SOCIO-ECONOMIC DEVELOPMENT AND BENEFIT SHARING PROJECT [SDBS]

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Low Agricultural Productivity and Food Insecurity in the Nile Basin Countries

KENYA

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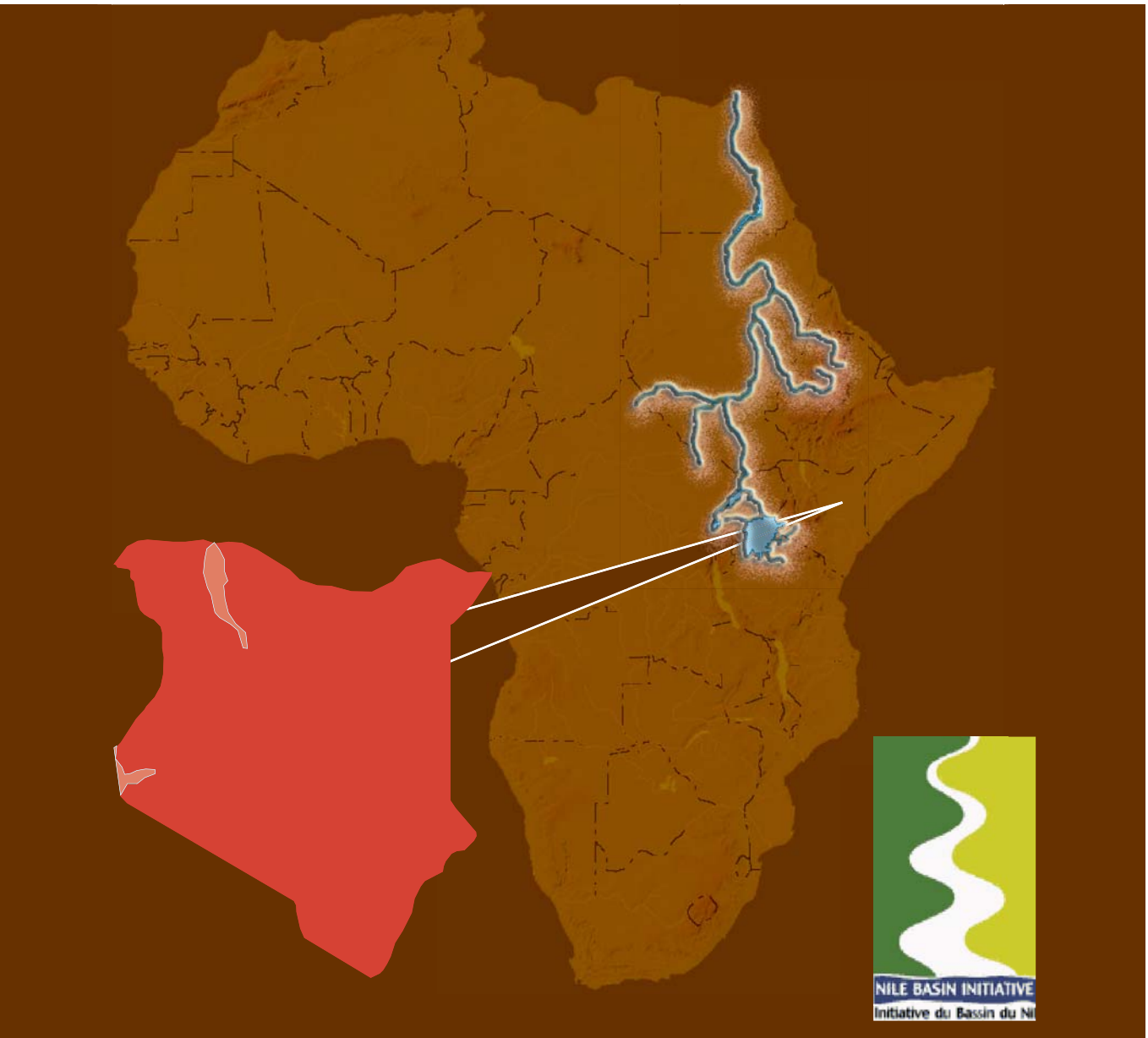

