potential partners, and also get access to market information (Jabbar et al. 2008).

Participation of sample traders in formal groups or associations that might play a role in the marketing process by providing various services and in price formation was very weak. Only 3% of traders at the primary market levels and 11% at the terminal market are members of trade association. At the secondary market level, membership is the highest (31%) in trade association.

Only 14% of the traders operating at the terminal markets go to secondary or primary market for purchasing animals, while 64% of the traders operating at the secondary markets do their business in 2–4 markets and 36% operate only in one market, but 21 % of the traders

operating in primary markets do their business in only one market, 29% in two markets and the remaining 50% in 3–6 markets.

Sources of information: Information on supply, demand and prices is an essential ingredient in any trading business as decisions on transactions and prices are made on the basis of this information. At the primary and secondary market levels, the available sources of information on prices, supply and demand are shown in Table 27. Personal observation, speaking with brokers/agents, speaking with regular customers and suppliers and speaking with other traders are major sources of information on prices, supply and demand at the purchase markets. Similar sources of information are used for information on the supply and demand in the sale markets and for export and import markets.

Table 27. *Distribution of traders in three states according to sources of information in primary and secondary markets on prices, supply, and demand condition of purchase markets*

Sources of information	Percent of traders reporting
Personal observation	100
Speaking with regular customers and suppliers	50
Speaking with brokers/agents	76
Speaking with other traders	46
No source	8
Mobile telephone	15
Exporters agents	4
From another primary market	2

Source: Traders survey data (2005).

The traders primarily get information on changes in government policies, regulations and taxes from other traders (36.8%), followed by newspapers (3.1%), and radio/television (11.1%). Almost 15% of traders have no source or access to information (Table 28).

Table 28. *Distribution of traders in three states of Sudan according to main sources of information in primary and secondary markets on taxes, regulations and other government policies*

Sources of information	% of traders reporting
Personal observation	25
Speaking with regular customers and suppliers	25
Speaking with brokers/agents	52
Speaking with other traders	75
No source	26
Mobile telephone	49
Exporters agents	20
From another primary market	3
Radio/TV	21
Marketing agencies	2

Source: Traders survey data (2005).

Contract violations: Transactions in livestock markets are based on verbal agreements as negotiated between the parties involved. There is no system of written documentation of transactions, with the exception of some cases on credit purchase where they have documents like Kimbyiala indicating the transaction as well as witnesses, or bonds, deferred payment cheques and the market fees receipt where they record the animal type and the agreed price, seller and buyer name. This lack of any written document increases the probability of contract violations. Certification fees are actually paid by only 17% of the traders.

The number of dispute, settled by local courts, with suppliers as well as with customers, is 6% among primary and secondary market traders. Traders experienced contract violations in the past year in the form of selling the same animal to another person, or attempts to renegotiate price. There were no cases of disputes settled by higher courts, or association arbitration, or community leader mediation, or by informal mediation by friends or by brokers/agents. Number of disputes settled by higher courts with customers was 2%, and that settled by community leader mediation with customers was also 2%.

The prevailing system of solving contract violations among primary and secondary market traders is referred to as *Joodia*. It is a system that involves a group of people from the community with talent in problem solving. At the terminal markets, trader's dispute settlement is solved by the informal mediation of friends, brokers/agents or by *Joodia*.

Property rights: Theft was the most common problem. Traders at primary and secondary markets faced this at stocking grounds (25%), at own premises (4%), from the market and while trekking (each 4%) and while transporting and at the open pasture (2%). About 61% of the sample traders did not suffer from theft of animals during the 12 months preceding the survey;—27% suffered once from theft and 6% twice among primary and secondary market traders. These sheep traders lost an average of 13,261 Sudanese dinars (USD 567) due to theft. In 26% of the cases of theft, the traders at primary and secondary markets do not suspect any one for stealing their animals as they do not know the culprit, but in 6% of the cases the members from known families are involved, and in 2% of the cases own employees are involved.

In order to protect animals from theft, traders employ a shepherd to look after animals and guard them. When animals are trekked the traders' means of protecting during trekking or transporting varies: 44% said they employed a good shepherd to look after animals and guard them, 18% travelled in convoys, and 7% had night halt near a reputed person's house.

4.1.2 Performance of traders

In an attempt to understand the marketing and transaction costs of livestock trading business in Sudan, information was collected from each sample trader about his most recent completed purchase and sale transactions. For some traders and brokers at primary and secondary markets, the date of the last purchase is the same date of selling those animals as they purchased and sold on the same day. For such traders there is no capital cost for holding stock. But other traders purchased and kept the animals for up to four months. Travel and transport cost for traders in primary markets is assumed zero or negligible, as they travel either on foot or on donkeys, for which appropriate opportunity costs could not be calculated. All transactions were done in physical presence of the contracting parties, most of the costs were direct physical marketing costs; and transfer of property rights involved simple procedures without formal contract negotiations, documentation and enforcement procedures.

At primary and secondary markets, categories of sheep purchased and sold by traders are heterogeneous in nature. A trader may buy a particular type of sheep, e.g. adult male, culled female, young male etc. or a combination of types in a mob or batch as a unit or as single animals. Sales may occur in the same manner. Average price per animal from these combinations (or mix) differs greatly. It may be noted that animals are not weighed in Sudanese primary and secondary markets or even at export terminal markets. Exporters have to create batches of relatively uniform weight animals out of the production and marketing system that supplies heterogeneous animals. They do this by guessing the weight of animals and making a batch consisting of animals within a range of weight, e.g. heavy or medium weight. Too many underweight animals in a batch of heavy weight will attract less price, too many overweight animals in the batch may not attract as much value as reasonably desired. Thus, traders make a balanced batch to maximize average price. Similar phenomena were observed in Somali export market chains (ILRI 2007).

Apart from type and weight, other animal characteristics that determine price are breed, colour, general body condition etc. but data on such factors need to be collected for individual animals to be meaningfully analysed using hedonic price models, which was not possible in this study. The survey of 56 traders provided detailed data for the groups/mobs/batches of animals they purchased and sold to estimate purchase and sale prices per head of sheep by type of animal at primary and secondary markets in the three states (Table 29). For certain types of animals, prices differed significantly between the three states, with prices in West Kordofan being generally highest. Within a state, prices differed between primary and secondary markets in most cases. Standard deviations were more often higher at primary market level, where heterogeneity of animals in a batch would be expected to be higher than in the secondary markets.

