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The Contribution of Livestock to the Sudanese Economy

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ACKNOWLEDGEMENTS

This work was made possible through the combined support of the Ministry of Animal Resources and Fisheries and the Sudan Central Bureau of Statistics, Republic of Sudan, and the Livestock Policy Initiative of the Intergovernmental Authority on Development, IGAD. We would particularly like to thank the following IGAD LPI staff: Dil Peeling, Chief Technical Adviser; Dr. Abdi Jama, Livestock Information Adviser; and Dr. Ammar Idris, National Technical Focal Point. Without their enthusiasm and persistence this report would not have been possible. Equally, this report could not have been written without access to material on livestock production collected by the Ministry of Animal Resources and Fisheries and without the assistance of numerous MOLD officers in interpreting this data. We would especially like to recognize the assistance of Dr. Fatima Mukhtar Mohammed, Director of the Information Center. We also appreciate the guidance of Hassan Ibrahim Hassan, National Accounts Director in the Central Bureau of Statistics. Dr. Hassan Ibraheim Khatab was instrumental in locating for us published sources on livestock production in Sudan which are no longer generally available, and Helen Young made available to us the Tufts University digital collection of material on pastoralism in Sudan.

DISCLAIMER

This report on Sudan is part of a series of Working Papers on The Contribution of Livestock to GDP in the IGAD Member States. These papers were planned and commissioned by the Inter-Governmental Authority on Development's Livestock Policy Initiative (IGAD LPI). The purpose of these papers is to provide support to Livestock Policy Hubs in the Member States to use study outcomes in their engagements with PRSPs processes in their respective countries to advocate and ensure that the representation of livestock in these national strategy documents is commensurate with its important contribution to economic growth, poverty reduction and food.

The designations employed and the presentation of material in this publication do not imply the expression of any opinion whatsoever on the part of either the Food and Agriculture Organization of the United Nations or the Inter-Governmental Authority on Development concerning the legal status of any country, territory, city or area or its authorities concerning the delimitations of its frontiers or boundaries.

The opinions expressed in this paper are solely those of the authors and do not constitute in any way the position of the FAO, IGAD, the Livestock Policy Initiative nor the governments studied.

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ABBREVIATIONS

GDP	Gross domestic product
IGAD	Intergovernmental Authority on Development
ILCA	International Livestock Centre for Africa
ILRI	International Livestock Research Institute
LPI	Livestock Policy Initiative
MARF	Ministry of Animal Resources and Fisheries
ISIC	International Standard Industrial Classification of All Economic Activities
SDG	Sudanese pound
SNA	System of National Accounts
TLU	Tropical Livestock Unit
SCBS	Sudan Central Bureau of Statistics

EXECUTIVE SUMMARY

This is the fourth in a series of reports on the contribution of livestock to the economies of the IGAD member states. Building on methodologies developed in earlier studies of the role of livestock in the economies of Ethiopia and Kenya, the present report undertakes an assessment of the contribution of livestock to Sudan's national economy. Conventional GDP accounting may ignore some of the benefits that people derive from livestock in subsistence-oriented economies, when households directly provision themselves, when economic exchanges are not calculated in monetary terms or when these exchanges go unrecorded. The present study assigns monetary values to the non-marketed goods and services provided by livestock, and estimates the contribution of livestock to the wider national economy - as exports, as inputs into manufacturing industries, and as a component of household consumption.

Official national accounts estimates are produced by the Sudan Central Bureau of Statistics (SCBS), and the Ministry of Animal Resources and Fisheries (MARF) is the single most important source of official data on livestock production and trade. This report refers to the Republic of Sudan prior to the independence of the Republic of South Sudan; the report therefore covers both North and South Sudan.

This report supports the following conclusions:

1. Estimates of the contribution of livestock to Sudan's economy are beset by one abiding challenge: the absence of reliable, current data. There are multiple deficiencies, but above all, no one knows how many livestock there now are in Sudan, the last national livestock census having taken place thirty-six years ago.
2. Official estimates of the size of Sudan's livestock populations are produced by MARF based on a herd growth model. The growth parameters in this model are not unreasonable and conform, in general, to those in the scientific literature reviewed in this report. However, there are theoretical reasons to doubt the suitability of the model, which depicts reasonably stable rates of herd growth irrespective of the effects of livestock numbers on resource availability, or the impact of fluctuating weather, security and market conditions. Unfortunately, the small number of state-level livestock surveys that have been conducted since the last national census in 1976 point in no consistent direction and do little to clarify the national situation.
3. In the late 1990s when oil exports were beginning, the agricultural sector produced about 40% of total national GDP. From 2006 to 2010, with petroleum now contributing over 11% to total GDP, the contribution of the agricultural sector averaged about 31% of the national gross domestic product.
4. With no conclusive evidence to support alternative national livestock population estimates, we have based calculations in this report on the official livestock population estimates produced by MARF. On this basis, our estimates of the contribution of livestock to national agricultural sector GDP - 33.843 billion SDG in 2009 (or about \$14.550 billion USD at 2009 exchange rates) - are broadly similar to the official 2009 estimates by SCBS - 28.670 billion SDG (about \$12.326 billion USD). The difference between these two estimates is 5.173 billion SDG, or a re-estimated increase of 18% over the official figure in 2009. Whereas the official figures for 2009 estimated a percentage contribution of the agricultural sector of just over 33% to total GDP, our revised estimates would now place that contribution at just over 36%. When compared

with the imprecision caused by uncertainties regarding the size of the national herd, these are negligible differences, and constitute an endorsement of SCBS's official estimates, subject to the reservations about data availability stated above.

5. In addition to their contribution to agricultural sector GDP, livestock provide a further 8.409 billion SDG in financial and transport services to their owners. Using conventional and internationally recognized accounting methods, these direct use benefits are either excluded from national accounts estimates or cannot be attributed to livestock.
6. The official figures nonetheless reveal the very significant contribution made by livestock to Sudan's domestic economy. Sudan's agricultural sector GDP includes crop, livestock, fisheries and forest production. Using official SCBS statistics, livestock has consistently provided more than 60% of the estimated value added to this sector in recent years, and is a substantially more important contributor to agricultural sector GDP than crop farming. With the advent of oil production and exports in the late 1990s, the relative contribution of the agricultural sector to national GDP has declined, but at no time in the last decade has the contribution of petroleum to GDP come close to equalling the contribution of agriculture, of which livestock provides the biggest part. Livestock is by value the largest subsector of Sudan's domestic economy, larger even than petroleum.
7. While not as large as its domestic economic contribution, livestock's share of exports is considerable, and it is growing. Official reports from the 1950s through the early 1970s suggest that livestock and livestock products constituted at that time about 6-7% of agricultural exports in most years. Since 1997, however, they have averaged 27% of agricultural exports, up to 47% in 2009. It would appear that the era in which crops dominated the agricultural export scene is long past. Taking a balanced view of their combined domestic and export significance, the livestock and crop subsectors are relatively evenly balanced in their contribution to the national economy.
8. Approximately 18% of total private expenditures for consumption - including both purchased items and home produce - are spent by households in Sudan on acquiring livestock products. Annually about 41 kg of meat and 26 kg of milk (either as fluid milk or converted to dairy products) are available per capita for domestic consumption.
9. According to the approximate calculations undertaken in this report, more than 70% of Sudan's livestock value added comes from northern Sudan (see Annex II 'Livestock population by states -2009' for a list of northern and southern states). The concentration of livestock output in northern Sudan suggests that, at least for the north, the independence of the Republic of South Sudan is unlikely to diminish the economic significance of livestock.
10. In common with the other IGAD states, there is insufficient data to quantify the contribution of animal power to Sudan's economy, despite the recognized significance of work animals in crop production and transport. We could not find adequate evidence on the extent of the unofficial cross-border trade in live animals from Sudan, and cannot even hazard a guess as to the magnitude of this trade. Adequately documented, these unrecorded uses of livestock would further enlarge the existing estimate of the economic significance of livestock.

These conclusions support the following recommendations:

1. It is essential that a livestock census or large scale sample survey be undertaken as soon as possible in both north and south Sudan. Until a reasonably complete national census or large-scale livestock survey has been conducted, there can be no compelling answer to the question of the economic value of Sudanese livestock and livestock products.
2. With technical support from interested international and national research institutes and universities, MARF and KNBS should undertake a national survey of the value of animal power to the economy in northern Sudan and of the role of animal power in sustaining both rural and urban livelihoods. This survey should include all forms of animal traction, transport and haulage by all species of working animals - cattle, equines and camels - in rural and urban areas and in all economic sectors - agriculture, manufacturing and services. As well as the commercial provision of animal power, the survey should assess the monetary value of the services that working animals directly provide for their owners.
3. Ignorance about the economic importance of animal power is a regional phenomenon, and our recommendation regarding research on animal power applies equally to Ethiopia, Kenya and Uganda, three other countries where IGAD is currently conducting studies on the economics of livestock and livelihoods. IGAD should consider introducing a region-wide programme of work on the economics of animal power, a subject that is chronically neglected by both academic research and government agricultural monitoring systems.
4. In Ethiopia, over half of livestock exports are unofficial, but at least the magnitude of the unofficial trade can be roughly estimated from academic and project-based studies. The same is not true for either northern or southern Sudan, where we know that unofficial cross-border live animal trading exists but there is insufficient evidence to estimate the importance or size of trade flows. As a regional organization committed to regional trade, IGAD should support investigations of unofficial livestock trading from both northern and southern Sudan. Some idea of the extent of this trade is essential to formulating policies to support regional economic integration.
5. Despite data shortcomings mentioned above, it is clear that livestock are the largest subsector of the Sudanese domestic economy and are a growing contributor to exports. The great bulk of all livestock production - possibly 90% of the total, though no one really knows the actual figure - comes from small holders and migratory producers. To a remarkable extent, the Sudanese economy is based on a combination of mobile and sedentary pastoral and agro-pastoral production by farming and herding households in almost every region and state. While it is beyond the remit of this consultancy to recommend specific policies, it is essential that Sudanese policy makers recognize the centrality of pastoralism to their economy and take practical steps to support the livestock sector.

1. INTRODUCTION - METHODS AND SCOPE OF THE PRESENT STUDY

This is the fourth in a series of reports on the contribution of livestock to the economies of the IGAD member states. The objective of this report is to assess the extent to which livestock's contribution to the Sudan national economy is reflected in national accounts, if necessary by assigning monetary values to the non-marketed services that livestock provide.

The overall objective of the IGAD Livestock Policy Initiative (LPI) is to enhance the contribution of the livestock sector to sustainable food security and poverty reduction in the IGAD region. The LPI project covers IGAD member states Djibouti, Ethiopia, Kenya, Somalia, Sudan and Uganda. The first report in this series examined the contribution of livestock to Ethiopia's agricultural sector GDP (IGAD LPI Working Paper No. 02 - 10, 2010). Additional reports on Ethiopia (IGAD LPI Working Paper No. 02-11) and Kenya (IGAD LPI Working Paper No. 03-11) expanded the scope of the original investigation to examine livestock-related economic benefits that are not conventionally considered to be part of official GDP estimates.

Building on methodologies developed in these earlier studies, the present report undertakes an assessment of the contribution of livestock to Sudan's national economy. Conventional GDP accounting may ignore some of the benefits that people derive from livestock in subsistence-oriented economies, when households directly provision themselves, when economic exchanges are not calculated in monetary terms or when these exchanges go unrecorded. The present study assigns monetary values to the non-marketed goods and services provided by livestock, and estimates the contribution of livestock to the wider national economy - as exports, as inputs into manufacturing industries, and as a component of household consumption.

1.1 A production-based method for estimating agricultural output

The estimation techniques that we will use in this study were piloted previously in investigations into Ethiopian and Kenyan livestock production (IGAD LPI WP. Nos. 02-11 and 03-11). Analysis proceeds in four stages, beginning with national livestock population estimates, in this case projections of national livestock populations provided by the Ministry of Animal Resources and Fisheries (MARF). In the second stage, production coefficients (estimates of the amount of physical product that will on average be produced by known number of animals) are applied to the livestock population estimates to generate estimates of the total output of goods such as meat, milk, dung for fuel or fertilizer, etc. Third, based on available information on producer or 'farm gate' prices, a monetary value expressed in Sudanese pounds (SD) - the gross value of production - is ascribed to the total output of each kind of livestock product. Finally, input costs (based in this case on information currently available in the national accounts) are deducted from the gross value of output to derive value added, the unit in which GDP is expressed.

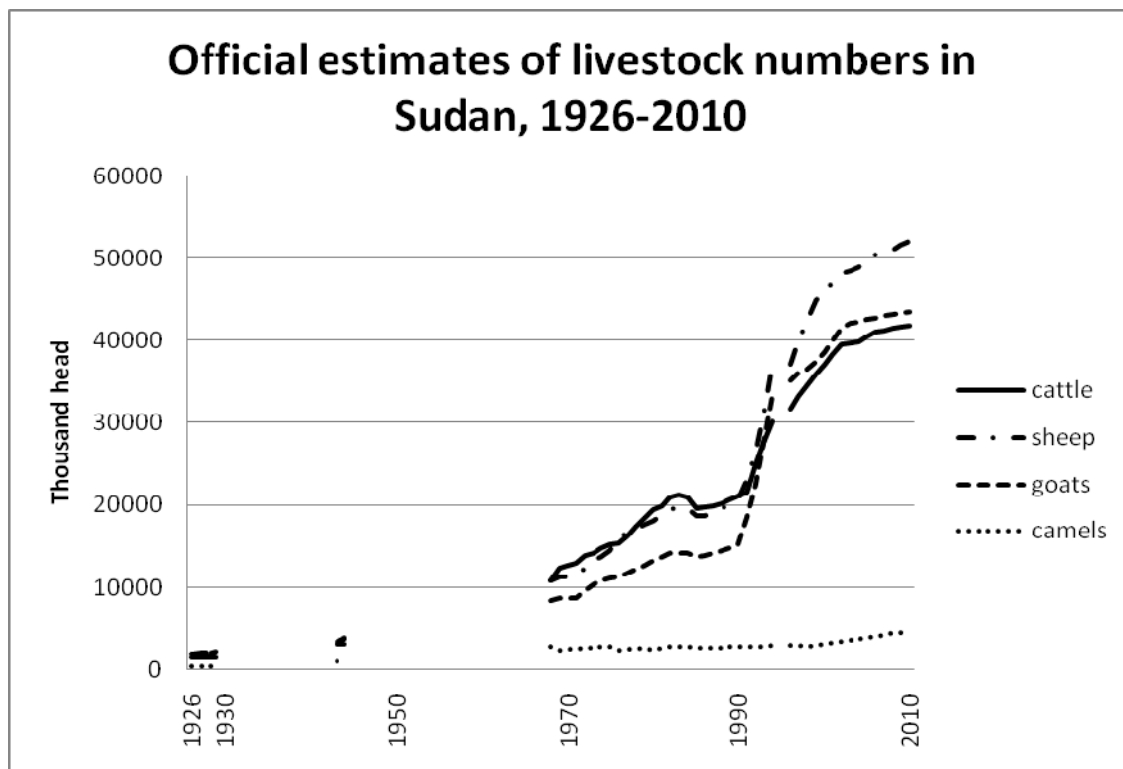
Using this approach, initially no distinction needs to be made between production destined for commercial sale, for immediate consumption by producers, or for export. This is an advantage in a semi-commercialized economy, such as Sudan's livestock sector, in which livestock owners consume a significant portion of what their herds produce. Home production for home consumption (or for informal local exchange and consumption) is frequently unrecorded in official marketing statistics. By basing estimates on total product output, Sudan's livestock GDP

estimates do not rely on incomplete marketing data and should, in principle, include subsistence production.