PMU, SOCIO-ECONOMIC DEVELOPMENT & BENEFIT SHARING PROJECT
NILE BASIN INITIATIVE

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Contents

List of Tables

List of Figures

List of Acronyms

AFC	Agricultural Finance Corporation
ASARECA	Association for Strengthening Agricultural Research in Eastern and Central Africa
CAADP	Comprehensive Africa Agricultural Development Programme
CBO	Community Based Organisation
DRC	Democratic Republic of Congo
EFFCH	Efficiency Change
EIA	Environmental Impact Assessment
ERS	Economic Recovery Strategy for Wealth and Employment Creation
FAOSTAT	Food and Agricultural Organisation Statistics
FRI	Fisheries Research Institute
IDR	Institute of Development Research
KMFRI	Kenya Marine and Fisheries Research Institute
LBDA	Lake Basin Development Authority
MALM	Malmquist index
MDG	Millennium Development Goals
NARIS	National agricultural research institutes
NBI	Nile Basin Initiative
NELSAP	Nile Equatorial Lakes Subsidiary Action Programme
NEPAD	New Partnership for African Development
NGOs	Non- governmental Organizations
OASs	One-stop Aqua Shops
R& D	Research and Development
RTAP	Regional Trade and Agriculture Project
SAPS	Subsidiary Action Programme
SDBS	Socio-Economic Development and Benefit Sharing Project-Nile Shared Vision Programme
SMM	Sio-Malaba-Malakisi
SRA	Strategy for Revitalisation of Agriculture
SSA	Sub-Saharan Africa
SVP	Shared Vision Programme
TECHCH	Technical Change
TFP	Total Factor Productivity
WFP	World Food Programme

Acknowledgement

The activities and subsequent results attained in this study would not have come to fruition without the invaluable contribution of various stakeholders. Notably, these include: colleagues in other Participating Institutions, the Nile Secretariat, Shared Vision Programme (SVP) Coordination Unit, SDBS-Project Steering Committee Members, other SVP projects, Subsidiary Action Programmes (NELSAP & ENSAP); the World Bank team, the United Nations Office for Project Services team and Department For International Development team. A word of thanks also goes to all stakeholders in the Nile Basin. Lastly, special appreciations go to the team at the SDBS-Project Implementation Unit for the tireless effort and time invested in guiding this study to a successful conclusion.

Executive Summary

Sub-Saharan Africa (SSA) has remained the only region in the world where livelihoods and food security have deteriorated. The rising world food and farm input prices portend even worse times especially for the Nile Basin region since this is where about 60 per cent of the undernourished people in SSA reside. Currently, the level of under-nourishment in SSA is high - about 33 per cent, compared to about 4 per cent in North Africa and 12 per cent in Asia and Pacific.

The study objective was to characterise productivity of farming systems within the Nile Basin region considered important for meeting food security needs and identify others with potential for improved agricultural productivity but which may require investment for enhancing food security within the region.

Specific objectives were to:

i. Examine productivity levels of dominant crop and livestock activities in the Nile Basin countries;
ii. Identify emerging/innovative farming activities that have potential to enhance productivity but which may require investment for up- and out-scaling.

This study used the Total Factor Productivity (TFP) index which is calculated as the geometric mean of two Malmquist productivity indexes to analyse crop and livestock productivity. Crop and livestock production data from 1984 to 2006 was obtained from FAOSTAT database, and other national databases including the KIPPRA/Ministry of Agriculture Data Compendium.

The main cause of insufficiency in food supply and therefore food insecurity in the Nile Basin region is found to be inadequate growth in agricultural output, probably arising from low levels of labour and land productivity. Comparison of productivity trends between Nile Basin countries shows that other countries have a lot to learn from especially Egypt in raising agricultural

productivity for cereals. Whereas productivity has been low and stagnant for the rest of the countries, that of Egypt has been rising. Egypt's performance is attributed to increased use of improved technology such as fertilisers and irrigation. Studies done in West African countries shows food security gains arising from investment in improved technology and marketing.