Table 29. *Average purchase and sale prices per animal by type of animal at primary and secondary markets in the three states of Sudan (in Sudanese dinars)*

	Gedarif		Blue Nile		West Kordofan	
	Purchase price	Sale price	Purchase price	Sale price	Purchase price	Sale price
Adult male						
Primary market	11,250	11,985	7376	8451	17,217	16,685
	(354)	(21)	(1727)	(1868)	(3244)	(8380)
Secondary market	13,350	14,740	11,060	10,242	14,900	17,850
	(3120)	(3466)	(2402)	(3013)	(3565)	(3682)
Young male						
Primary market	7727	9091	6250	8250	12,750	14,750
			(354)	(354)	(1768)	(1768)
Secondary market	10,780	11,710	10,242	11,043	14,800	15,467
	(502)	(1433)	(3013)	(2606)	(3020)	(3287)
Culled female						
Primary market	–	–	–	–	10,000	13,000
Secondary market	–	–	8000	9000	16,000	16,600
Breeding female	–	–				
Primary market	–	–	8367	9000	–	–
			(1451)	(1673)		
Secondary market	–	–	9000	9625	19,000	20,000
			(2828)	(3359)		
Young female						
Primary market	–	–	7500	9650	7500	9000
Secondary market	–	–	–	–	7500	–

Note: Figures in the parentheses are standard deviations. Those without SD are averages for too few cases to allow test statistics to be calculated. Statistical tests show that price differences between states are significant in case of purchase and sale prices of adult sheep, purchase and sale prices of young sheep, and purchase and sale prices of breeding female. – Data not available
Source: Trader survey data (2005).

For any particular type of animal, the difference between purchase and sale prices at a given market level is expected to be low as these transactions often take place the same day and do not involve extra cost of feed, water, transportation plus other transaction costs of marketing at a different market. For the same type of animal, the difference between purchase price at primary market and sale price at secondary market is expected to be large, but net difference will be lower (perhaps comparable to the purchase and sale price difference at the primary market) once marketing and transaction costs are considered. Generally traders at primary and secondary markets handling a reasonable size mixed batch (say over 30 animals of different types) make a profit of 300–500 Sudanese dinars (USD 1.3 to 2.2) per head.

The number and composition of animals bought and sold by 56 sample traders at primary and secondary markets in their most recent transactions before the survey are shown in Table

30. Eighty-one percent of purchased animals were adult males, out of which export animals are mostly derived. Young males comprising 16% of purchase may also provide some export animals. Overall, 59% of all purchases were sold at these markets. Only 49% of the adult males were sold, but nearly all the animals in the other categories were sold there. This means that only about 40% of the animals purchased at the primary and secondary markets may end up in terminal markets for export. The remainder may end up in domestic markets for consumption or back to the producers for breeding and flock replenishment.

Table 30. *Number and composition of sheep transacted at selected primary and secondary markets by sample traders in three states of Sudan*

Type of animal	Number purchased	Number sold	% purchases sold
Adult male	5333 (80.7)	2622 (67.4)	49
Young male	1028 (15.6)	1020 (26.2)	99
Culled adult female	46 (0.7)	46 (1.2)	100
Breeding female	100 (1.5)	100 (2.6)	100
Young female	102 (1.5)	102 (2.6)	100
Total	6609 (100)	3890 (100)	59

Figures in the parentheses are column percentages.
Source: Traders survey (2005).

4.1.3 Major marketing problems

In about 76% of primary and secondary markets, the local administrative units are responsible for market fees, taxation, security, infrastructure development as well as being responsible for issuing trade licenses. In twenty-one percent of primary markets, no one is responsible. At the administrative unit level, some of the local community leaders have developed arrangements with some private individuals to collect fees from the market transactions without providing any services. In Blue Nile State, no one is responsible for management and fee collection in primary markets.

Sample traders in primary and secondary markets were asked to mention three marketing problems, in descending order of importance, for sheep and goat marketing. A particular problem might have been mentioned as number one by one trader, and as number two or three by another trader. Taking all three responses together, the most important sheep marketing problems from traders' point of view in primary and secondary markets in the three states are summarized in Table 31. Multiple taxes, unstable price, lack of infrastructure/ facilities at the markets and unauthorized road taxes are the most important problems mentioned by traders. Low demand, low price in import market and no or limited access to formal credit are also major problems. It may be recalled that almost none of the traders mentioned institutional credit as source of their start up capital.

Table 31. *Major marketing problems as perceived by traders in primary and secondary markets in the three states of Sudan*

Major problems	% of traders reporting
Multiple taxes/high taxes	57
Unstable prices	35
Market have no infrastructure/facilities	33
Unauthorized road taxes	30
Low demand in the market/low demand for type of animals available in market/low price	33
No or limited access to formal credit	21
Low export market price/low demand in importing countries	23
High local price	14
Poor quality animals/absence of grades and standards	14
Unlicensed traders in market/Saudi traders buy directly/difficulties in obtaining license	14
No system of certification/Certification not done properly	8
No system for dispute settlement/others	5
High veterinary certificate fees (official and unofficial)/dispute on who will pay fees/ tough penalties for not paying fees	16

Source: Traders survey data (2005).

4.2 Export markets

4.2.1 Structure of the export trade

The LMMC played a key role in export trade until the early 1990s: a large number of exporters were involved in live sheep export, mainly serving as agents of the LMMC. The numbers of live sheep exporters declined from 350 in 1985 to 21 in 1995 when market liberalization policies were introduced and the direct role of LMMC in the export business was gradually reduced. This was therefore an indication of the increasing concentration in the export business. During the period from 2003 to 2006, there were a total of 72 live sheep exporters—companies and business firms or people. Among these, over the four-year period, the largest exporter handled 24% of the volume of export, top 3 exporters handled 43%, top 5 handled 60% and top 10 handled 78% of the total export volume (Table 32). Thus the live sheep export business is highly concentrated.