In officially estimating agricultural GDP, the Sudan Central Bureau of Statistics (SCBS) generally follows the approach outlined above. The problem in Sudan is that the accuracy of the entire calculation rests on an estimate of the size of the country's livestock population, and there has been no attempt to count the national herd since an aerial census was conducted in 1975 (Watson et al. various volumes from 1976 and 1977). Figure 1 presents current official estimates of the numbers of livestock in Sudan from the early 20th century to the present.

The numbers in Figure 1 have been generated by a variety of estimation procedures: the subjective estimates of experienced senior veterinary officers in the colonial period, an aerial survey in 1975, constant assumed rates of growth, and since the late 1980s, a herd growth and output model (Arab Organization for Agricultural Development 1987). Except during an extreme drought in the mid-1980s, all these estimation techniques depict an ever larger national herd, with remarkably high rates of growth in the 1990s.

Figure 1



Source: MARF

The accuracy of these estimates is questionable simply because projections - however carefully they are constructed - are unlikely to reflect the dynamics of herd growth or decline over a thirty-six year period. There are also theoretical reasons to suppose that the official livestock population estimates are unlikely to be accurate. There are two generally accepted interpretations of herbivore/livestock population dynamics - disequilibrium and equilibrium models (Ellis and Swift 1988; Caughley 1977) - and the Sudanese herd growth model conforms to neither of these alternatives. In the disequilibrium model, population changes are driven by climatic factors that cause abrupt shifts in animal mortality and reproductive rates, and

correspondingly large swings in animal numbers. In the equilibrium model, population changes are driven by incremental 'density dependent' alterations in recruitment and death rates, basically a slowing of herd growth as animal numbers approach carrying capacity.¹ The official Sudanese model to predict herd growth assumes relatively constant reproductive/recruitment and mortality rates irrespective of herd size and current weather conditions, and resembles neither theoretical alternative.

Preparations may be afoot in the Ministry of Animal Resources and Fisheries to undertake a new livestock census, but the results of any new livestock census would, at best, be available in several years. In the meantime, a clearer understanding of the size of Sudan's national herd depends on a re-examination of evidence that is currently available. At least seven states have attempted to count their livestock - either from the air or using ground surveys - since the last national aerial count of 1975: Jonglei in 1983, Gezira in 1986, Red Sea in 1989, Khartoum in 1999, River Nile in 2006 and North and South Kordofan in 2010. Annex II assembles - we believe for the first time - the results of these state-level censuses, the 2010 national and state-level official projections, and the estimates from the 1975 aerial census for individual states. This material points to several conclusions:

- The censuses in Gezira and Red Sea State were undertaken in the 1980s following a severe drought that caused widespread livestock die-offs. These censuses record much steeper falls in livestock numbers than the declines depicted nationally in official estimates (Fig. 1). Livestock producers in Gezira have unusually good access to irrigated forage; livestock production in Red Sea State is reliant on very low and erratic rainfall. These are by Sudanese standards two contrasting environments for livestock keeping. That both of these states recorded large declines in livestock numbers suggests that official estimates underestimated herd losses due to drought in the 1980s.
- The 2010 census results and 2010 official estimates of livestock numbers in South Kordofan are roughly similar, a remarkable result given that official estimates have been extrapolated from data last collected in 1975.
- The 2010 census results and official estimates of livestock numbers in North Kordofan are very different for each herd species, but the official estimates are roughly equivalent to the surveyed livestock biomass estimates when the different herd species are converted to the standard TLU (Tropical Livestock Unit, equal to 0.7 cattle, 1 camel, or 0.1 sheep or goats). The 2010 official livestock population estimates (Table 1) were generated by a model that assumes constant conditions. In comparison to actual 2010 survey results, the official model has underestimated the number of sheep by several orders of magnitude and overestimated the numbers of all other herd species. There would appear to have been a dramatic shift in the species composition of Kordofan herds in favor of Sudan's most important livestock export species - sheep.

¹ Observers were predicting a slowing of herd growth in Red Sea Province as early as 1989: '... the survey area [Red Sea Province] as a whole may be supporting as many animals as it can permanently sustained, and ... there is little room for further increase without improvements in productivity or rangeland quality....the general conclusion that the livestock populations are close to their sustainable limits must be accepted.' (ERGO 1990: 89).

- River Nile census results for 2006 and official estimates for 2009 are substantially at variance both in terms of total livestock biomass and in terms of the estimated populations of different herd species.
- The census returns for Jonglei (1983) and Gezira (1986) are based on several aerial counts conducted at different times of the year, and document wide seasonal swings in livestock populations due to nomadic herd movement. These fluctuations underscore the unavoidable degree of imprecision in livestock population estimates in particular pastoral areas that are used by mobile herds.

In sum, the state-level livestock census since 1975 point in no consistent direction, sometimes matching and sometimes deviating from official estimates by a wide margin. In addition to the problems of modeling biological growth rates over many generations, recent survey results from North Kordofan point to another complicating factor: economic change. The growth in sheep numbers at the expense of other herd species in North Kordofan suggests that producers in that state are responding to the economic opportunities presented by sheep exports, and that biological modeling alone is not enough to capture the changing composition and size of the national herd. Changes in herd species composition have also taken place in response to the loss of pastures to large-scale agricultural schemes, and the subsequent re-integration of new livestock husbandry systems into the schemes (Abu Sin 1982; DEVCO-RIM 1987; ERGO 1990).² The only tentative conclusion that can be drawn is that the accuracy of official estimates - when these are finally field checked - is likely to vary state by state.

This report will nonetheless use the official livestock population estimates to calculate the contribution of livestock to agricultural GDP. There is no reason to suppose that these figures are particularly accurate, but we employ them because:

- They are official
- There is insufficient available evidence to adjust or amend the official figures to make them more reliable.

A truly compelling case for the national economic importance of livestock depends on a new national livestock census.

1.2 Organization of the report

This report is divided into two parts.

Part I examines what some economists have termed the 'direct use values' of livestock in Sudan. Direct use values, which will be defined in greater detail in the introduction to Part I, include the kinds of agricultural outputs that are enumerated in conventional GDP estimates. The calculations undertaken in Part I will therefore provide a means to cross-check current Sudan GDP estimates for livestock production against a new set of estimates. Part I also examines two kinds of

² Writing in the late 1970s, Wilson anticipated shifts in the species composition of South Darfur herds as a result of high animal numbers: 'Cattle numbers can be expected to decrease in future years, mainly as a result of the continuation of poor reproductive levels and high death rates. Sheep ... are likely to maintain their numbers...The ability of goats to reproduce, grow, and survive under conditions of deteriorating fodder production, their eclectic dietary tastes and efficiency of food conversion enable them to do well under present Darfur conditions. ...a decrease in cattle numbers will almost inevitably mean and increase in goat numbers....The shift from grazing to browse as the principal source of protein is a further advantage to [camels]. Their numbers in the area, particularly in the dry season, can be expected to increase.' (Wilson 1977: 504, 507).

economic contributions made by livestock - to financial services and to transport, traction and haulage - that are poorly represented in standard GDP calculations organized according to international conventions. Though not exclusively, both of these kinds of economic activity tend to directly support the livelihoods of livestock owners.

Part II of the report examines some of the non-agricultural contributions livestock make to the wider Sudanese economy. Agricultural GDP is based on the value of unprocessed or lightly processed agricultural produce at point of first sale. Some agricultural produce is consumed at this stage, but much is taken up by other sectors of the economy that use it, modify it, and add value to it. As these livestock goods and services transit through the wider economy they continue to contribute to national GDP, not in the form of agricultural output but classified now as services or manufactured products. The GDP benefits derived from livestock in this way appear under a variety of accounting headings and are not readily attributed to livestock, which makes it difficult to assess the full extent of livestock's influence on the national economy. To remedy this situation and to gain a clearer understanding of the size of the livestock sector and the economic linkages between livestock production and the wider economy, Part II of the report examines three different ways Sudanese make use of livestock outputs - for private consumption, as exports, or as inputs into other domestic industries.

2.PART I: DIRECT USE BENEFITS OF LIVESTOCK

2.1 Introduction

Direct use values refer to livestock outputs in the form of goods and services, both marketed and for non-commercial or subsistence use. The concept of direct use value was developed by economists attempting to quantify the economic benefits derived from the natural environment (Barbier 1993) and has subsequently been applied to livestock (Hesse and McGregor 2006).

Direct use values include but are broader than conventional definitions of Agricultural GDP. Agricultural GDP expresses in monetary terms the value of the goods that livestock produce - items such as live animals for slaughter and dairy products, manure, fibres, hides and skins. As long as enough of these products are traded to establish a producer price, home-produced goods that are directly consumed by livestock owners are routinely included in agricultural GDP, though there may be practical difficulties in estimating the volume and value of these subsistence goods. Estimates of agricultural GDP therefore include, or should include, the value of both marketed and un-marketed or informally marketed goods produced by livestock. The same cannot be said for the un-marketed services that livestock provide for their owners. For reasons discussed later in this report, the financial services provided by livestock - as credit, insurance or savings - are excluded entirely from GDP calculations, and only a part of the benefits derived from animal power are recognized, usually as contributions to transport rather than agricultural sector GDP.

The concept of direct use value pulls together under one heading all the various economic benefits derived from livestock - from both goods and services, whether they are marketed or for subsistence, both in the agricultural and other sectors of the economy. This is useful for an analysis, like the present one, that attempts to construct a comprehensive estimate of the economic benefits derived from livestock. The concept of direct use also includes a broad range of livelihood benefits that livestock owners depend upon in practice, but which cannot for technical reasons be incorporated into national accounts. The concept of direct use therefore provides a more balanced expression than GDP accounting of the economic reasons why livestock owners keep and value their animals. Since agricultural GDP is one component of direct use value, it is nonetheless possible to compare the results of this more inclusive assessment with those based on national accounting guidelines.

The following sections of Part I estimate the value of the goods and financial services provided by livestock to the Sudanese economy. The economic contribution of animal power is briefly discussed but there is insufficient evidence to quantify the value of these services.

2.2 Live animal offtake and milk output

The monetary values of meat and milk output are the main components of official estimates of the contribution of livestock to agricultural GDP. We therefore begin our appraisal with an estimation of these values.

2.2.1 Cattle milk

Dairy output is a complex result of the interaction of multiple variables - the percentage of cows in the herd, the proportion of those cows that lactate per year, output per lactation, the level of extraction for human use, etc. For comparative purposes, the interplay of these factors is

summarized in a single measure in Annex III: litres of milk offtake for human consumption per 100 head of cattle.

In modelling cattle milk and meat production, MARF assumes that 25-30% of the herd is male and a corresponding percentage, 70-75%, is female and that adult females have an annual calving rate of 63-66% with a milk yield for human consumption of 336 litres per cow per lactation. The research literature cited in Annex IV suggests a mean lactation yield per cow in South Sudan of about 317 litres or milk output per lactation of 82.3 litres of milk production for human consumption per head of cattle in southern herds. For northern Sudan the literature summarized in Annex III suggests a mean lactation yield of 663 litres per cow producing milk output for human consumption of 160 litres per head of cattle. In both northern and southern cattle herds, a little more than 40% of the herd consists of breeding females and about a quarter of all cattle are giving milk each year.

- A. North Sudan cattle 29,210,477 head (Annex II)* 160 litres of milk per head = 4,673,676,320 litres or 4,673,676 tons of milk for human consumption * 1952 SDG/ton = 9,123,015,552 SDG in 2009
- B. South Sudan cattle 12,352,525 head (Annex II)* 82.3 litres of milk per head = 1,016,612,807 litres or 1,016,613 tons of milk for human consumption * 1952 SDG/ton = 1,984,428,576 SDG in 2009.
- C. Total Sudan cattle milk production for human consumption: A + B = 5,690,289 tons in 2009 * 1952 SDG/ton = 11,107,444,120 SDG

2.2.2 Camel milk

In modelling camel milk production, MARF assumes that breeding females make up 47-48% of the national camel herd with an average annual calving rate of 52%, yielding on average 36 litres of milk per lactation for human consumption. The studies summarized in Annex V suggest a mean lactation yield per female camel of 1762 litres, or on average the production of 368 litres of milk for human consumption per head of camels. Using the production estimates developed for this report, in 2009 the 4,520,999 camels that officially existed in northern Sudan produced an estimated 1,663,727,632 litres or 1,663,728 tons of camel milk for human consumption. According to official estimates, there are no camels in southern Sudan.

- A. 4,520,999 head of camels in North Sudan (Annex II) * 368 litres of milk for human consumption per head = 1,663,727,632 litres or 1,663,728 tons of camel milk for human consumption * 1952 SDG/ton = 3,247,597,056 SDG in 2009.

2.2.3 Sheep and Goat Milk

In modelling sheep milk production, MARF assumes that breeding ewes constitute 69-70% of the flock and have a lambing rate of 112% per annum and a milk yield for human consumption of 18 litres per lactation, or 18 litres * 1.12 = 20.16 litres of milk for human consumption per year per breeding ewe, or 20.16 *.7 = 14.1 litres of milk production for human consumption per head of sheep, assuming that breeding ewes are 70% of the national sheep flock.