The potential for orphan crops which are drought resistant has generally remained unexploited. Yet about 40 per cent of the Nile Basin population is in dry areas. Beef TFP increased by 1.5 per cent annually, which is attributed to both innovation and efficiency. With dairy, the average increase in TFP was about 3.3 per cent p.a and mostly attributable to technological change. The overall efficiency deteriorated by at least 0.4 per cent. TFP for broilers increased slightly by 0.3 per cent whereas that for eggs declined by an equivalent 0.3 per cent mainly due to reduced efficiency.

There are many, complex and inter-related factors that explain linkages between agricultural productivity and food security in the region. These include high dependence on rain-fed agriculture, low soil fertility, collapse of breeding services, high cost and poor quality feeds, prevalence of pests and diseases, weak agricultural extension and information services, and limited access to land and credit. Other factors include the poor state of transportation, limited domestic marketing infrastructure, limited market information, limited regional trade, and insecurity and conflicts.

The emerging and innovative approaches with potential for up- and out-scaling to enhance food security include aquaculture, irrigation development, promotion of rain-fed Nerica rice and *Spirulina* production. These initiatives are promising and have good potential.

Several recommendations made include:

i Public expenditure on food security crops, for example, close the "yield gap" for orphan crops, such as Nerica;

ii Production of seeds and clean planting materials;

iii Investment in irrigation farming and water harvesting technologies;

iv New-product development; value addition, fortification; and

v Data coordination mechanism for NBI

An investment initiative for up-scaling aquaculture in the Sio-Malaba-Malakisi basin is presented. Currently, less than 1 per cent of the total area with aquaculture potential is under utilized. The declining fish capture production from Lake Victoria requires urgent action and aquaculture presents an alternative livelihood for the Lake region households. Critical constraints are high pond construction costs, information asymmetry, and unavailability of inputs.

The proposed strategies for up-scaling aquaculture include:

- Strengthening the extension services to increase awareness on aquaculture;
- Capacity building for aquaculture development;
- Provision of credit and financial services;
- Facilitate the development of fish feeds industry;
- Development of hatcheries;
- Improvement of wetland land tenure systems;
- Sustainable water management;
- Development of marketing infrastructure;
- Environmental conservation; and
- Completion and implementation of the fisheries/aquaculture policy.

Brief Overview

This report forms the Food Security Cluster report of the leading participating institution (PI): The Kenya Institute Public Policy Research and Analysis (KIPPRA). Food security is one of the agreed areas of socio-economic development and benefit sharing. The other PIs in the cluster are the Institute of Development Research (IDR) of Addis Ababa University (Ethiopia) and Development Studies and Research Institute (DSRI) of the University of Khartoum (Sudan).

A scoping study carried out in 2007 identified a number of critical issues on food security in the Nile Basin countries which include: low agricultural productivity, poverty, poor infrastructure, environmental degradation, market access, unstable food prices, drought, conflicts and health and nutritional insecurity. The three PIs selected low agricultural productivity, poverty and poor infrastructure for detailed study due to the severity of the effects on food security in the region and the potential for benefits sharing if addressed at trans-boundary level.

This report first presents the leading PIs' main study on low agricultural productivity and food insecurity in the Nile Basin countries. Issues of poverty and food insecurity are covered by the DSRI, while IDR covers aspects related to infrastructure and food security. The highlights of these two studies are presented in Part D of the report under the cluster report activities.

While acknowledging that causes and prescriptions for low agricultural productivity in much of SSA are well documented, the high levels of malnourishment and limited trade, especially in the Nile Basin Countries, make such a study relevant. More so, the recent surge in world food prices and input prices necessitates an analysis of ways of enhancing food production and distribution in the region.

Unlike other regions of the world, much of Africa relies on diversified farming systems for food production and food security. The many farming systems make it difficult to single out a few with best opportunities for improvement as was possible in much of Asia or the developed countries. Limited resources in the region raise the need for singling out farming systems with the highest technical opportunities and socially compatible approaches for enhancing productivity but which may require investment for up- and out-scaling. While there may exist viable home-grown and innovative technologies to improve agricultural productivity, especially for smallholder farmers, some of these experiences are generally lonely islands of achievements. This report highlights some of these initiatives and presents an investment plan for one of the activities under the Nile Equatorial Lakes Subsidiary Action Programme (NELSAP); the Sio-Malaba-Malakisi integrated River Basin management project that straddles the Kenya-Uganda border.