The structure of the sheep meat export business is even more concentrated. The number of exporters of sheep meat declined from 14 in 2002 to 5 in 2006, with only one company (Swakni) exporting more than 95% of total meat exports. Meat exporters usually have their sheep slaughtered at the established slaughterhouses, which are few. Sheep were slaughtered for export mainly in Kadaro abattoir and to a lesser extent in Sabalogha or Ghanawa; the first two abattoirs are governmental. There was some slaughtering in Nyala and GIMCO slaughterhouses and both are private.

Table 32. *Number of Sudanese live sheep exporters and number of animals exported, 2003–06*

No. of exporter	Total number of sheep exported	% of total exported	Cumulative (%)
1	1,362,962	23.9	23.9
2	546,165	9.6	33.5
3	542,080	9.5	43.4
4	463,537	8.1	53.5
5	462,282	8.1	59.6
6–10	825,442	18.2	77.8
11–15	723,998	11.2	90.0
16–72	570,272	10.0	100.0
Total	5,702,728	100.0	

Source: MARF (unpublished data).

4.2.2 Performance of live sheep export traders

Traders at primary and secondary markets start sorting and grading animals to create relatively more homogenous mobs or batches out of their multiple purchases in order to sell to export traders or their agents who visit these markets. The larger traders transport standardized animals to the terminal markets for selling to exporters. Performance of traders as measured by costs and returns for heavy and light weight export quality sheep originating in one selected market in each of the three states and ending up at the export port are summarized in Tables 33 and 34. In these and subsequent tables on this topic in this section, costs and returns are shown on per animal basis because domestic traders and exporters normally use per animal rates for pricing, costing, and return calculations in their usual trade business, and all formal and informal fees and taxes related to this business are also calculated and charged on an animal unit basis. Some charges, such as broker fees, may of course vary depending on the scale of the business but the going rate represents an average for a given market, which has been used here for estimation of costs and returns.

Among the cost items, the main cost difference was in the buying price by local traders in the three states—buying price in Gedarif and Damazeen being higher than in el Khowei. It is interesting to note that the buying price of heavy weight sheep in el Khowei is similar to the average selling price of adult male sheep in the secondary markets in West Kordofan state, but the buying prices in Gedarif and Damazeen are much higher than the selling prices of adult sheep in the secondary markets in these two states. The buying prices for lightweight sheep did not differ as much between the three states. The reason for this is unclear, except that the export animals are graded higher weight and higher quality animals derived from the mixed lots or batches traded at the secondary markets. In case of el Khowei, which is a prime export supply hinterland, the animals traded may be of a more homogenous character than in the other two states.

Table 33. *Marketing costs and margins for export live sheep (average live weight 45 kg) originating in selected markets in three states of Sudan (SD/head), June 2005*

Items	Gedarif in Gedarif	Damazeen in Blue Nile	Khowei in W Kordofan
Producers price	18,000	19,000	17,500
Local trader's margin (broker fees)	2000	2000	1000
Average purchase price	20,000	21,000	18,500
Market fees	300	200	160
Middlemen commission	100	100	100
Guarantor fees	50	50	50
Veterinary health certificate fees	180	100	100
Value added tax	185	100	–
State tax stamp	–	–	50
Municipality tax	500	150	65
Business tax	125	0	0
Producers' union	0	25	15
Education support fees	0	–	40
Veterinary services fees (local authority)	180	100	200
Federal wounded tax	25	25	25
Zakat	40	40	40
Shepherds and water cost (3 days)	300	–	50
Subtotal cost at market level	21,985	21,890	19,395
Showak vet. quarantine: inspection, vaccination, *Brucella ovis* test and supervision	385	–	–
Khowei vet. quarantine fees	–	–	77
Federal vet. inspection, vaccination	150	150	150
Incentives; inspection, vaccination	60	60	60
Brucella test	60	60	60
Transportation cost to Port Sudan	468	1000	1000
Truck driver incentive and labour cost (for guarding and keeping sheep in upright position during the drive)	50	100	140
Port Sudan local authority fees	50	50	50
Port Sudan inspection incentive	50	50	50
Unloading at Port Sudan and loading to Sawakin	50	50	50
Transportation cost (Port Sudan/Sawakin)	300	300	300
Unloading at Sawakin and shepherd cost	50	50	50
Feed and water (Port Sudan/Sawakin (7 days)	500	500	500
Total cost FOB Sawakin	24,158	24,260	21,882
Exporters profit margin	1142	1040	3418
Selling price FOB Sawakin sea port	25,300	25,300	25,300

Selling price FOB Sawakin Sea port = USD 110 = 25,300 SD.
Source: Calculated from field surveys and personal communication with traders (2005).

Traders' buying price (which should be the same as producers' selling price) of heavy weight live export quality sheep in Gedarif secondary market (Gedarif State) averaged 71% of the export price in Sawakin. In Damazeen market in Blue Nile, it was 75% and in Khowei market

in West Kordofan State it was 69% (Table 33). As for the light weight export quality lambs, the buying price in Gedarif, Damazeen and el Khowei was respectively 77%, 67% and 73% of the export price (Table 34). These shares are rather high, but they seem reasonable because they are far selected higher quality animals out of the heterogeneous supply. If producer price for all types of animals sold at the primary markets is considered, the producer share of final consumer price (weighted average of export and domestic consumer price) should be much lower than is apparent in Tables 33 and 34.

Table 34. *Marketing costs and margins of light weight export quality lamb (average 25 kg live weight or 12 kg carcass weight) originating in selected markets in three states to export port, June 2005*

Items	Cost in SD by market of origin		
	Gedarif	Damazeen	El Khowei
Producer prices	11,500	10,000	11,000
Local trader's margin	1000	1000	1000
Average purchase price	12,500	11,000	12,000
Market fees	300	150	160
Middlemen commission (purchase)	100	100	100
Guarantor fees	50	200	50
Veterinary health certificate	180	100	200
Business tax	125	–	200
Value added tax	185	100	–
Feed and labour cost	200	150	500
Transport cost to Omdurman market	550	1000	600
Inroad tax and expenses	50	100	50
Middlemen commission (selling)	200	100	100
Labour and feed cost	200	200	200
Total cost	14,640	13,200	14,160
Profit margin	360	1800	840
Selling price at Sawakin sea port	15,000	15,000	15,000

Source: Calculated from field surveys and personal communication with traders (2005).