In modelling goat milk production, MARF assumes breeding nannies constitute 69-70% of the flock and have a kidding rate of 114% per annum and a milk yield for human consumption of 64 litres per lactation. Using these assumptions, annual milk yield per nanny is 64 * 1.14 = 73.0 litres per

nanny per year, or $73 * .7 = 51.1$ litres of milk production for human consumption per head of goats, assuming that breeding female goats constitute 70% of the national goat flock.

Insufficient research has been conducted on milk production by small stock in Sudan to permit an appraisal of MARF's milk yield estimates (see Annex VI for a summary of the available evidence). Employing MARF's assumptions, north and south Sudan produced the following volumes of goat and sheep milk in 2009:

- A. South Sudan goats 12,937,730 head * 51.1 litres of milk per head = 661,118,003 litres or 661,118 tons for human consumption * 1952 SDG/ton = 1,290,502,336 SDG in 2009
- B. South Sudan sheep 12,811,421 head * 14.1 litres of milk per head = 180,641,036 litres or 180,641 tons for human consumption * 1952 SDG/ton = 352,611,232 SDG in 2009
- C. North Sudan goats 30,332,270 head * 51.1 litres of milk per head = 1,549,978,997 litres or 1,549,979 tons for human consumption * 1952 SDG/ton = 3,025,559,008 SDG in 2009
- D. North Sudan sheep 38,743,585 head * 14.1 litres of milk per head = 546,284,548 litres or 546,285 tons for human consumption * 1952 SDG/ton = 1,066,348,320 SDG in 2009
- E. Total Sudan goat milk production for human consumption A + C = 2,211,097 tons * 1952 SDG/ton = 4,316,061,344 SDG in 2009
- F. Total Sudan sheep milk production for human consumption B + D = 726,926 tons * 1952 SDG/ton = SDG in 2009

2.2.4 Cattle offtake

In modelling cattle offtake, MARF assumes an extraction rate of approximately 15% of the total herd, with an average dressed slaughter weight of 146 kg for domestic consumption and 200 kg for export. Available evidence supports MARF's 15% extraction rate. In North Sudan, roughly this percentage of the herd is sold or slaughtered per year. In South Sudan, roughly this percentage of the herd is sold, slaughtered, or dies and is consumed per year. There is, however, scant evidence on recent offtake rates (i.e. in the last quarter century) in either North or South Sudan. Given fluctuating levels of insecurity and increased commercial involvement by pastoral producers, current offtake rates could well be substantially different from those in published sources. Evidence available to this study is summarized below:

- In the Jonglei area of South Sudan in the 1970s, intentional disposal was 7.1% (Payne and El Amin 1977) and total disposal was 12% per annum including animals that had died, a large proportion of which will be eaten (Niamir 1982).
- Fellata and Dinka cattle in Bahr el Ghazal Province had an annual offtake rate of 3.4% with annual mortality running at 12.3%. If fallen animals are consumed, the offtake rate is somewhat less than 15.7% (Zessin and Baumann 1985).
- Total offtake (sales and consumption) in South Darfur is 16% with a death rate of 19% (which are not consumed) (Wilson et al. 1980).
- In two-year study of Dinka herds in the Jonglei area, 26.2% of animals exited herds on an annual basis, broken down as follows: The annual gross offtake rate was 14.81%

(consisting of death, sales, sacrifice and debt or fine payments); 9.23% of the herd left to circulate in pastoral society in marriage payments or other social exchange arrangements; and 2.17% was lost and unaccounted for (calculations based on Howell et al. 1988, pages 279, 294-5; and Mafit-Babtie 1983, page 88).

- 34.3% of cattle recorded in progeny histories in Red Sea Province (ERGO 1990) either were eaten or sold, but this is not an annual rate.
- A. Cattle offtake North Sudan: $29,210,477 \text{ head of cattle} * .15 = 4,381,572 \text{ head} * 1079 \text{ SDG/head in 2009} = 4,727,715,702 \text{ SDG}$
- B. Cattle offtake in South Sudan: $12,352,525 \text{ head of cattle} * .15 = 1,852,879 \text{ head} * 1079 \text{ SDG/head in 2009} = 1,999,256,171 \text{ SDG}$
- C. Total cattle offtake in Sudan A + B = $6,234,451 \text{ head of cattle} * 1079 \text{ SDG/head in 2009} = 6,726,972,629 \text{ SDG}$

2.2.5 Camel offtake

In modelling camel offtake, MARF assumes an average yearly extraction rate of 16-19% of the herd and a dressed weight of 155 kg per head. In this study we will employ MARF's lowest estimated offtake value of 16% annually, in line with the scanty available evidence, cited below:

- 15% (annual sales and consumption) in South Darfur (Wilson et al 1980).
- 24% sales of camel progeny in Red Sea study (ERGO 1990); this is not an annual rate.
- 15% annual offtake Butana (Abbas et al 1992)

Camel offtake in North Sudan (and for Sudan as a whole since there are negligible numbers of camels in South Sudan) can be estimated as:

A. $4,520,999 \text{ (head of camels in 2009)} * .16 = 723,360 \text{ head} * 1024 \text{ SDG/head} = 740,720,640 \text{ SDG in 2009.}$

2.2.6 Sheep and goat offtake

MARF modelling assumes a sheep extraction rate of 27% per year, providing carcasses with a dressed weight of 12 kg for domestic consumption and 15 kg for export. In modelling goat offtake, MARF assumes an average yearly extraction rate of 24-26% of the total flock and a dressed slaughter weight of 8 kg per head. Available evidence, though out of date, supports MARF's estimated extraction rates - 27% annually for sheep and 25% annually for goats. We will use these rates in this study; published sources that support this decision are summarized below.

- In the Jonglei area, 35% of male goats and 32% of male sheep; 22% female goats and 18% female sheep were deliberately killed, sold, exchanged or given away by their owners (Howell et al 1988: 295). 67.9% of sheep were female and 72.9% of goats were female. These percentages imply the disposal of 9.5 male goats and 16.0 female goats per 100 head per year and 10.3 male sheep 12.2 female sheep per 100 head per year. The derived goat offtake rate is therefore 25.5% and the offtake rate for sheep is 22.5%.
- In South Darfur the sheep offtake rate is given as 26% and goat at 28% (Wilson et al 1980.)

- ERGO (1990) give sheep progeny sales rates of 26.45 for Beja flocks in Red Sea Province; this is not necessarily an annual offtake rate, but probably approximates one because of the short life cycle of sheep.
 - ERGO (1990) give goat progeny sales rates of 26.6% for Beja flocks in Red Sea Province; this is not necessarily an annual offtake rate, but probably approximates one because of the short life cycle of goats.
- A. South Sudan goats 12,937,730 head * .25 annual offtake = 3,234,432 head * 100 SDG/head = 323,443,200 SDG in 2009
 - B. South Sudan sheep 12,811,421 head * .27 annual offtake = 3,459,084 head * 193 SDG/head = 667,603,212 SDG in 2009
 - C. North Sudan goats 30,332,270 head * .25 annual offtake = 7,583,067 head * 100 SDG/head = 758,306,700 SDG in 2009
 - D. North Sudan sheep 38,743,585 head * .27 annual offtake = 10,460,768 head * 193 SDG/head = 2,018,928,224 SDG in 2009
 - E. Total Sudanese goat offtake in 2009 was A + C = 10,817,499 head * 100 SDG/head = 1,081,749,900 SDG in 2009
 - F. Total Sudanese sheep offtake in 2009 was B + D = 13,919,852 head * 193 SDG/head = 2,686,531,436 SDG in 2009

2.3 Manure as fertilizer/fuel

MARF estimates manure output for different species of livestock (MARF 2009, Table 3-9; see also Niamir 1982), but we could locate no information on the amounts of manure that Sudanese farmers actually used or the prices they were willing to pay to purchase manure that they did not produce for themselves. Without information on rates of use and farm gate prices, it is not possible to place an economic value on manure production.

2.4 Animal power

In 2009 the average sale price of donkeys and horses was 405 SDG per head and 1059 SDG per head, respectively. To put these prices in perspective, in 2009 a donkey was on average worth 38% and a horse was worth 98% of the mean sale price for cattle. That people are willing to pay these prices implies that equines - which have no economic uses aside from transport - provide significant transport benefits that could, in principle, be quantified. Indeed, numerous sources testify to the importance of equines in transporting people, agricultural produce, fuel, and water, but we could locate no studies that estimated the monetary value of these services, and this report therefore contains no estimate based on field observations of the contribution of animal power by ruminants or equines to agricultural or transport sector GDP.

A rough calculation, however, can provide a very approximate idea of the likely magnitude expressed in monetary terms of the direct use value that might be imputed to equine power. In 2009, the capital value of ruminants in Sudan was approximately 47.817 billion SDG and these ruminants produced meat and milk valued at 33.326 SDG, or an annual return to investment in ruminant livestock of about 70% excluding all costs of production. In 2009, the capital value of the 784,578 horses was .623 billion and donkeys were worth 2.283 billion (using official estimates

of equine populations valued at 75% of their sale price, see section 2.5.2), or a combined capital value for equines of 2.906 billion SDG. If we assume that equine owners in Sudan demand a 70% return on their livestock investment comparable to that which they get from ruminants, then the direct use value of the transport services provided by equines amounted to about 2.034 billion SDG in 2009.

2.5 Livestock-based financial services

2.5.1 Livestock as credit

The credit or financing benefits of livestock derive from the ability of livestock owners to dispose of their animals for particular purposes at a time that they choose - their ability to 'cash in' on the value of their animals as needed. This flexibility gives livestock owners access to money without the need to borrow and confers an additional financial benefit beyond the sale, slaughter or transfer value of their livestock. This additional financial benefit can be estimated as the opportunity cost of rural credit - what it would otherwise cost a livestock owner to obtain funds comparable to those produced by liquidating a part of the herd (Bosman et al. 1997). Employing this method of estimation, the additional finance value of a livestock holding is equivalent to the interest that the owners would be required to pay to obtain loans equal to the value of their livestock offtake.

There is evidence that livestock actually function as a substitute supply of credit for their owners in Sudan, in a way that closely replicates the reasoning used to compute this financial component of the value of livestock. Access to credit is a longstanding problem for Sudanese farmers, as the following quotation shows:

Part of the reason for absenteeism [from agricultural holdings on the Gezira Scheme] is the almost perennial cash flow problems of average tenants [of the Gezira Scheme]. Payment for cotton comes long after the need to pay workers for land preparation and harvest work. Although the SGB [Sudan Gezira Board] makes advances for these purposes, the amount provided is widely regarded as inadequate, whilst advances are not made for other crops. As a result, resort to the shail credit system keeps many tenants permanently indebted to local merchants, and off-Scheme employment and sharecropping are strategies to avoid this situation.' (DEVCO-RIM 1987: Appendix IV, page 16)

Pastoralists, who hold large stocks of animals and can use them to meet credit needs, are one sector of Sudanese agriculture that successfully avoids the indebtedness that plagues farmers:

No institutional credit is available for animal owners in this sub-system [pastoral] of agriculture. They rarely look for non-institutional sources and meet all their cash demand from selling animals and animal products' (Gregg and Ahmed 1983: 18).

Our challenge, then, is to estimate the very real value that pastoralists or other livestock owners derive from using animal sales to avoid indebtedness.

There are several impediments to accurately calculating the credit value of Sudanese livestock. One of these is the Islamic prohibition in Northern Sudan on interest bearing loans. Since interest payments serve as a proxy for the credit value of livestock offtake, the absence of such payments is initially a problem.

In northern Sudan Sharia-compliant lending takes several common forms:

- *Murabah* in which the financier provides goods which the borrower pays for in instalments over time, essentially an Islamic equivalent of hire-purchase. The implicit rate of interest in this instance is the difference between the cost to the financier of providing goods relative to the sum of the instalment payments made by the borrower.
- *El-salam* (formal) or *sheil* (informal) forward crop-financing or 'purchase with deferred delivery' (Elhiraika and Ahmed 1998) in which the producers sell part of their future harvest at a price that is lower than its anticipated post-harvest market value. In this case the implicit interest rate is the differential - positive or negative - between the price the farmer receives for selling his crop early to the lender and the price that the farmer would have received by selling after harvest.
- *Musharaka* or profit sharing in which the financier and borrower essentially form a business partnership and share any losses or profits. The implicit interest rate in this case is unclear since these arrangements mix elements of profit taking with any payment of interest.

Murabah, el-salam and sheil transactions, though not musharaka agreements, have implicit interest rates comparable for our purposes to the formal interest charges associated with standard forms of credit. Murabah, el-salam and sheil are common forms of credit provision in northern Sudan and therefore set a de facto interest rate. Table 1 documents the range of implicit interest rates for Sharia-compliant small-scale credit in Northern Sudan.

Table 1 provides additional circumstantial evidence of the importance of livestock as a form of credit self-provision. According to Table 1, the highest implicit credit interest rates - above 100% per annum - come from agricultural areas in which many farmers are likely to have insufficient animals to effectively undertake self-financing. Conversely, interest rates are lowest in Darfur - in the region of 15% or less per annum - where producers have more animals, less need for credit, and hence may be in a better bargaining position if they do seek credit through institutional channels. It should be noted, however, that the evidence on credit in agricultural areas in Table 1 tends to be several decades old, and may reflect conditions before the creation of programmes to make formal credit available to small holders. The apparently extortionate interest rates documented by some studies may also be mitigated by high rates of inflation, which require lenders to charge high nominal interest rates in order to avoid actually losing money. Very few rural credit studies provide information of the rate of currency inflation at the time of the study.

The greatest uncertainty regarding real rural interest rates is caused, however, not by nominally interest free Sharia-compliant lending, but from genuinely interest free private lending. The prevalence of this form of lending and the amounts involved is very poorly documented. Kevane (1993) states that only 19% of loans in the rainfed sector in Butana were likely to be interest bearing (Kevane 1993), but other studies ignore this issue. An idea of the significance of personal lending on mean rural credit interest rates can be estimated from data in Kenya, where we do have a recent national survey that included both institutionalized (formal and informal) and private lending. In Kenya institutionalized credit interest rates in rural areas ran at about 25% p.a., although roughly half of all lending was not conducted through institutions, but was done privately among neighbours, friends and kin. When this personalized lending was taken into

consideration, apparent mean rural interest rates fell from 25% p.a. to 6.3% per annum (KNBS 2006).

Table 1: Sources of agricultural credit and annual interest rates

Region	Credit type	Implicit annual interest rate	Source
National, 2008	Commercial <i>murabah</i> contracts	8-18% p.a.	Khojali and Hansen 2010
Unspecified	Traditional sharecropping	17% of crop, for inputs only	Khojali and Hansen 2010
Darfur	Bank micro finance loans	12-18% p.a.	Khojali and Hansen 2010
Darfur	Short-term loans to retailers by wholesalers	Less than 15-18% p.a.	Khojali and Hansen 2010
Gezira scheme	<i>Sheil</i> to small farmers	About 50%, loan duration uncertain	Adam and Apaya 1973
Gezira scheme	<i>Sheil</i>	3,189% p.a.	Saleem 1987
Rahad scheme	<i>Sheil</i>	4,273% p.a.	Saleem 1987
Gezira scheme and Gedaraf area	<i>Sheil</i> , <i>el-salam</i> and cash	128% p.a. (inflation adjusted)	Elhiraika and Ahmed 1998
National	<i>Murabah</i> bank microfinance	36-48% p.a.	Ibrahim 2003
Kordofan, 1979	<i>Sheil</i>	50% p.a.	Gregg and Ahmed 1983
Unspecified	<i>Sheil</i>	300% p.a.	Mohammed 1986
Gezira Scheme	<i>Sheil</i>	115-280% p.a.	Ali 1986
Gezira Scheme, 1973-4	<i>Sheil</i>	726%	El Medani 1983

If the situation in Kenya is any indication, it is likely that no one actually knows the prevailing average interest rate on rural credit in Sudan. In the absence of Sudanese evidence, we will, in this study, use the rural Kenya interest rate of 6.3% p.a. On this basis, the total estimated value of national livestock offtake in 2009 is given in Table 2.

Table 2: Value of livestock offtake in 2009, SDG

Livestock species	Offtake value northern states	Offtake value southern states	Total
Cattle	4,727,715,702	1,999,256,171	6,726,971,873
Camel	740,720,640	0	740,720,640
Sheep	2,018,928,224	667,603,212	2,686,531,436
Goat	758,306,700	323,443,200	1,081,749,900
Total	8,245,671,266	2,990,302,583	11,235,973,849

At an assumed annual interest rate of 6.3%, the credit value of livestock in northern Sudan can be estimated as 8,245,671,266 SDG (Table 2) * .063 = 519,477,290 SDG; the credit value of livestock in southern Sudan is 2,990,302,583 SDG (Table 2) * .063 = 188,389,063 SDG.

The total imputed value of all Sudanese livestock as a source of credit to their owners is estimated to be 707,866,353 SDG or .708 billion SDG in 2009.

2.5.2 Self-insurance

Part of the insurance or security value of livestock comes from the ability of owners to liquidate their own herds in an emergency. In this instance, the level of security provided to a particular

individual depends on the value of that individual's assets, and livestock ownership functions as self-insurance. The value of this form of asset-based insurance can be calculated as the annual cost that herd owners would need to pay to purchase insurance coverage equal to the capital value of their herd (Bosman et al. 1997).

The state-owned Sheikhan Insurance and Reinsurance Company is the largest insurance company by market share in Sudan and offers a range of policies covering crops (excepting traditional crop production on rain-fed land), livestock (excluding herded livestock), equipment, vehicles and inventory. In Darfur in 2010 the company insured microfinance loans with policies that cost on average 2.4% p.a. of the value of the cover provided (calculated from figures provided in Khojali and Hansen 2010). We will take 2.4% as the prevailing rural insurance rate for estimating the imputed insurance value of Sudanese livestock.

The insurance value of the Sudan national herd is based on an assessment of the capital value of that herd, which is undertaken in Table 3. We have no data on the relationship between the average producer prices that owners receive for livestock when they sell them relative to the average value of the animals that remain behind in their herds. For the purposes of this calculation, we have assumed that the mean value of livestock as capital is 75% of their mean sale value.

The estimated self-insurance value of livestock in the northern states is 34.996 billion SDG * 0.024 = .840 billion SDG in 2009. The insurance value of livestock in southern states is 12.821 billion SDG * 0.024 = .308 billion SDG in 2009.

The total value of livestock in Sudan as asset-based self insurance can be estimated as 1.148 billion SDG in 2009.

Table 3: The capital value of Sudan livestock in 2009

Livestock species	2009 population northern states	2009 population southern states	Assumed mean value/head SDG at 75% of sale price	Capital value of stocks - northern states	Capital value of stocks - southern states
Cattle	29,210,477	12,352,525	809	23,631,275,890	9,993,192,725
Sheep	38,743,585	12,811,421	145	5,617,819,825	1,857,656,045
Goats	30,332,270	12,937,730	75	2,274,920,250	970,329,750
Camels	4,520,999	0	768	3,472,127,232	0
Total	-	-	-	34.996 billion SDG	12.821 billion SDG

2.5.3 Risk pooling

Like all farmer-managed livestock, pastoral animals will have the self-insurance value that can be ascribed to all livestock in Sudan, as discussed in the previous section. For pastoralists the insurance value of livestock derives not only from their ability to liquidate their individual herds, but also from their ability to call upon assistance from fellow pastoralists in time of need. These collective insurance schemes are based on the gifting and loaning of livestock within pastoral communities. Since transfers are in-kind - meat, milk, live animals and traction/transport services - contributions into these systems are roughly comparable to withdrawals from them. The value of the system from the perspective of resource givers and receivers is therefore approximately equal: recipients extract a level of support from the system that equals what donors are willing to

contribute. The value of this communal system of livestock insurance is therefore equal to the level of livestock loaning and gifting within a pastoral community.

Recent research in southern Ethiopia and northern Kenya suggests that about 10.5% of pastoral livestock in these countries is shared (Barrett et al. 2006; McPeak et al. forthcoming 2011). With respect to Sudan, in the early 1980s, more than 9% of Dinka cattle left their owners herds each year to circulate within pastoral society, either as marriage payments (6.8% annually) or to meet other social obligations (2.4% annually; calculations based on Howell et al. 1988, pages 279, 294-5; and Mafit-Babtie 1983, page 88). There is no information on how long cattle are likely to live after these transactions, but if they live for five or six years following transfer, then about half of all cattle in a normal southern herd were animals that had been exchanged with other pastoralists. This is, moreover, a conservative estimate of the proportion of socially obligated cattle in these herds, for at least among the Nuer, the offspring of exchanged female animals keep alive the social links represented by their dams (Hutchinson 1996). The result is a tightly integrated, cattle denominated social system in which the only animals that do not link together multiple people are those that have been purchased by their owners in the market (Hutchinson 1996). When cattle are such an integral part of social relations, it is not immediately obvious how to quantify their contribution to social and economic security. For purposes of this calculation, 10.5%, as in Kenya and Ethiopia, is a conservative estimate of the proportion of pastoral animals in southern and northern Sudan that are potentially subject to risk-pooling lending/borrowing arrangements.

If 10.5% of all pastoral animals in Sudan are involved in livestock sharing networks and if 90% of the national herd is owned by pastoralists, the financial benefits derived from risk pooling or collective insurance can be calculated as follows:

- In northern Sudan 34.996 billion SDG (the capital value of northern livestock, Table 3) * 0.9 * 0.105 = 3.307 billion SDG as the value of group-based livestock risk pooling in 2009.
- In southern Sudan 12.821 billion SDG (the capital value of southern livestock, Table 3) * 0.9 * 0.105 = 1.212 billion SDG as the value of group-based livestock risk pooling in 2009.
- The total value derived from using livestock exchanges to collectively buffer risk was 4.519 billion SDG for Sudan as a whole in 2009.

2.6 Summary of Part I

Table 4 compares the gross value of livestock production from northern and southern states, based on estimates in this report for milk production and ruminant offtake, and on official estimates by SCBS for the value of poultry, eggs and fish. The total gross value of livestock production in Sudan in 2009 was approximately 33.843 billion SDG, of which 24.708 billion SDG (or roughly 73% of the national total) could be identified as coming from northern states, and 6.618 billion (about 20% of the national total) from southern states, with the remaining 7% unallocated. Annex VII 'Summary of recommended formula to estimate the contribution of ruminant livestock to agricultural GDP, and estimates for 2009' provides a summary of the formula and input values used to create Table 4.

Table 4: Gross value of livestock production in 2009, SDG

Product	Northern states,	Southern states	Sudan total
Cattle milk	9,123,015,552	1,984,428,576	11,107,444,120
Camel milk	3,247,597,056	0	3,247,597,056
Sheep milk	1,066,348,320	352,611,232	1,418,959,552
Goat milk	3,025,559,008	1,290,502,336	4,316,061,344
Subtotal milk	16,462,519,936	3,627,542,144	20,090,062,080
Cattle offtake	4,727,715,702	1,999,256,171	6,726,971,873
Camel offtake	740,720,640	0	740,720,640
Sheep offtake	2,018,928,224	667,603,212	2,686,531,436
Goat offtake	758,306,700	323,443,200	1,081,749,900
Poultry meat, tons	n.a.	n.a.	302,746,300
Subtotal animal offtake	8,245,671,266	2,990,302,583	11,538,720,149
Eggs	n.a.	n.a.	287,309,800
Fish	n.a.	n.a.	728,861,300
Manure for fertilizer	n.a.	n.a.	
Change in stocks	n.a.	n.a.	1,198,176,400
TOTAL OUTPUT	24,708,191,202	6,617,844,727	33,843,129,729

Table 5 compares the official SCBS estimates of the gross value of livestock output to the recalculated estimates contained in this report. The principal difference between the two estimations is the higher value ascribed to milk output in this report than in official SCBS estimates. However, SCBS attributes to animal offtake a higher value than this report, and the resulting difference in the total national value of livestock production is 5.173 billion SDG, or a re-estimated increase of only 18% over the official figure.

Table 5: Official and re-estimated volume and gross value of livestock production in 2009

Product	CBS, volume of production	CBS, value 000 SDG	This study, volume of production	This study, value 000 SDG
Cattle milk, tons	-	-	5,690,289	11,107,444
Camel milk, tons	-	-	1,663,728	3,247,597
Sheep milk, tons	-	-	726,926	1,418,960
Goat milk, tons			2,211,097	4,316,061
Subtotal milk offtake tons	7,406,000	14,454,142	10,292,040	20,090,062
Cattle offtake, head	6,175,000	6,498,866	6,234,451	6,726,973
Camel offtake, head	404,000	535,355	723,360	740,721
Sheep offtake, head	19,814,000	3,002,693	13,919,852	2,686,531
Goat offtake, head	17,322,000	1,661,388	10,817,499	1,081,750
Poultry meat, tons	28,000	302,746	-	302,746
Subtotal animal offtake		12,001,048		11,538,721
Eggs, dozens	55,594,000	287310	-	287310
Fish, tons	70,000	728861	-	728861
Manure for fertilizer		-		
Change in stocks		1198176	-	1198176
TOTAL PRODUCT OUTPUT		28,669,537		33,843,130

Sources: CBS GDP values for 2009 are from unpublished records. Livestock sale prices are calculated from Table 5-5 'Average animal prices in markets' MARF 2009.

The principal problem with these calculations - both the official SCBS and the re-estimated totals - is the poor reliability of the data upon which they are based. There are several reasons for this ambiguity:

- Because little field research on livestock production has been conducted in rural areas of Sudan in the last couple decades, both the official and revised livestock production coefficients rely in large measure on data that is a quarter of a century old.
- Producer prices are based on market surveys in northern Sudan, despite the likelihood that prices in southern Sudan are substantially different from those in the north.

These difficulties pale in significance, however, compared to the imprecision introduced by livestock population estimates that are over three decades out of date. No one knows how many livestock there are in Sudan, and until this situation is rectified all estimates of the value of their output are little more than guesses. The magnitude of this problem is indicated by the results from recent livestock enumerations in two other IGAD countries, Kenya and Uganda. Like Sudan, both of these countries had neglected to census their livestock for over three decades. When they did count their livestock - Kenya in 2009 and Uganda in 2008 - the results were unexpected. Table 6 compares the size of officially estimated livestock populations in each country in the year before the census, expressed as a percentage of the enumerated census population in the following year. In both countries some livestock populations were officially underestimated by half or more, and, given the standard problems of the underreporting of livestock holdings by their owners, the estimates in Table 6 are likely to be a conservative estimate of the level of underestimation in Kenya and Uganda.

Table 6: Census adjustments to livestock population estimates in Kenya and Uganda

	Kenya 2008 as % of 2009	Uganda 2007 as % of 2008
Cattle	77	63
Goats	52	66
Sheep	58	50
Camels	38	-
Pigs	-	67
Poultry	93	71
Donkeys	43	-

In the absence of livestock population figures based on the actual counting of animals, the estimates of livestock value added for Sudan contained in this report could be off by as much as 50%. What our analysis does provide is a framework for computing reliable estimates whenever more evidence becomes available, and for disaggregating the livestock contributions of the northern and southern states. Even at the crude level of precision that is now possible, the magnitude of the difference between livestock output in northern and southern Sudan is notable, with over 70% of the total value of Sudanese livestock output coming from the north.

Table 7 estimates the gross value of both goods and services derived from livestock in Sudan in 2009. Like the estimates of the contribution of livestock to GDP, these figures must be treated with caution, and, in fact, suffer from several additional sources of imprecision:

- Despite the widespread importance of animal traction power in agriculture and the importance of animal transport for the movement of agricultural produce, there is insufficient field data to permit the quantification the value of these livestock services. We have in this report estimated the direct use value of equine power, but this estimate is not based on field studies and is indicative only.

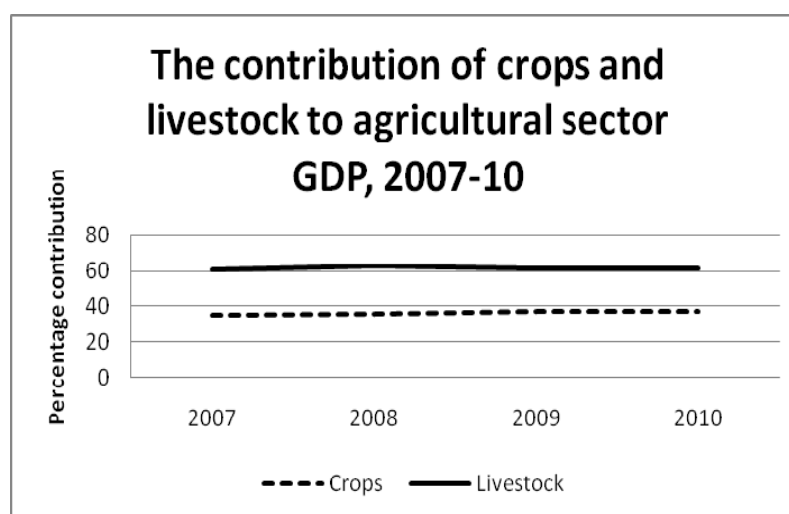
- We could not locate information on credit interest rates or on the cost of insurance in southern Sudan, should these be different from rates in northern Sudan, which is likely since the south does not follow Islamic financial practices.