Another example for marketing margins and transaction costs for sheep purchased from Gedarif and exported either as live sheep (average 45 kg light weight) through Port Sudan or as meat (average 25 kg live weight) through Khartoum export abattoirs is illustrated in Table 36. Purchase price of the animals at the local market accounted for 80% of the final selling price for both live sheep and meat export, which appear quite high even though these are selected higher grade and higher quality animals. Rate of profit is higher for live sheep export than in meat export, but absolute profit per animal is not comparable because the size and type of animals and the investment involved are not the same. Given the different requirements of the live sheep and meat export outlets, animals cannot be easily redirected from one outlet to the other in case of a short run change in relative prices.

Table 35. *Marketing cost per head (in SD) of live sheep from production areas to the export port in Sudan for two export companies in 2006*

	Cost items	Fadous Company	H.H. Company
1	Purchase price	18,000	18,000
2	Market fees (local authorities)	300	150
3	Local pasture fees (local authorities)	100	100
4	Labour (herding)		100
5	Vaccination fees	150	100
6	Quarantine fees (MARF)	105	150
7	Vaccination services by veterinary authorities staff	30	30
8	Veterinary authorities staff for loading services	30	77
9	Brucella test fees	40	50
10	Local veterinary authority		20
11	Veterinary laboratory labour cost for brucella test	25	25
12	Taxation stamp duty	50	50
13	Local authority fees (el Khowei)	50	50
14	Jihadia fees	10	15
15	Producers union fees (Itihad el Roah)	10	10
16	Shaheed fees	20	25
17	Jareeh fees	25	50
18	Water		100
19	Transit		50
20	Loading labour cost	23	25
21	Internal transport		100
22	Administrative cost		200
23	VAT for local transport per head (10%)	150	60
24	Transport cost from inspection centres to Port Sudan	1500	600
25	Feed and water, labour, drugs cost for 7 days	1000	1000
26	Duties/fees (at port of shipment)	205	100
27	Port fees (at port of shipment)	120	50
28	Port Sudan veterinary quarantine inspection fees	30	30
29	Port Sudan veterinary quarantine services fees	10	10
30	Port Sudan local authorities environment fees	100	100
31	Clearance fees	20	15
32	Transport cost from Port Sudan to Sawakin	200	200
33	Internal transport		50
34	Loading and unloading at Sawakin	100	100
35	Labour cost (shepherds)		100
36	Sawakin local authority		100
37	Labour cost for loading		50
38	Loading inside ship (vessels)	25	25
39	Veterinary authorities fee		45
40	Endorsement of certificates and other documents		250
Total cost		22,428	22,362
Revenue USD 120 @ 230 SD = 1 USD		27,600	27,600
Margin (SD)		5172	5238

Note: VAT for local transport per head (10%) is refundable. H.H. Company Limited worked on commission basis, the finance is by the Saudi importer.
Source: Fadous Trade and Investment Company limited, and H.H. Company Limited (2006).

Table 36. *Marketing costs and margins per head for live sheep and meat export from Gedarif State in Sudan (May 2005)*

Cost items	Live sheep export (Average 45 kg live weight)		Meat export (Average 25 kg live weight)	
	Value (SD)	%	Value (SD)	%
Average purchase price	20,000	79.1	12,500	83.3
Market fees	300		300	
Middlemen cost	100		100	
Guarantor	50		50	
Veterinary health certificate fees	180		180	
Veterinary inspection, vaccination, Brucella test and supervision	385		–	
Stocking tax	175		175	
Zakat	40		40	
Business tax	125		125	
Wounded tax	25		25	
Transportation cost	465		550	
Quarantine and port cost	150			
Feed and labour cost			200	
Facilitations			50	
Subtotal marketing costs	1995	7.9	1795	12.0
Total cost	21,995	87.0	14,295	95.3
Profit margin	3305	13.0	705	4.7
Selling price	25,300	100	15,000	100

Source: Trader survey data (2005).

We have previously presented the local prices of animals transacted at primary and secondary markets in West Kordofan state, part of which are transported by traders to terminal markets for selling to exporters. However, some exporters purchase export quality sheep in lots from larger or commercial herders directly themselves or through their designated agents or through brokers, and export to Jeddah. This reduces the number of intermediaries. Broker's commission varies greatly depending on the number and size of the commercial herds accessed to make an export lot or batch, the distance and the effort made. The commission ranges between 100 and 500 SD/head. Cost and returns for such an operation from el Khowei market area to Jeddah are summarized in Table 37. Producer price or purchase price in this case accounted for 78% of all domestic costs or 59% of the final Jeddah price. The gross profit margin of the exporter was USD 19.55 per head or about 18% of the final price. Whether this was a normal profit margin could not be judged because of the lack of information on opportunity cost of capital in the market.

Table 37. *Estimated cost and margins of heavy weight (average 45 kg live weight) sheep from el Khowei market in West Kordofan in Sudan to Jeddah via Port Sudan (June 2005)*

Items	Value/head (SD)	% of final price
Average purchase price/head	15,000	59.2
Market fees	100	
Middlemen commission	150	
Guarantor fees	50	
Health inspection (West Kordofan Ministry of Agriculture)	100	
State tax stamp	50	
Producers union fees	15	
Education support fees	25	
Veterinary services fees (local authority)	20	
Federal wounded tax	25	
Zakat	40	
Shepherds and water cost (3days)	50	
Khowei veterinary quarantine fees	77	
Federal veterinary inspection, vaccination	150	
Incentives; inspection, vaccination	60	
Brucella test	60	
Subtotal marketing costs at el Khowei	972	3.8
Transportation cost by trucks (Khowei/Port Sudan)	1000	
Truck driver incentive and labour cost (shepherd or Gellab for guarding and keeping after sheep)	140	
Port Sudan local authority fees	50	
Port Sudan inspection incentive	50	
Unloading at Port Sudan and Loading to Sawakin	50	
Transportation cost (Port Sudan/Sawakin)	300	
Unloading at Sawakin and shepherd cost	50	
Feed and water Port Sudan/Sawakin (7 days)	500	
Rejection and mortality cost	500	
Customs, duties, ports and clearance cost	350	
Business tax (addition or subtraction tax 1%)	200	
Subtotal costs between el Khowei and Sawakin	3290	13.1
Total cost Free Aside ship (FAS)	19,262	76.1
	= USD 83.75	
Shipping freight	USD 4.00	
Transport (plus loading and unloading) at livestock market	USD 2.70	
Total cost including freight to Jeddah	USD 90.45	82.2
Gross profit	USD 19.55	17.8
Selling price at Jeddah (Saudi Arabia)	USD 110.00	100.0

Source: Trader survey data and personal communication (2005).