Table 7: Direct use benefits derived from ruminants and equines, 2009 in billion SDG

Type of benefit	Gross value of livestock production	Services not in current GDP estimates
Value added livestock products	33.843	
Benefit from financing/credit		.708
Benefit from self-insurance		1.148
Benefit from risk pooling/stock sharing		4.519
Transport and traction power from equines		2.034
Ruminant animal power		No estimate
Sub-totals	33.843	8.409
Total economic benefits	42.252	

Despite the caveats attached to this analysis, it would appear that livestock nonetheless make a very significant contribution to Sudan's domestic economy. Sudan's agricultural sector GDP includes crop, livestock, fisheries and forest production. Figure 2 shows that livestock production, using official SCBS statistics, has provided more than 60% of the estimated value added to this sector in recent years, and is a substantially more important contributor to agricultural sector GDP than crop agriculture.

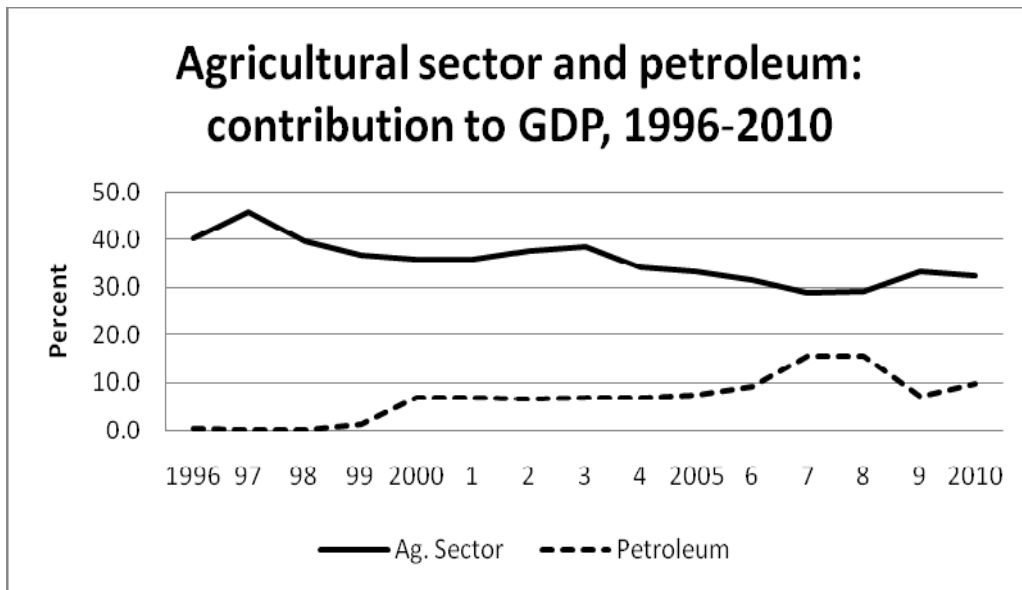
Figure 2



Source: Central Bureau of Statistics, unpublished data

Figure 3 examines the contribution of the agricultural sector as a whole (crop, livestock, forestry and fisheries combined) to national GDP. The period covered in Figure 3 begins in the late 1990s before petroleum was exported from Sudan. At this time agriculture was clearly the most important sector in the Sudanese economy, providing just under half of national GDP. With the rise of oil exports, the relative importance of agriculture has declined, but at no time has the contribution of petroleum to GDP equalled the contribution of the agricultural sector, of which livestock forms the biggest part. Livestock remains the largest contributor to domestic economic performance.

Figure 3



Source: Central Bureau of Statistics, unpublished data

3. PART II: CONTRIBUTION OF LIVESTOCK TO THE WIDER ECONOMY

3.1 Introduction

This final part of the report examines three different ways the Sudanese economy uses livestock products - for private consumption, as inputs into other domestic industries, and as exports.

3.2 The role of livestock in household consumption and expenditure

Livestock food products (meat, milk, dairy products and eggs) constitute about 31.1% of household expenditures on food and beverages. In addition to household expenditures on livestock derived foods, expenses on shoes and 31.1% of overall expenditure on restaurants and catering can be assumed to be associated with livestock products. Altogether these livestock-associated expenditures constituted on average 18.2% of total household expenditures for the three years from 2006-2008. For other categories of expenditure that might be expected to be supported in some measure by livestock production (transport or clothing, for instance) available evidence does not allow the disaggregation of the livestock contribution (all estimates are based on recalculated values in CBS 2006-08, pages 71-76).

In 2009 there were an estimated 39,154,490 people in Sudan (MARF 2009: Table 6-3). Table 8 analyzes the livestock food products available to this population for consumption in 2009.

Table 8: Meat and milk available for domestic consumption, 2009

	Offtake for domestic consumption, head	Meat for domestic consumption, kg ¹	Offal (25% of meat production), kg	Total meat and offal, tons	Per capita, kg/year
Cattle offtake, head	6,234,451	910,229,846	227,557,461	1,137,787,307	29.06
Camel offtake, head	723,360	112,120,800	20,030,200	132,151,000	3.38
Sheep offtake, head	13,919,852	167,038,224	41,759,556	208,797,780	5.33
Goat offtake, head	10,817,499	86,539,992	21,634,998	108,174,990	2.76
Ruminant total	-	1,275,928,862	310,982,215	1,586,911,077	40.53
Poultry meat, tons	-	28,000,000		28,000,000	0.72
Total all meat	-	1,303,928,862	310,982,215	1,614,911,077	41.25
Milk offtake ²					26.29

Notes: ¹Based on dressed slaughter weights of 146 kg for cattle, 155 kg for camels, 12 kg for sheep and 8 kg for goats.

²Fluid milk available for consumption or processing into dairy products

3.3 Livestock products as inputs into manufacturing

In the nine years between 2000 and 2008, the manufacturing of food, beverages and tobacco accounted for 60.9% of Sudan's manufacturing and handicraft GDP (CBS 2006-08). It is not possible on the basis of published evidence to identify what proportion of food and beverage manufacturing was associated with the processing of livestock products. On average between 2000-2008 the manufacture of textiles, wearing apparel and leather accounted for 3.3% of Sudan's manufacturing GDP. How much of this manufacturing activity used livestock products also

cannot be determined from available data (all estimates are based on recalculated values in CBS 2006-08, table 2.2).

3.4 The export of livestock and livestock products

Livestock make a smaller contribution to national exports than they do to GDP. Before oil exports began, livestock and crops combined provided about four fifths of Sudan's exports by value, with by far the greater contribution coming from the crop sector. Following the advent of oil, the combined significance of crop and livestock exports has fallen to between five and ten percent of total national exports. Since 2000 live sheep have been Sudan's most important livestock export commodity, followed in importance by hides and skins, camels and goats. The great bulk of live sheep and goats are officially exported to Saudi Arabia following quarantine and, with the exception of the cross border trade to Chad, Libya and Egypt, it would appear that official live animal and meat export statistics capture most of the trade in these products. We have, however, obtained no estimates of the likely volume and value of the unofficial cross-border livestock trade from Sudan.

Table 9: Live animal official exports, 2000-2010

Year	Sheep	Goats	Cattle	Camels
2000	731242	16599	315	145246
2001	15507	13883	-	18550
2002	1602638	53164	2655	155710
2003	1315399	57639	184	88423
2004	1703562	101989	750	132602
2005	1271787	1096654	501	131156
2006	1422109	102378	-	116184
2007	615843	30290	3658	85862
2008	610832	14337	1198	140757
2009	1510996	104630	19265	154477
2010	1813926	120693	5130	172196
Destinations	Saudi Arabia, UAE, Libya, Egypt, Kuwait, Jordan	Saudi Arabia, Egypt, UAE	Egypt, Kuwait, Saudi Arabia, Lebanon, Syria, Yemen	Saudi Arabia, Egypt, Qatar, UAE, Yemen, Libya

Source: MARF unpublished data

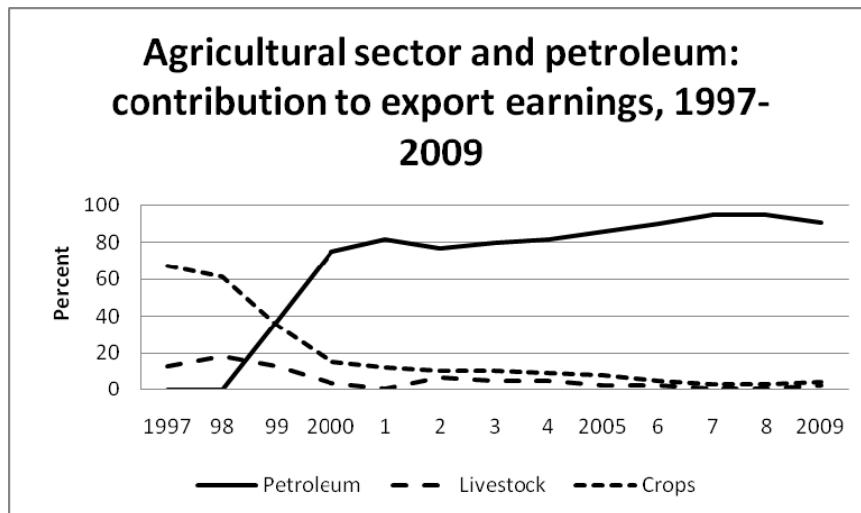
Table10: Meat exports, 2000-2010

	Sheep		Goats		Cattle		Camels	
	Head	Weight, tons	Head	Weight, tons	Head	Weight, tons	Head	Weight, tons
2000	534552	6157.82	43067	311.91	13133	2350.09	97	9.53
2001	437210	785.293	4843	35.711	799	1714.239	144	12.257
2002	652398	7148.788	49582	353.848	1886	347.073	64	6.647
2003	700216	7837.112	30997	221.293	839	178.214	174	16.273
2004	510673	5570.909	32637	217.1	5514	765.3	599	57.4
2005	428796	4710.5	3790	27.2	5115	656.4	282	27.9
2006	224087	2263.9	1182	8.4	-	-	100	10.2
2007	207796	2130.87	1623	12.37	-	-	62	12.22
2008	22709	207.356	257	1.567	12	2.935	6	0.712
2009	161121	1756.62	91	0.55	37	18.381	-	-
2010	409793	4126.53	762	4.731	3923	991.287	3	0.498
Destinations	Jordan, Qatar, UAE, Iraq, Kuwait		Oman, UAE, Jordan		Egypt, Qatar, Oman, UAE, Iraq, Kuwait, Jordan		Qatar, UAE	

Source: MARF unpublished data

Figure 4 compares the value of official livestock exports to the export value of petroleum and crops, beginning in 1997, the year before petroleum exportation began. Figure 4 graphically displays the dominant role of petroleum in Sudan's exports in the last decade, despite the continuing importance of crop and livestock production in the domestic economy.

Figure 4



Source: Central Bureau of Statistics, unpublished data

It would also appear that the upsurge in oil exports has masked a fundamental shift in the relative importance of crop and livestock exports. In the 1960s and early 1970s approximately 97-98% of all of Sudan's export earnings came from agriculture (Ministry of Agriculture, Food and Natural Resources 1974; Department of Agriculture 1967), and by far the bulk of these agricultural earnings came from crop rather than livestock production. For example, in the decade from 1957 to 1966, only 6.58% of all agricultural exports came from livestock, and in 1971 and 1972 the livestock contribution was 3.55% and 5.46%, respectively. These figures suggest that the importance placed on crop agriculture in official government thinking and policy may reflect the historical importance of crop exports in the late colonial and early independence period.

Since that time, however, there has been a gradual shift. In the late 1990s before oil exports began, crops and livestock combined provided roughly 80% of Sudan's exports, and crop exports were still more valuable than livestock and livestock products, but by a narrower margin. In the most recent year for which there are records, 2009, livestock exports made up nearly half of all agricultural exports - 47% of the total. Export levels fluctuate and 2009 was an unusually good year for livestock. Nonetheless, in the thirteen year period since 1997, livestock and livestock products have on average provided 27% of the value of Sudan's agricultural exports (SCBS unpublished data) - despite occasional RVF (Rift Valley Fever) embargos and the disruption to livestock trade caused by the Darfur conflict. And the contribution of livestock to exports would undoubtedly be substantially greater if we could estimate the magnitude of the unofficial, cross-border trade in live animals.

3.5 Summary of Part II

1. Approximately 18% of total private expenditures for consumption - including both purchased items and home produce - are spent by households on acquiring livestock products.

2. Annually about 41 kg of meat and 26 kg of milk (either as fluid milk or converted to dairy products) are available per capita for domestic consumption.
3. The agricultural sector provided the bulk of Sudan's exports from before independence until 1999, when petroleum replaced agriculture as Sudan's primary export earner. Masked by the export oil boom, there has been a significant shift in the composition of agricultural exports. From the late 1950s before Independence until at least the early 1970s, livestock provided about 6% of total agricultural exports. On the other hand, in 2009, the most recent year for which we have records, 47% of official agricultural exports were in the form of livestock and livestock products, a figure which would be higher if there existed any reliable estimates of the magnitude of the unofficial cross-border trade in live animals from Sudan to neighbouring countries. The shifting composition of agricultural exports, away from crops and in favour of livestock, calls into question the presumption that the cropping subsector is the dominant provider of Sudan's agricultural export earnings. The current situation is, in fact, relatively evenly balanced between crop and livestock exports.

4. CONCLUSIONS AND RECOMMENDATIONS

Estimates of the contribution of livestock to Sudan's economy are beset by one abiding challenge: the absence of reliable, current data.

There are multiple deficiencies. Since the 1980s little field research has been conducted on the productivity of Sudanese livestock kept by smallholders and pastoralists, who maintain the bulk of the country's livestock. Also, MARF's data on producer prices is obtained solely from markets in north Sudan, despite the likelihood that southern prices are substantially different. Above all, however, no one knows how many livestock there now are in Sudan, the last livestock census having taken place thirty-six years ago.

Official estimates of the size of Sudan's livestock populations are produced by MARF based on a herd growth model. The growth parameters in this model are not unreasonable and conform, in general, to those in the scientific literature reviewed in the Annexes to this report, but there is no reason to expect the outputs from the official model to reflect current realities. That would probably be asking too much of any model, given the complexities of livestock population dynamics over more than three decades at the national level. There are also theoretical reasons to doubt the suitability of the model, which depicts reasonably stable rates of herd growth irrespective of the effects of livestock numbers on resource availability, or the impact of fluctuating weather, security and market conditions. Unfortunately, the small number of state-level livestock surveys that have been conducted since the last national census in 1976 point in no consistent direction and do little to clarify the national situation. The solution to this impasse is not, however, to perfect current modelling techniques, but rather to conduct a national livestock census. Until a reasonably complete national census or large-scale livestock survey has been conducted, there can be no compelling answer to the question of the economic value of Sudanese livestock and livestock products.

With no conclusive evidence to support alternative national livestock population estimates, we have based calculations in this report on the official livestock population estimates produced by MARF. On this basis, our estimates of the contribution of livestock to national agricultural sector GDP - 33.843 billion SDG in 2009 - are broadly similar to the official 2009 estimates by SCBS - 28.670 billion SDG. The difference between these two estimates is 5.173 billion SDG, or a re-estimated increase of only 18% over the official figure in 2009. When compared with the imprecision caused by uncertainties regarding the size of the national herd, these are negligible differences, and constitute an endorsement of SCBS's official estimates, subject to the severe reservations about data availability stated above.

What the official figures reveal is the very significant contribution made by livestock to Sudan's domestic economy. Sudan's agricultural sector GDP includes crop, livestock, fisheries and forest production. Using official SCBS statistics, livestock has consistently provided more than 60% of the estimated value added to this sector in recent years, and is a substantially more important contributor to agricultural sector GDP than crop agriculture. With the advent of oil production and exports, the relative contribution of the agricultural sector to nation GDP has declined, but at no time in the last decade has the contribution of petroleum to GDP come close to equalling the contribution of the agricultural sector, of which livestock provides the biggest part. Livestock is by value the largest subsector of Sudan's domestic economy, larger even than petroleum.

While not as large as its domestic contribution, livestock's share of exports is considerable, and it is growing. Official reports from the 1950s through the early 1970s suggest that livestock and livestock products constituted at that time about 6-7% of agricultural exports in most years. Since 1997, however, they have averaged 27% of agricultural exports, up to 47% in 2009. It would appear that the era in which crops dominated the agricultural export scene is long past. Taking a balanced view of their combined domestic and export significance, the livestock and crop subsectors are relatively evenly balanced in their contribution to the national economy, and Sudanese agricultural and investment policies should accommodate this reality. According to the approximate calculations undertaken in this report, more than 70% of Sudan's livestock value added comes from northern states. The concentration of livestock output in northern Sudan suggests that, at least for the north, the independence of southern Sudan is unlikely to diminish the economic significance of livestock.

In common with the other IGAD states, there is insufficient data to quantify the contribution of animal power to the national economy, despite the recognized significance of work animals in crop production and transport. We could also find inadequate evidence on the extent of the unofficial cross-border trade in live animals from Sudan, and cannot even hazard a guess as to the magnitude of this trade. Adequately documented, these unrecorded uses of livestock would further enlarge the existing estimate of the economic significance of livestock.

These conclusions support the following recommendations:

1. It is essential that a livestock census or large scale sample survey be undertaken as soon as possible in both north and south Sudan.
2. With technical support from interested international and national research institutes and universities, MARF and KNBS should undertake a national survey of the value of animal power to the economy in northern Sudan and of the role of animal power in sustaining both rural and urban livelihoods. This survey should include all forms of animal traction, transport and haulage by all species of working animals - cattle, equines and camels - in rural and urban areas and in all economic sectors - agriculture, manufacturing and services. As well as the commercial provision of animal power, the survey should assess the monetary value of the services that working animals directly provide for their owners.
3. Ignorance about the economic importance of animal power is a regional phenomenon, and our recommendation regarding research on animal power applies equally to Ethiopia, Kenya and Uganda, three other countries where IGAD is currently conducting studies on the economics of livestock and livelihoods. IGAD should consider introducing a region-wide programme of work on the economics of animal power, a subject that is chronically neglected by both academic research and government agricultural monitoring systems.
4. In Ethiopia, over half of livestock exports are unofficial, but at least the magnitude of the unofficial trade can be roughly estimated from academic and project-based studies. The same is not true for either northern or southern Sudan, where we know that unofficial cross-border live animal trading exists but there is insufficient evidence to estimate the importance or size of trade flows. As a regional organization committed to regional trade, IGAD should support investigations of unofficial livestock trading from both northern and southern Sudan. Some idea of the extent of this trade is essential to formulating policies to support regional economic integration.

5. Despite data shortcomings mentioned above, it is clear that livestock are the largest subsector of the Sudanese domestic economy and are a growing contributor to exports. The great bulk of all livestock production - possibly 90% of the total, though no one really knows the actual figure - comes from small holders and migratory producers. To a remarkable extent, the Sudanese economy is based on a combination of mobile and sedentary pastoral and agro-pastoral production by farming and herding households in almost every region and state. While it is beyond the remit of this consultancy to recommend specific policies, it is essential that Sudanese policy makers recognize the centrality of pastoralism to their economy and take practical steps to support the livestock sector.

ANNEXES

Annex I Consultancy terms of reference

Title: The Contribution of Livestock to the National Economies of IGAD Member States - the case of Sudan and Uganda.

Subscriber: Mr. Roy Behnke

Background

The overall objective of the IGAD Livestock Policy Initiative is to enhance the contribution of the livestock sector to sustainable food security and poverty reduction in the IGAD region. The project purpose is to strengthen the capacity in IGAD, its member states, regional organizations, and other stakeholders to formulate and implement livestock sector and related policies that sustainably reduce food insecurity and poverty. The IGAD member states covered by the project are Djibouti, Ethiopia, Kenya, Somalia, Sudan and Uganda.

IGAD LPI activities in Sudan and Uganda are being undertaken in cooperation with their respective Livestock Policy Hubs (LPH) - a multi-stakeholder, advisory groups hosted by the Ministry of Animal Resources and Fisheries (Sudan) and the Ministry of Agriculture, Animal Industry and Fisheries (Uganda). The LPHs has in this context expressly asked IGAD LPI to undertake this study on the contribution of livestock to GDP in both countries and are looking to use the outcome in their engagement with Poverty Eradication Paper development process in the case of Sudan, and with the National Development Plan in Uganda. These are part of their cooperation with IGAD LPI to improve the profile of livestock in the national development strategies. This request is supported by one of the findings of the Mid-Term Review of the IGAD LPI project which established that whereas Output 1 of the IGAD LPI log frame³ highlighted the relevance of livestock to GDP, the importance of the contribution of livestock to GDP in the countries was not adequately stressed. Furthermore, an IGAD LPI working paper has emphasised the range of services that livestock provide to the livelihoods of different socioeconomic groups. Many of these services are not marketed and it is therefore suspected that they are not currently reflected in the region's national income accounting. In response to this the IGAD LPI is commissioning studies to look at and articulate the contribution of livestock to GDP in the IGAD member states to attract the increased investment that the sector deserves. The study was initially carried out in Ethiopia with a view to replication in the other IGAD member states. The findings will ultimately be linked to ongoing in-country livestock policy development processes that are supported by the project, especially those related to the better integration of livestock in PRSP (Medium Term Plans) processes and the allocation of national resources. The findings will inform policy hub and working group meetings, and the process of allocating public funds.

The study in is also anticipated to be a valuable resource to the Bureaus of Statistics. For that reason and in order to facilitate access to data, collaboration with the Bureaus through the offices of one of their staff in both countries is also anticipated.

³ The first output of the logframe is increased awareness by public, private, and tertiary sector organizations of the potential contribution of livestock and the livestock sector to growth, food security and poverty reduction.

Objective

In collaboration with the Ministry of Animal Resources and Fisheries and the Central Bureau of Statistics (Sudan) and the Ministry of Agriculture, Animal Industry and Fisheries and the Ugandan Bureau of Statistics (Uganda), the consultant will;

1. Assess and capture all contributions of livestock to the national economy, irrespective of whether or not current methodologies of GDP calculation cover them. This will involve satellite accounting by looking at the contribution of livestock to other sectors such as manufacturing and transport and add these values to the agricultural GDP estimates.
2. Provide a subsequent assessment of how far the contribution of livestock to national economy is reflected in national income accounting in the country. This will require assigning values to the non marketable services that livestock provides and familiarity with the System of National Accounts (SNA). Under this consultancy, the consultant is not required to provide an exhaustive overview of the methodologies adopted by the Bureaus.

Specific Activities

In order to address the objective of the study, and in collaboration with the Ministry of Animal Resources and Fisheries and the Central Bureau of Statistics (Sudan) and the Ministry of Agriculture, Animal Industry and Fisheries and the Ugandan Bureau of Statistics (Uganda), the consultant will;

1. Carry out a situational analysis (mainly through literature review and interviews) on how livestock is currently computed in GDP calculations within national income accounting and how and where livestock contributes to the overall economy in Sudan and in Uganda.
2. Propose a methodology for the internal computation of livestock in GDP that includes assigning values to the non marketable services that livestock provides.
3. Propose an approach for the assessment of the contributions of livestock to the overall economy (satellite accounting).
4. Report the situational analysis findings and the proposed methodology in an inception report to IGAD LPI which will be shared with the LPHs for discussion and comments.
5. Apply the proposed methodology and the approach (ideally in collaboration with a national consultant drawn from the Bureaus of Statistics) in determining the contribution of the livestock sector to national GDP and to the overall economy in both countries.
6. (Ideally in collaboration with a national consultant drawn from the Bureaus of Statistics), report the findings of the study in a draft report to be presented to IGAD LPI and members of the LPHs for comments.
7. Prepare a final report to IGAD LPI containing the findings of the study and a critical assessment of the application of the methodology and the approach in Sudan and in Uganda, together with any pertinent recommendations for how similar studies could be implemented the remaining IGAD Member States.
8. Present findings to members of the Sudan Livestock Policy Hub.
9. Prepare up to two policy briefs for each country, and two policy briefs based on a previous study in Kenya.

Outputs

1. Inception Report presenting the findings of the situational analysis and the proposed methodology and approach for each country.
2. Draft report of findings and the application of the methodology and the approach in Sudan and Uganda.
3. Final report containing the study findings for each country, with an assessment of the application of the methodology and further recommendations for its application elsewhere.

Duration: 192 days and will require an international flight to each of Sudan and Uganda.

Provision has been made for up to 2 national flights in Sudan for the consultancy team if required.

Reporting

The consultant will report to FAO IGAD LPI against agreed outputs and for contractual matters. The final report and its contents will be agreed upon between the consultant and IGAD LPI and the national stakeholders. This work will require the full collaboration of the key departments in charge of national accounts in both Sudan and Uganda.

Annex II Livestock Populations

Livestock populations 1975

NORTHERN STATES 1975							
	Cattle	Sheep	Goats	Camels	Donkeys	Horses/M	Source
North Darfur	907,081	1,409,533	1,193,613	226,103	151,212	39,598	22
South Darfur	2,735,360	1,232,024	1,117,220	142,083	104,038	25,600	21
North Kordofan	937,127	2,470,580	1,683,647	851,587	108,912	4,472	23
South Kordofan	1,467,367	830,053	696,030	1,798	32,867	998	24
Kassala	642,883	1,589,532	925,009	567,949	69,844	1,084	14
Blue Nile	1,006,000	1,041,000	435,000	41,000			AOAD 1987:
Gezira	503,916	216,321	1,143,711	146,051	103,583	5,330	11
White Nile	1,563,568	2,207,686	657,336	77,877	61,346	3,873	13
Northern Nile Province	14,419	208,615	151,969	114,613			AOAD 1987: 245
Province	43,717	272,488	263,030	59,058	41,969	647	16
Khartoum	56,871	269,920	429,969	13,740	26,444	463	12
SOUTHERN STATES 1975							
	Cattle	Sheep	Goats	Camels	Donkeys	Horses/M	Volume
Upper Nile	1,428,092	1,047,465	375,866	4,922	3,081	0	18A
Jongoli	1,404,553	174,619	460,900	0	0	3,179	18B
Bahr el Gazal	1,227,707	718,238	604,099	0	1,346	0	20A
El Buheytrat	700,719	333,130	303,946	0	38	0	20B
East Equitoria	797,774	914,824	240,485	28,430	3,734	0	19A
West Equitoria	229	1,269	20,055	0	0	0	19B
TOTAL	15,437,383	14,937,297	10,701,885	2,275,211	708,414	85,244	

Source: *Sudan National Livestock Census and Resource Inventory, Resource Management and Research*, various volumes cited in the Table, and *Rehabilitation of the Agricultural Statistical Information System in Sudan, Volume I, Main Report*, Arab Organization for Agricultural Development, 1987, for Northern and Blue Nile Provinces.