An important feature of Sudanese livestock marketing chain—including both domestic and export routes—is that in reality producers supply a significant part of the business capital by accepting deferred payments from traders. The system runs on the basis of trust among

the chain actors, and allows active and vigorous business in the absence of formal sector credit for the livestock producers and traders. The Animal Resource Bank usually provides finance to exporters, but rarely or inadequately to smaller traders who are the backbone of the export trade. This deferred payment may be one possible reason for higher producer price of export quality sheep as producers perhaps add time value of money in asking the sale price.

4.2.3 Major marketing problems of live sheep and meat exporters

Major purchase problems for traders at primary, secondary and tertiary markets are the lack of sufficient numbers of sheep during the dry season and the high cost involved along the chain. Hamari sheep within the range of 46–48 kg live weight is the preferred quality in Saudi Arabia, but supply of this type of sheep varies by season and they are also very costly.

For exporters, the main problem is competition from other exporting countries in the Saudi market. Export batch size ranges between 4000 and 20,000 heads at a time and 30 to 50 batches are exported during a year, depending on the local supply and demand in the export market. Time schedule and export program is not fixed by live sheep exporters, except during Hajj season. Mostly they depend on the demand and purchase order from the importer. Traders reported that major health problems in the market are sheep pox, mange and diarrhoea, which affect procurement, inspection, batch formation and transportation. This is because much risk is involved when animals from different sources and with unexposed symptoms at the time of purchase are bulked for long distance transportation. Sometimes, exporters ship animals to Saudi Arabia without prior contract, and the transaction deal occurs after the arrival of sheep in Saudi Arabia, which means the exporters take the burden of extra feed and water and any other risk until the lots are sold. This may reduce their bargaining power and make them vulnerable to the pressure to sell at lower prices as keeping animals longer for better price will entail extra cost which may or may not be recoverable. Traders' suggestions to improve live sheep export included minimizing the government taxes, fees and levies plus subsidies or incentives to support live sheep exports.

In case of sheep meat export, 60% of the exporters purchase by kg carcass weight of export lamb meat and pay in cash, 20% purchase through commission agents from el Salam terminal market and 20% purchase through commission agents from production areas. Purchase problems of sheep were shortage of supply during summer, especially during May and June, high prices and emaciation, and possibility of loss due to theft. Major meat exporters' problems were multiple taxes and fees with virtually no services, taxation problem at the federal level, lower exchange rate, and competition from other countries in terms of prices.

Exporting companies reported airfreight problems as there were no specialized flights for meat. Only cargo or passenger flights carry meat whenever there is space, and with small space available on the planes, there are booking problems and delay in peak season. Also there was no storage or cooling facilities or chilling containers at Khartoum airport, which seriously hamper delivery of meat at right temperature in case of flight delays.

4.3 Spatial price integration

Supply hinterlands for Sudanese export sheep is quite large as shown previously and varies in terms of types of animals (breed, size, colour, meat quality and taste). If the demand for these varying types of animals in Saudi market is not differentiated, i.e. if one type is easily substituted for another depending on availability, then there should be price competitiveness in the domestic market for sheep originating in different supply hinterlands. Also if there is no formal barrier to enter any market for any livestock trader and if there is free flow of information, sheep markets should be integrated, and prices in supply markets and terminal markets should move together. Opportunities for deriving rent or premium price for special demand will be less. Among the three states surveyed in this study, Gedarif and Blue Nile have common borders and are nearer to Khartoum, the largest domestic market, as well as the export ports, while West Kordofan is farther away from these two states as well as from Khartoum and the export ports. This study attempted to establish if the relative prices in the markets in these three states and the terminal market in Khartoum move together, i.e. to test if prices in these states may be integrated and transmitted easily.

One widely used method to test for spatial market integration is to apply co-integration test. This method tests for co-movement of prices from different places and searches for long-run relationships between them. When prices of the same commodity from different places move together in the long run, the information of local surplus and deficit is considered to be well transmitted across space. Therefore, the market for that good is considered well integrated. Market integration occurs when product flows between markets on the same terms and conditions as within markets. A highly integrated commodity market is likely to increase market efficiency through efficient resource allocation and price transmission, which is likely to lower transaction costs and increase incomes to actors, see for example Ochieng et al. (2006).

Co-integration is an econometric technique for testing the correlation between non-stationary time series variables. If two or more series are themselves non-stationary, but a linear combination of them is stationary, then the series are said to be co-integrated. Before the 1980s, many economists used linear regressions on de-trended non-stationary time series data, which Engle and Granger (1987) and others showed to be an inappropriate approach

that could produce spurious correlation. It is often said that co-integration is a means of valid hypothesis testing between two variables having unit roots (integrated of order one). That means a series is said to be integrated of order d if one can get a stationary series by 'differencing' the term d times. The usual procedure for hypothesis testing between non-stationary variables is to run OLS regressions on data which had initially been differenced. Although this method is appropriate for large samples, co-integration provides more powerful tools when the data sets are limited, as most time-series are.

The two main most common methods for testing for co-integration are: the Engle-Granger two-step method (Engle and Granger 1987) and the Johansen (1988) procedure. In practice, co-integration is used for such series in typical econometric tests, but it is more generally applicable and can be used for integrated variables of higher order to detect correlated accelerations or other second differencing effects.

In autoregressive models in econometrics, a unit root is present if the coefficient | b | = 1 in $y_t = ax + by_{t-1} + \varepsilon_t$, where y_t is the variable of interest at time *t, b* is the slope coefficient, and ε_t is the error component. If the unit root is present, the time series is said to have a stochastic trend or being *integrated of order one* or I (1). An augmented Dickey-Fuller test is a test for a unit root in a time series sample (Dickey and Fuller 1979). The ADF statistic, used in the test, is a negative number. The more negative it is, the stronger the rejections of the hypothesis that there is a unit root at some level of confidence (Said and Dickey 1984).

In this study, market integration was tested using monthly sheep market price data from secondary sources for six years (2001–06) for Omdurman terminal market in Khartoum and el Obeid and Demazeen secondary markets in West Kordofan (now part of North Kordofan) and Blue Nile respectively. Thus 72 observations were available for each market (Appendix 2). The test focused on investigating the price co-integration between Omdurman terminal market and el Obeid and el Damazeen secondary markets. First, the sheep price series for Omdurman, el Obeid and el Damazeen were tested for stationarity using the ADF unit root test. After confirmation of non-stationarity, the price series were tested for co-integration applying the Johansen (1988) method. Econometric Views (E Views) software was used in the estimation of parameters.

For testing co-integration relationship in the three livestock markets, the adopted price dates were the monthly average prices. Price data were collected by category of sheep (such as adult male sheep) and divided into two categories in terms of trade, whether for domestic consumption or for export. For adult male sheep, no price differential by grade, quality or breed was recorded. The prices for two markets—Omdurman and el Obeid—were derived from the daily average prices collected by Animal Resources Services Company

and calculated as weighted monthly averages. The same was done by el Damazeen Animal Resources authorities.

Estimated statistics for the test for stationarity of the prices are shown in Table 38. The ADF test statistics are all larger than the critical values at less than 5% for some and less than 10% for others. The ADF series first difference statistics are larger than the critical values at less than 5% or 10% level, so the null hypothesis of existence of unit root is accepted, i.e. the hypothesis of price stationarity is rejected.

Table 38. *Estimated statistics for unit root test for prices movement and three estates in Sudan*

Series in log	ADF series test	ADF series first difference
Omdurman	–1.6209	–3.9127
El Obeid	–0.9458	–3.8883
El Damazeen	–2.1694	–4.5775

Series H0: Unit root; H1: Stationarity around a constant. Critical values –2.89 (5%) and –2.58 (10%).

First difference H0: Unit root with drift; H1: Linear trend stationarity. Critical values –3.40 (5%) and –3.13 (10%).

Since the price series are non-stationary, Johansen's co-integration test was applied and results are presented in Table 39. R is the number of co-integrated vectors (in matrix). If R = 0 there is no integration. The values of r indicate that the markets are co-integrated. Also Lambda-max test values (Eigen value) are less than critical values and trace test statistics are also less than the critical values, which indicate potential long run co-integration relationship between the livestock markets under discussion, thus revealing that the prices will move together overtime and converge towards equilibrium in the long run.

Table 39. *Johansen's co-integration test results for number of co-integrated vectors for prices in three livestock markets in Sudan*

Series in log	Null hypothesis	Lambda-max test	Critical* values	Trace test	Critical* values	VAR (p) order
Omdurman, el Damazeenn and el Obeid	r=2	3.7	8.1	3.7	8.1	1
Omdurman** and el Obeid	r=1	4.3	9.1	4.3	9.1	1
Omdurman and el Damazeen	r=1	2.7	8.1	2.7	8.1	2
El Damazeen** and el Obeid	r=1	6.8	9.1	6.8	9.1	1

* at 5% ** Restrictions on intercept imposed.

The results of impulse response function show that a shock to the price in one market will manifest in the other market as well, as illustrated in Figures 14 to 19. Responses between two markets have been mapped on a pair wise basis, showing the impact of price change in one market on the price in another and vice versa.