Livestock population by states - 2009

	Cattle	Sheep	Goats	Camels
North Kordofan	935168	7150679	3591410	1185858
South Kordofan	7340026	3077834	3353425	507708
North Darfur	681633	3722271	2877455	565577
South Darfur	4177082	3804759	2985630	152358
West Darfur	4014986	3866625	4370270	408698
Elgedarif	1026606	2103444	1051461	327320
Kassala	835416	2000334	1661568	659614
Red Sea	133002	360885	713955	273973
Blue Nile	1995024	3918180	450008	13563
Sennar	1566925	1361052	1626952	111669
Elgezira	2456373	2448863	2128884	117998
White Nile	3462198	2500418	2539949	33908
Northern	249378	969234	1142328	47018
River Nile	99751	1020789	1198579	109408
Khartoum	236909	438218	640396	6329
Northern States	29210477	38743585	30332270	4520999
	Cattle	Sheep	Goats	Camels
North Upper Nile	1034919	685682	458662	0
Unity	1242734	1593050	1830321	0
Gongoli	1541987	1500251	1259157	0
North Bahr Elgazel	1662520	1376519	1700511	0
West Bahr Elgazel	1313391	1247631	1168290	0
Albohairat	1379892	1319808	1527431	0
Warab	1608488	1381674	1427910	0
Bahar Elgabal	922699	1355897	1202906	0
E. Equatoria	935168	1098122	1181271	0
W. Equatoria	710727	1252787	1181271	0
Southern States	12352525	12811421	12937730	0

Source: MARF 2009

Livestock population by states - 2010

	Cattle	Sheep	Goats	Camels
North Kordofan	968503	7223357	3065603	1212613
South Kordofan	7349936	3098701	3366678	519163
North Darfur	668176	3760104	2888827	578337
South Darfur	4217861	3843430	2997429	155795
West Darfur	4050817	3905925	4387541	417919
Elgedarif	1044025	2135239	1055616	334705
Kassala	960503	2020665	1668134	674496
Red Sea	125283	416632	716777	280154
Blue Nile	2004528	3905925	451786	13869
Sennar	1461635	1374886	1633382	114188
Elgezira	2463899	2473753	2137297	120660
White Nile	3466163	2551871	2549987	34673
Northern	250566	979085	1146842	48079
River Nile	83522	1005125	1203316	11877
Khartoum	250566	442672	642927	6472
Northern States	29357983	39137369	30452141	4623000
	Cattle	Sheep	Goats	Camels
North Upper Nile	1039849	692651	460475	0
Unity	1248654	1609241	1837554	0
Gongoli	1549333	1515499	1264133	0
North Bahr Elgazel	1670440	1390509	1707231	0
West Bahr Elgazel	1319648	1260312	1172907	0
Albohairat	1386465	1333222	1533467	0
Warab	1616151	1395717	1433553	0
Bahar Elgabal	927094	1369678	1207660	0
E. Equatoria	939623	1109283	1185939	0
W. Equatoria	714113	1265520	1185939	0
Southern States	12411369	12941632	12988859	0
TOTAL	41761000	52079000	43441000	4623000

Source: Information Center, Ministry of Animal Resources and Fisheries, unpublished records

Khartoum State

	Cattle	Sheep	Goats	Camels
1975	56,871	269,920	429,969	13,740
1999 CBS	179,275	358,040	541,367	4,282
2009 Official	236,909	438,218	640,396	6,329
2010 Official	250,556	442,672	642,927	6,472

Source: Information Center, Ministry of Animal Resources and Fisheries for 2009 and 2010; *Agricultural Census Results Khartoum State 1997-1998*, Sudan Central Bureau of Statistics, for 1999; *Sudan National Livestock Census and Resource Inventory*, Resource Management and Research for 1975

Gezira Project

	Cattle	Sheep	Goats	Camels
1965	145,326	231,379	160,845	5,515
1975	294,489	325,574	225,773	8,061
1975	372,415	625,984	750,711	3,402
1981	440,775	658,563	410,139	2,977
1986 Feb	217,586	347,367	425,976	821
1986 Ap	291,281	448,300	549,900	7,625

Source: *Gezira Livestock Integration Study Final Report, Volume IV, 1987*

Gezira State

	Cattle	Sheep	Goats	Camels
1975	503,916	216,321	1,143,711	146,051
2009	2,456,373	2,448,863	2,128,884	117,998
2010	2,463,899	2,473,753	2,137,297	120,660

Source: Information Center, Ministry of Animal Resources and Fisheries for 2009 and 2010; *Sudan National Livestock Census and Resource Inventory*, Resource Management and Research for 1975

Red Sea State

	Cattle	Sheep	Goats	Camels
1975	40,700	187,563	373,714	82,981
1989	8,996	182,789	380,570	45,114
2009	133,002	360,885	713,955	273,973
2010	125,283	416,632	716,777	280,154

Source: *Integrated Livestock Surveys of Red Sea Province, Sudan*, Environmental Research Group Oxford for 1975 and 1989; Information Center, Ministry of Animal Resources and Fisheries for 2009 and 2010

South Kordofan

	Cattle	Sheep	Goats	Camels
1975	1,467,367	830,053	696,030	1,798
2009 official	7,340,026	3,077,834	3,353,425	507,708
2010 official	7,349,936	3,098,701	3,366,678	519,163
2010 IFAD	7,129,000	3,802,000	2,422,000	451,000

Source: Information Center, Ministry of Animal Resources and Fisheries for 2009 and 2010 official statistics; IFAD unpublished records for 2010; *Sudan National Livestock Census and Resource Inventory*, Resource Management and Research for 1975

North Kordofan

	Cattle	Sheep	Goats	Camels
1975	937,127	2,470,580	1,683,647	851,587
2009 official	935,168	7,150,679	3,591,410	1,185,858
2010 official	960,503	7,223,357	3,605,603	1,212,613
2010 IFAD	465,000	22,265,000	2,064,000	747,000

Source: Information Center, Ministry of Animal Resources and Fisheries for 2009 and 2010 official statistics; IFAD unpublished records for 2010; *Sudan National Livestock Census and Resource Inventory*, Resource Management and Research for 1975

River Nile

	Cattle	Sheep	Goats	Camels
1975	43,717	272,488	263,030	59,058
2006	68,174	354,159	242,245	18,731
2009 official	99,751	1,020,789	1,198,579	109,408
2010 official	83,522	1,005,125	1,203,316	111,877

Source: Information Center, Ministry of Animal Resources and Fisheries for 2006, 2009 and 2010; *Sudan National Livestock Census and Resource Inventory*, Resource Management and Research for 1975

Jonglei State

	Cattle	Sheep	Goats	Camels
1975	1,404,553	174,619	460,900	0
1982 mid-wet season	337,554	64,284		0
1982 early dry season	350,052	73,976		0
1982 late dry season	560,701	119,690		0
2009 official	1541987	1500251	1259157	0
2010 official	1549333	1515499	1264133	0

Source: Information Center, Ministry of Animal Resources and Fisheries for 2009 and 2010; *The Jonglei Canal: Impact and Opportunity*, Howell et al. for 1982; *Sudan National Livestock Census and Resource Inventory*, Resource Management and Research for 1975

Annex III National Accounts -background documentation

GDP by kind of activity at current market prices, million SDG

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Agriculture, Livestock, Forestry & Fishing	14547.9	17986.3	21411.0	23369.4	28454.7	31190.8	32985.5	37480.6	44969.6	52691.4
Petroleum	2777.5	3193.0	3811.6	4760.7	6461.2	9110.2	17612.2	19792.3	9621.2	15654.2
Other Mining and Quarrying	99.4	105.0	119.6	120.1	157.0	191.6	212.1	272.0	309.8	364.8
Manufacturing and Handicrafts	3354.1	4426.6	4862.1	6392.5	7322.3	8041.7	8781.9	9726.3	11508.2	13672.9
Electricity and Water	227.4	303.6	128.7	828.9	1070.8	1819.6	1981.4	2242.4	2513.0	2894.3
Building and Construction	1485.5	1893.4	2136.3	2614.5	3824.0	4242.7	4650.5	5239.3	6171.2	7457.6
Commerce, Restaurant and Hotels	6466.3	7016.7	8643.7	10773.1	12662.9	14328.0	16727.8	18376.2	21107.6	24827.4
Transport and Communication	4308.2	4069.4	5580.9	8410.5	12501.6	14147.0	13781.2	15045.5	17076.2	19835.4
Finance, Insurance, Real-estate	3194.6	4117.4	4387.2	5340.1	6597.6	7613.0	7808.9	8961.1	10399.1	11860.8
Community ,Social and Personal Services	753.2	811.9	854.6	916.7	994.6	1118.6	1258.2	1393.5	1522.6	1735.0
Nominal Financial Institutions	-179.6	-293.4	-379.7	-546.7	-884.0	-1026.1	-719.6	-789.3	-872.7	-1417.9
Government Services	2227.5	2433.3	2661.7	3845.6	4269.1	5297.4	5943.7	6680.6	7481.6	8362.4
Private non-profit services to Households	593.9	638.7	669.0	707.9	744.3	861.0	996.4	1109.3	1206.7	1309.1
Import Duties	802.6	1054.2	847.0	1188.0	1531.0	1783.4	1997.4	2217.1	2645.1	2956.6
TOTAL GDP	40658.6	47756.1	55733.8	68721.4	85707.1	98718.8	114017.5	127746.9	135659	162204

Source: Unpublished data SCSB

GDP percentage contribution by kind of activity

Source: Unpublished data SCSB

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Agriculture, Livestock, Forestry & Fishing	40.3	45.6	39.7	36.7	35.8	35.8	37.7	38.4	34.0	33.2	31.6	28.9	29.3	33.15	32.48
Petroleum	0.4	0.3	0.3	1.5	6.8	6.8	6.7	6.8	6.9	7.5	9.2	15.4	15.5	7.09	9.65
Other Mining and Quarrying	0	0	0	0.36	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.23	0.22
Manufacturing and Handicrafts	7.8	6.4	6.0	5.9	6.8	8.2	9.3	8.7	9.3	8.5	8.1	7.7	7.6	8.48	8.43
Electricity and Water	0.7	0.6	0.5	0.6	0.7	0.6	0.6	0.2	1.2	1.2	1.8	1.7	1.8	1.85	1.78
Building and Construction	4.3	3.7	9.2	6.1	3.4	3.7	4.0	3.8	3.8	4.5	4.3	4.1	4.1	4.55	4.60
Commerce, Restaurant and Hotels	18.0	16.3	16.9	17.0	16.9	15.9	14.7	15.5	15.7	14.8	14.5	14.7	14.4	15.56	15.31
Transport and Communication	11.2	9.6	11.8	14.4	11.6	10.6	8.5	10.0	12.2	14.6	14.3	12.1	11.8	12.59	12.23
Finance, Insurance, Real-estate & Business Services	8.7	8.1	8.1	8.2	8.3	7.9	8.6	7.9	7.8	7.7	7.7	6.8	7.0	7.67	7.31
Community, Social and Personal Services	2.3	2.1	2.1	2.1	2.0	1.9	1.7	1.5	1.3	1.2	1.1	1.1	1.1	1.12	1.07
Nominal Financial Institutions	-0.6	-0.8	-1.1	-0.5	-0.6	-0.4	-0.6	-0.7	-0.8	-1.0	-1.0	-0.6	-0.6	-0.64	-0.87
Government Services	2.7	3.1	3.1	3.8	4.1	5.5	5.1	4.8	5.6	5.0	5.4	5.2	5.2	5.51	5.16
Private non-profit services to Households	1.8	1.9	1.6	1.8	1.6	1.5	1.3	1.2	1.0	0.9	0.9	0.9	0.9	0.89	0.81
Import Duties	2.3	3.0	1.9	1.9	2.2	2.0	2.2	1.5	1.7	1.8	1.8	1.8	1.7	1.95	1.82
TOTAL GDP	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Percentage contribution of petroleum, non-petroleum and agricultural exports, 1997-2009

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Petroleum & Petroleum Products	0	0	37	75	81.7	77	79.7	82.4	86	90	95	94.5	91
Non-Petroleum Products	100	100	63	25.4	18.3	23	20.3	17.6	14	10.2	5.4	5.5	9
Crops	67	61	35	15	12	10	10	9	8	5	3	3	4
Livestock and Products	13	18	13	4	1	7	5	5	3	3	1	1	3
Total Exports	100	100	100	100	100	100	100	100	100	100	100	100	100

Source: Unpublished data SCSB

Petroleum, non-petroleum and agricultural exports, 1997-2009, thousands of Sudanese pounds SDG

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Petroleum & Petroleum Products	0	0	688,802	3,606,774	3,828,288	4,073,410	5,139,562	7,200,243	9,117,533	10,395,545	16,918,582	23,246,069	15,628,283
Non-Petroleum Products	769,528	1,006,928	1,164,417	1,225,789	858,867	1,213,790	1,311,318	1,535,066	1,484,248	1,179,700	974,777	1,365,939	1,507,503
Crops	519,039	614,829	641,087	732,580	580,837	553,822	662,035	824,551	862,388	617,741	589,437	739,234	646,417
Livestock and Products	99,420	176,292	241,210	206,155	61,463	361,803	340,264	421,507	308,591	295,605	168,523	211,345	581,604
Agricultural Sector Total	618459	791121	882297	938735	642300	915625	1002299	1246058	1170979	913346	757960	950579	1228021
Total Exports	769,528	1,006,928	1,853,219	4,832,563	4,687,155	5,287,200	6,450,880	8,735,308	0,601,781	1,575,244	7,893,359	4,612,008	7,135,786

Source: Unpublished data SCSB

Agricultural sector GDP - subsector % contribution and in million SDG, 2007-2010

	2007		2008		2009		2010	
	%	SDG	%	SDG	%	SDG	%	SDG
Agriculture	34.89	12456.35	35.48	13232.43	36.94	16661.4	37.05	19522.4
Livestock	60.66	19945.95	63.03	23506.62	61.4	27606.6	61.39	32347.0
Forestry	0.07	23.67	0.11	41.75	0.1	39.5	0.1	46.2
Fishing	1.38	453.16	1.38	515.08	1.47	662.1	1.47	775.8
Total	100	32879.13	100	37295.87	100	44969.6	100	52691.4