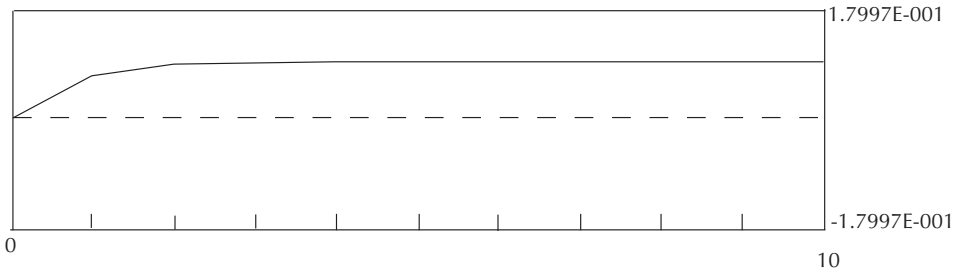


Figure 14. *Response of LN [def Omdur] to a unit shock in LN [def EI Obeid].*

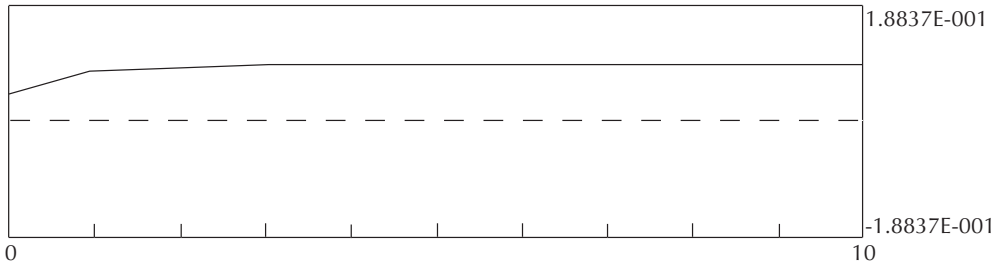


Figure 15. *Response of LN [def EI Obeid] to a unit shock in LN [def Omdur].*

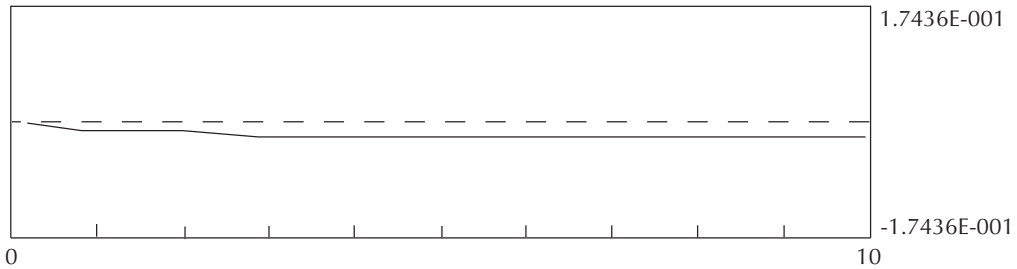


Figure 16. *Response of LN [def Omdur] to a unit shock in LN [def EI Damaz].*

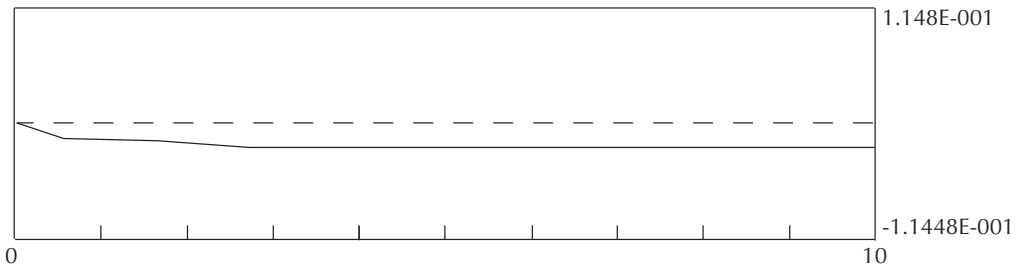


Figure 17. *Response of LN [def EI Damaz] to a unit shock in LN [def Omdur].*

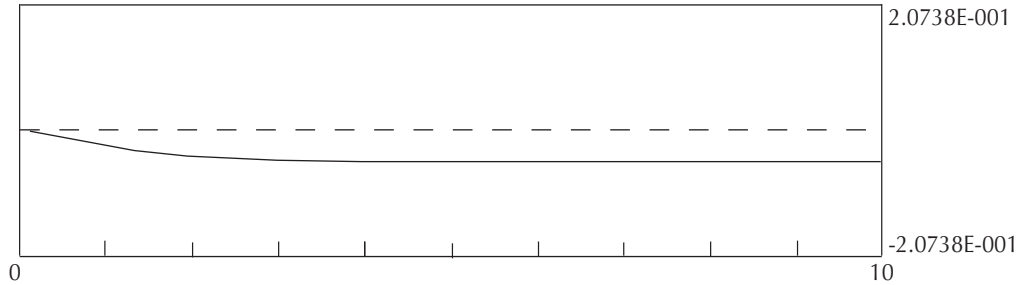


Figure 18. *Response of LN [def el Obeid] to a unit shock in LN [def eI Damaz].*

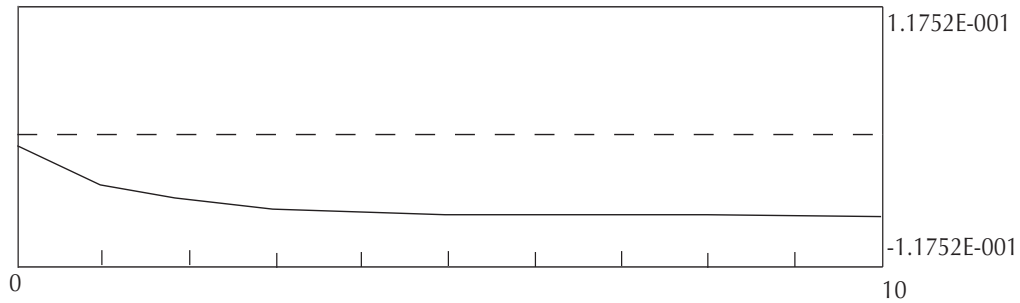


Figure 19. *Response of LN [def el Damaz] to a unit shock in LN [def EI Obeid].*

Figures 14 to 19. *Impulse response functions for price shocks in the selected markets.*

Figures 14 and 15 illustrate the presence of co-integration between Omdurman and el Obeid sheep markets and indicate that the two markets are dependent on each other. A price shock in el Obeid sheep market will create a sharp response in Omdurman market initially, then level off (Figure 14), but the reverse response, i.e. the effect of a price shock in Omdurman on el Obeid, is not that strong (Figure 15). Granger Causality test which involves examining whether lagged values of one series have significant in-sample explanatory power for another variable to provide proof of the direction of price flow from the major source market to the terminal market was applied to validate the responses in Figures 14 and 15. It was found that whenever there is a positive change in el Obeid sheep market, the Omdurman sheep market reacts to that change positively.

Figures 16 and 17 show that a price shock in el Damazeen will have weak response in Omdurman, but a price shock in Omdurman will have a mild negative response in el Damazeen. This could be due to small volume of supplies from el Damazeen to Omdurman market. Figures 18 and 19 show that a price shock in el Damazeen will have a negative response in el Obeid, but the reverse will generate a stronger negative response. This may also occur because both markets are supply markets for Omdurman, but not so much for each other. Because of the differences in their relative importance as supply sources, they react slightly differently.

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Appendix 1 Local names of the important diseases/ conditions reported by livestock producers in the survey areas

Disease/ condition	Local name	Brief description reported by the respondent	Scientific name
Abortion	Torah	Abortion	Abortion
Arthritis	Abu radaa/Guruz	Lameness, inability to move	Arthritis
CCPP	Abu neeni/Abu koweris	Cough, difficulty breathing, crust in nostril	CCPP
Diarrhoea	Reet/Khorg	Diarrhoea	Diarrhoea
Foreign body	Omdaradim/Jesimgarib	Emaciation, palpable hard body in stomach	Abomesal phytobezoars
Dullness	Dogass	Tired, depression	Dullness
Haemorrhagic septicaemia	Tasamom	Bloat, swelling about the throat, sudden death	H.S
Heartwater	Abu kashar/Abu gelaib/ Khadar/Abu dadoya	Respiratory stress, diarrhoea, emaciation, nervous signs, water in heart and death	Heartwater
Mastitis	Goruz/Hadaya	Oedema of udder	Mastitis
Pneumonia	Abu feshaifish/ Om tonkul/Iltihab	Cough, nasal discharge, difficulty breathing, off food	Pneumonia
Poisoning	Samti/Tasamom	Bloat, diarrhoea, sudden death	Plant poisoning
Peste des petits ruminants	Abu demayaa	Nasal discharge, lachrimation, diarrhoea, death	PPR
Sheep pox	Jadari	Skin lesions (nodule and ulceration), cough	Sheep pox
Stomatitis	Abu khadra	Errosion on tongue and gum	Stomatitis
Wounds	Dabara/Juroah	Wound	Wound
Internal parasites	Hulaa, Hoomra, Dedan	Oedema at the jaw, diarrhoea, emaciation, warms in faeces	Haemonchosis/ Paramphistomum
Botulism	Abu regaiba/Abu denaib	Nervous signs, death	Botulism
Abscess	Koraj	Oedematous nodules at lateral side neck	Caseous lymphadenitis
Avitaminosis	Aama	Blindness	Avitaminosis
Foot rot	Abu dulaa	Lameness	Foot rot
Tick infestation	Gurad/gamul	Emaciation and presence of ticks on the body	Tick and lice infestation

Source: Mohammed (2006).

Appendix 2 Monthly sales volume and prices of adult male sheep in Omdurman market, Khartoum

Month	2001		2002		2003		2004		2005		2006	
	Sales	Average price	Sales	Average price	Sales	Average price	Sales	Average price	Sales	Average price	Sales	Average price
January	5512	22,000	NA	9300	31,711	NA	31,125	11,500	41,324	12,500	32,559	25,000
February	7209	21,000	9697	8800	22,605	12,000	21,887	12,000	51,483	21,000	26,062	21,000
March	9705	22,000	10,700	9500	28,231	13,000	25,346	11,000	31,777	17,000	29,333	20,000
April	6525	27,000	14,645	8700	30,244	11,500	21,217	12,000	24,049	12,500	30,094	20,000
May	6049	27,000	18,532	8750	29,696	16,750	21,356	12,000	31,135	20,000	27,420	19,500
June	7045	29,000	19,382	9600	26,506	10,250	21,399	15,000	24,118	21,000	19,886	22,000
July	7583	22,000	19,320	9900	30,890	12,000	20,373	16,000	20,427	27,000	29,292	24,000
August	8657	21,000	21,566	9600	29,598	12,500	21,940	17,000	29,409	25,000	34,508	26,000
September	8909	22,000	32,000	9100	39,663	11,000	27,384	16,500	32,217	23,000	36,551	20,000
October	11,347	21,000	25,017	8700	36,307	10,000	29,476	13,500	38,566	26,000	32,257	27,000
November	13,535	20,000	30,161	8300	32,631	10,500	29,330	13,500	31,970	16,500	36,577	19,000
December	12,836	22,000	28,219	8100	33,285	10,000	41,324	14,500	48,455	25,000	44,021	28,000
Total	104,912		220,239		371,367		312,157		404,929		378,560	
Annual average price		23,000		9029		11,770		13,708		20,542		22,625

Price in Sudanese dinar.
Sources: Animal Resources Services Company, Sudan, unpublished data.

Appendix 3 Monthly sales volume and prices of adult male sheep in el Obeid livestock market, North Kordofan

Month	2001		2002		2003		2004		2005		2006	
	Average price	Sales	Average price	Sales	Average price	Sales	Average price	Sales	Average price	Sales	Average price	Sales
January	8750	1088	12500	10,562	7350	4699	14,500	3441	18,000	8297	16,000	4758
February	8700	1742	8300	9208	7565	2108	11,500	2191	12,750	779	15,000	1506
March	7650	1970	5750	2965	6350	2628	12,000	2889	14,000	1492	15,000	1785
April	7600	2056	6350	3583	7500	3263	12,500	1522	5500	1797	15,750	1774
May	7600	2340	5650	3150	9500	1941	13,250	844	12,500	1101	18,750	1785
June	7350	1717	6500	2494	11,000	556	13,000	1357	15,000	1577	18,250	2215
July	6900	2103	8500	3650	11,500	3353	13,500	939	14,000	1323	16,250	2411
August	5900	3028	8350	10,728	10,000	1581	13,000	1584	14,000	2819	15,750	4467
September	5750	4550	8500	6712	9500	2128	13,000	1776	13,500	2195	15,250	3896
October	5500	2383	5600	4352	11,000	5633	13,500	1466	14,500	1854	15,750	2605
November	6250	6090	7350	3094	9000	2567	13,500	1715	14,500	2128	16,500	2880
December	7250	2721	8250	1482	12,500	2734	13,500	6738	16,000	2176	19,000	5123
Total		31,786		61,980		31,637		26,195		27,538		35,207
Annual average price	7100		7633		9397		13,063		13,688		16,521	

Price in Sudanese dinar.
Sources: Animal Resources Services Company, Sudan, unpublished data.

Appendix 4 Monthly sales volume and prices of adult male sheep in el Damazeen livestock market, Blue Nile State

Month	2001		2002		2003		2004		2005		2006	
	Average price	Sales	Average price	Sales	Average price	Sales	Average price	Sales	Average price	Sales	Average price	Sales
January	16,500	2380	14,500	2310	14,500	3600	12,500	4700	16,000	4500	16,500	2610
February	19,750	3000	17,500	3100	16,250	3900	12,500	3450	12,750	3100	14,000	1200
March	13,500	2370	17,500	3425	16,250	4150	13,250	2850	12,750	4200	13,250	700
April	13,500	2300	16,500	2375	18,00	3970	13,500	2000	14,250	3270	13,500	3100
May	14,500	2820	19,000	2900	17,000	3200	13,250	2005	17,000	2800	13,750	4000
June	15,500	2200	14,000	2070	15,500	2870	14,000	1005	16,250	7200	14,600	5200
July	13,500	2000	16,500	1300	13,500	2807	16,750	615	16,750	1613	17,600	786
August	14,750	2900	16,500	1200	13,500	2300	16,750	573	16,500	653	17,500	747
September	14,000	2200	14,750	1500	13,500	1930	16,750	620	18,000	1100	17,500	489
October	17,000	2315	13,500	1900	14,750	2107	19,750	413	15,000	1250	18,000	5030
November	17,000	2500	16,500	2800	14,500	2215	19,750	1220	17,000	1300	16,500	9500
December	15,750	1800	16,500	2917	14,000	2317	18,250	1816	20,000	2300	13,500	3200
Total		28,758		27,797		35,366		21,267		33,286		36,562
Annual average price	14,437		16,104		15,354		15,584		16,021		15,517	

Price in Sudanese dinar.
Sources: Animal Resources Services Company, Sudan, unpublished data.

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