Source: Unpublished data SCSB

Annex IV Cattle milk

<i>Area</i>	<i>Production system; herd size</i>	<i>% cows in herd</i>	<i>% lactating in herd; ratio lactating to total cows ()</i>	<i>Yield litres/cow/ lactation Yield/day (litres)</i>	<i>Litres offtake per 100 head of cattle</i>	<i>Source</i>
Regional comparisons						
Ethiopia	National		20.6%	448 litres per lactation	9216	IGAD WP No. 02-10
Kenya	Highlands - intensive	52		1733 lit per cow	90,000 lit per 100 head of cattle	IGAD LPI WP 03-11
Kenya	Semi-arid		28.75% herd lactating	378 lit/cow/lactation	10,845 lit/100 head of cattle	IGAD LPI WP 03-11
Kenya	Arid				5900 lit/100 head of cattle	IGAD LPI WP 03-11
Southern States/southern cattle breeds						
Jonglei	Dinka - Twic	40.5	Calving interval 24 months; 20.25 % of herd lactates each year	352 days lactation at 1.215 kg per day	428 kg annually per cow lactating or 8667 kg per 100 head of cattle	Howell et al 1988
Jonglei	Nuer - Gaaweir	43.3	Calving interval 18 months; 28.87% of herd lactates each year	190 days lactation at 1.74 kg per day	331 kg annually per cow lactating or 9556 kg per 100 head of cattle	Howell et al 1988
Jonglei	Shilluk	n.d.; assume 43.3 with low age 1 st calf	Calving interval 16 months; 75% of adult females lactate each year, or 32.47% herd lactates each year	240; 1.37 kg in dry season, wet season no data; pp 305 gives 1.7 kg per day average	408 kg annually per cow lactating or 13,248 kg per 100 head of cattle	Howell et al 1988
Abyei, South Kordofan	Dinka - Ngok	30	64% calving interval or 19.2% herd lactating	300 day lactation at 0.8 kg per day for lactation yield of 100-450 or 235 kg on average	235 kg annually per cow lactation or 4512 kg per 100 head of cattle	Niamir 1982
Kongor area of Jonglei Province	Dinka	49.9	28.2	990-1040 ml per cow per day (pp 78, 80) for about 180 days * 1.015 kg = 183 kg per cow per year	183 kg per cow per year or 5161 per 100 head of cattle	Payne and El Amin 1977
Sudan - southern		41%	25.8%	317 litres per cow per lactation	8228 lit per 100 head of cattle	Five studies listed above - unweighted mean

states mean value						
Jonglei	Dinka agropastoral	40.5	Calving interval 24.4 months; about 50% of cows lactating	352 day lactation yielding 463 kg of milk in total for human use, or 447 kg on average per year	9052 kg per 100 head of cattle per year	Howell et al 1988
Jonglei	Nuer agropastoral	43.3	ditto	ditto - using results of intensive monitoring	9678 kg per 100 head of cattle per year	Howell et al 1988
Bor District, Jonglei Province	Bor Dinka	36.1	17.7% of herd are lactating cows			ILACO 1981
Around Juba	Dinka		Calving interval about 13.5-15.5 months	Daily yield average 0.7 kg for 7-8 month or about 160 kg per lactation		Marchot 1983
Northern States/northern cattle breeds						
<i>Area</i>	<i>Production system; herd size</i>	<i>% cows in herd</i>	<i>% lactating in herd; ratio lactating to total cows ()</i>	<i>Yield litres/cow/ lactation Yield/day (litres)</i>	<i>Litres offtake per 100 head of cattle</i>	<i>Source</i>
Butana		40.3	20.63 month calving interval; 58% calving rate; 23% of herd lactating	538.26 lit per lactation	12,380 liters per 100 head of cattle	Musa et al. 2006
Kenana		48.7	17.01 month calving interval; 71% annual calving rate; 35% of herd lactating	598.73 lit per lactation	20,956 per 100 head of cattle	Musa et al 2006
South Darfur	Baggara pastoral	42.8 (Wilson and Clarke 1976 a, b.)	59% calving percentage (Wilson and Clarke 1976 a, b.); 25% of herd lactating	582 kg/cow/ lactation of 270 days with average yield of 2.16 kg per day	14,550	Kerven 1987
Kordofan	Baggara	43	48.7 calving rate or 20.1% of herd lactating	480 kg/cow/lactation of 300 days with average yield of 1.6 kg/day	9648	Michael 1987; Bunderson 1984
Red Sea	Beja	40.1	59.6% mean annual	4.1 litres mean	26,568	ERGO 1990

			calving % or 24% of herd lactating	daily milk output; lactation period unreported; assume 270 days or 1107 litres/lactation		
Gezira		40.6	44.5% mean annual calving %; 18% of herd lactating	2 to 3 lit per day - mean daily output of 2.5 lit for 270 days (assumed) or 675/lactation	12,150	RIM-DEVCO 1987
Sudan - northern states mean value		42.6	24.2	663 litres per cow per lactation	16,042 lit per 100 head of cattle	Unweighted mean of six above studies
Khartoum			46.% of herd lactating			CBS 1998
South Darfur	Baggara pastoral	42.8	59% calving percentage	No data	No data	Wilson and Clarke 1976 a and b

Annex V Camel milk

<i>Area</i>	<i>Production system; herd size</i>	<i>% she camels in herd</i>	<i>% lactating in herd; ratio lactating to total she camels ()</i>	<i>Yield litres/camel/ lactation Yield/day (litres)</i>	<i>Litres offtake per 100 head of camels</i>	<i>Source</i>
Regional comparisons						
Ethiopia	National		20% of herd lactating	1326 litres per lactation	26,520 litres	IGAD LPI WP No. 02-10
Kenya	National		34% of herd lactating	547 lts/lactating camel/year	18,598 litres	IGAD LPI WP No. 03-11
Sudan						
Butana	Nomadic	41.6	Assume 21.7% of total herd lactating females, based on Wilson et al. 1980	1654 kg per lactation	35,892	Darosa and Agab n.d.
Butana	sedentry	41.6	Assume 21.7% of total herd lactating females, based on Wilson et al. 1980	2925 kg per lactation	63,472	Darosa and Agab n.d.
Red Sea	Beja	40.5%	Mean annual calving 38.6%, or 15.6% of herd lactating	Mean daily milk output at 2.5 litres for human consumption * 365 days = 912 kg per lactation	15.633 milking camels per 100 head @ 2.5 liters/day for * 365 days = 14,227 litres	ERGO 1990
Sinnar, Gedaref, Gezira and Kordofan	various	45.8	Assume 21.7% of total herd lactating females, based on Wilson et al. 1980	4.53 lit/day ; lactation yield 1557 lit over an 11.48 month period	33,787 lit per 100 head of camels	Ishag and Ahmed 2011.
Sudan - national mean value		42.4	20.2	1762	36,844 lit per 100 head	Unweighted mean of 4 above studies
Butana				8 lit/day peak lactation down to 1.38 lit/day at end of dry season. Crude mean of min/max is 4.69 lit per day		Salman 2002; cited in Eisa and Mustafa 2011
Western Sudan				2.36 lit/day mean		Bakheit 1999; cited in Eisa and Mustafa 2011.
Khartoum			37% of herd lactating			CBS 1998
Butana	mixed		35% annual calving rate			Abbas et al. 1992
North Kordofan				848 lit per lactation		EI-Hag et al. 2002
South Darfur	Jammala and Baggara	43	21.7% of total herd lactating females assuming one year lactation			Wilson et al. 1980

Annex VI Sheep and goat milk

<i>Area</i>	<i>Production system</i>	<i>Percent flock lactating/year</i>	<i>Litres offtake per lactation</i>	<i>Litres offtake per 100 head sheep/goats</i>	<i>Source</i>
Regional comparisons					
Ethiopia	National - goats	43% breeding female and 1.45 mean annual kidding rate	46.5 litres per lactation	2899	IGAD LPI WP No. 02-10
Kenya	Arid and semi-arid goats	40% flock female	.351/day/adult female *365 = 128 litres/ adult female/year	5120	IGAD LPI WP No. 03-11
Sudan					
Jonglei	Nuer/Dinka agropastoral - goats	Females 73% of flock; 1.46 births per year; 246 day kidding interval, 1.40 litter size and 208% annual kidding rate Twic Dinka	144 grams per day - small sample and one season only (pp 138 Vol. 3 Livestock Studies)		Howell et al. 1988
Jonglei	Nuer/Dinka agropastoral - sheep	Females 68% of flock ; 1.67 births per year; 216 day lambing interval, 1.08 litter size and 182 % lambing rate per year	Rarely milked	Negligible	Howell et al. 1988
South Darfur	Baggara - sheep	275 days lambing interval, 1.14 litter size and 151% lambing per year	Rarely milked	Negligible	Wilson 1976b
South Darfur	Baggara - goats	238 day kidding interval, 1.20 litter size and 241% annual kidding rate			Wilson 1976a
Kongor area of Jonglei	Dinka	54.8% of flock is mature females			Payne and El Amin 1977
South Darfur	Baggara - sheep	57% of flock breeding females giving 1.45 young per year			Wilson et al. 1980
Red Sea	Beja - sheep	36% of flock breeding females with mean lambing % of 63.9 = 23% of flock giving milk every year	Milked for domestic use 0.7 litres/day for 60 days = 42 litres per lactation	966 litres per 100 head of sheep	ERGO 1990
Red Sea	Beja - goats	32.87% of flock breeding females with mean Kidding % of 59.9 = 19.7% of flock giving milk each year	Yield 0.7 litres/day for domestic use; lactation period not given, assumed to be 60 days =42 litres per lactation	827 litres per 100 head of goats	ERGO 1990
Gezira		51.3% of sheep flock adult female and 22.65 of ewes giving milk annually	Yield less than .5 lit daily		RIM-DEVCO 1987
Gezira		52.4% of goat flock adult female and 48.35 of nannies giving milk annually	Yield less than .5 lit daily		RIM-DEVCO 1987
Khartoum	Sheep	38.1% of flock lactating			CBS 1998
Khartoum	Goats	40.1% of flock lactating			CBS 1998
South Darfur	Baggara - goats	50% of flock breeding females giving 2.08 young per year			Wilson et al. 1980

Annex VII Summary of recommended formula to estimate the contribution of ruminant livestock to agricultural GDP, and estimates for 2009

1. cattle milk:

- A. Head of north Sudan cattle * 160 litres of milk per head * farm gate price
 $29,210,477 \text{ head} * 160 \text{ litres per head} = 4,673,676,320 \text{ litres or } 4,673,676 \text{ tons of milk for human consumption} * 1952 \text{ SDG/ton} = 9,123,015,552 \text{ SDG in 2009}$
- B. Head of south Sudan cattle * 82.3 litres of milk per head * farm gate price
 $12,352,525 \text{ head} * 82.3 \text{ litres per head} = 1,016,612,807 \text{ litres or } 1,016,613 \text{ tons of milk for human consumption} * 1952 \text{ SDG/ton} = 1,984,428,576 \text{ SDG in 2009.}$
- C. A + B = value in SDG of national cattle milk production
 $A + B = 5,690,289 \text{ tons in 2009} * 1952 \text{ SDG/ton} = 11,107,444,120 \text{ SDG in 2009}$

2. camel milk:

head of camels in North Sudan * 368 litres of milk for human consumption per head * farm gate price = value in SDG of national camel milk production
 $4,520,999 \text{ head} * 368 \text{ litres per head} = 1,663,727,632 \text{ litres or } 1,663,728 \text{ tons of camel milk for human consumption} * 1952 \text{ SDG/ton} = 3,247,597,056 \text{ SDG in 2009.}$

3. sheep milk:

- A. Head of south Sudan sheep * 14.1 litres of milk per head * farm gate price
 $12,811,421 \text{ head} * 14.1 \text{ litres per head} = 180,641,036 \text{ litres or } 180,641 \text{ tons for human consumption} * 1952 \text{ SDG/ton} = 352,611,232 \text{ SDG in 2009}$
- B. Head of north Sudan sheep * 14.1 litres of milk per head * farm gate price
 $38,743,585 \text{ head} * 14.1 \text{ litres per head} = 546,284,548 \text{ litres or } 546,285 \text{ tons for human consumption} * 1952 \text{ SDG/ton} = 1,066,348,320 \text{ SDG in 2009}$
- C. A + B = value in SDG of national sheep milk production
 $B + D = 726,926 \text{ tons} * 1952 \text{ SDG/ton} = 1,418,959,552 \text{ SDG in 2009}$

4. goat milk

- A. Head of south Sudan goats * 51.1 litres of milk per head * farm gate price
 $12,937,730 \text{ head} * 51.1 \text{ litres per head} = 661,118,003 \text{ litres or } 661,118 \text{ tons for human consumption} * 1952 \text{ SDG/ton} = 1,290,502,336 \text{ SDG in 2009}$
- B. Head of north Sudan goats * 51.1 litres of milk per head * farm gate price
 $30,332,270 \text{ head} * 51.1 \text{ litres per head} = 1,549,978,997 \text{ litres or } 1,549,979 \text{ tons for human consumption} * 1952 \text{ SDG/ton} = 3,025,559,008 \text{ SDG in 2009}$
- C. A + B = value in SDG of national goat milk production
 $A + B = 2,211,097 \text{ tons} * 1952 \text{ SDG/ton} = 4,316,061,344 \text{ SDG in 2009}$

5. cattle offtake

- A. Head of cattle north Sudan * .15 * farm gate price
 $29,210,477 \text{ head} * .15 = 4,381,572 \text{ head} * 1079 \text{ SDG/head} = 4,727,715,702 \text{ SDG in 2009}$
- B. Head of cattle south Sudan * .15 * farm gate price
 $12,352,525 \text{ head} * .15 = 1,852,879 \text{ head} * 1079 \text{ SDG/head} = 1,999,256,171 \text{ SDG in 2009}$
- C. A + B = value in SDG of national cattle offtake
 $A + B = 6,234,451 \text{ head of cattle} * 1079 \text{ SDG/head} = 6,726,972,629 \text{ SDG in 2009}$

6. camel offtake:

Head of camels in north Sudan * .16 = value of SDG of national camel offtake
 $4,520,999 \text{ head} * .16 = 723,360 \text{ head} * 1024 \text{ SDG/head} = 740,720,640 \text{ SDG in 2009.}$

7. sheep offtake:

- A. Head of south Sudan sheep * .27 annual offtake * farm gate price
 $12,811,421 \text{ head} * .27 = 3,459,084 \text{ head} * 193 \text{ SDG/head} = 667,603,212 \text{ SDG in 2009}$
- B. Head of north Sudan sheep * .27 annual offtake * farm gate price
 $38,743,585 \text{ head} * .27 = 10,460,768 \text{ head} * 193 \text{ SDG/head} = 2,018,928,224 \text{ SDG in 2009}$
- C. A + B = value in SDG of national sheep offtake
 $A + B = 13,919,852 \text{ head} * 193 \text{ SDG/head} = 2,686,531,436 \text{ SDG in 2009}$

8. goat offtake:

- A. Head of south Sudan goats * .25 annual offtake * farm gate price
 $12,937,730 \text{ head} * .25 = 3,234,432 \text{ head} * 100 \text{ SDG/head} = 323,443,200 \text{ SDG in 2009}$
- B. Head of north Sudan goats * .25 annual offtake * farm gate price
 $30,332,270 \text{ head} * .25 = 7,583,067 \text{ head} * 100 \text{ SDG/head} = 758,306,700 \text{ SDG in 2009}$
- C. A + B = value in SDG of national goat offtake
 $A + B = 10,817,499 \text{ head} * 100 \text{ SDG/head} = 1,081,749,900 \text{ SDG in 2009}$

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