On low agricultural productivity, the report shows the trends and highlights possible underlying factors specific to the Nile Basin. Comparison of productivity trends between Nile Basin countries shows that other countries have a lot to learn from Egypt especially in raising agricultural productivity. However, there are emerging issues about water use efficiency in Egyptian irrigation systems. Whereas productivity has been low and stagnant for all other countries, that of Egypt has been rising and in some cases performs better than comparable countries in South East Asia. Egypt's performance is attributed to increased use of improved technology such as fertiliser and irrigation. Comparison with countries in West Africa also shows dividends in terms of food security gains arising from investment in improved technology and marketing.

The report presents a strong case for increasing investment as a lever to stimulate crop and livestock supply response, especially given the rising food price trends. Although the high food prices have a negative effect in the short-run on food net-buyers in the region, the rising food and farm input prices also offer an opportunity for innovative policies in the region and for increased intra-regional trade.

On emerging and innovative approaches to enhance food security, the report presents case studies on aquaculture, irrigation development, promotion of rain-fed Nerica rice and *Spirulina* production, a technology currently being promoted in Nyanza Province of Kenya, and has potential for addressing malnutrition and nutritional challenges posed by HIV/AIDS, malaria and hunger. The study concludes that these initiatives are promising and have good potential for up- and out-scaling. If implemented, their benefits would offer leverage for socio-economic development through improved food security, besides other important welfare-enhancing outcomes especially among rural people in the Nile Basin region.

Section A

Low Agricultural Productivity and Food Insecurity in the Nile Basin Countries

1

Introduction

1.1 Background

Sub-Saharan Africa (SSA) has for a long time remained the only region in the world where livelihoods and food security have deteriorated. The rising world food and farm input prices portend even worse times especially for the Nile Basin region since it already houses about 60 per cent of the undernourished people in SSA. Currently, the level of under-nourishment in SSA is high - about 33 per cent, compared to about 4 per cent in North Africa and 12 per cent in Asia and Pacific.

The predominant cause of food insecurity among smallholders in the region is stagnating crop productivity; and among the nomadic pastoralists, the inherent low productivity of a livestock-production system that has remained outside mainstream development. Any strategy to improve food security depends fundamentally on the ability to improve the productivity of the domestic production systems. The rising food price presents an opportunity for the region to increase agricultural production and intra-regional trade. Improved agricultural productivity is not only a means of increasing both the physical availability of food and the incomes of food-insecure people, but it can also contribute indirectly to other people by way of markets through increased purchasing power and by providing the added public and private resources that can be invested in improved infrastructure, services and safety nets.

Unlike other regions of the world where food production and food security depend on a limited number of farming systems, with the exception of Egypt, diversity is the norm in most of the Nile Basin countries, as it is for the rest of sub-Saharan Africa (SSA). The many farming systems make it difficult to single out a few with good opportunities for improvement as was possible in much of Asia. Due to limited resources, there is need for identification of farming systems that have technical opportunities for enhancing productivity

but which may require investment for up- and out-scaling. Such investment may be at the micro, meso or macro level. Evidence exists of viable home-grown and innovative technologies to improve agricultural productivity in smallholder rain-fed and irrigated farming systems. However, some of these experiences are generally lonely islands of achievements with little or no socio-economic or biophysical appraisal of preconditions for success and tradeoffs with other uses and users. Although not exhaustive, this study makes an attempt at documenting some of these innovations.

1.2 Study objectives

The study objective is to characterize productivity of farming systems within the Nile Basin region considered important for meeting food security needs and identifying others with potential for improved agricultural productivity, but which may require investment for enhancing food security within the region.

Specific objectives are to:

i Examine productivity levels of dominant crop and livestock activities in Nile Basin countries;

ii Identify emerging/innovative farming activities that have potential for enhancing productivity but which may require investment for up- and out-scaling.

Although the study initially proposed to characterize major farming systems in the Nile Basin countries and incorporate a measure of water use efficiency in the assessment of productivity, this was not possible due to time limitation.

1.3 Methodology

This section provides the theoretical and empirical aspects used in analyzing crop and livestock productivity.

1.3.1 Assessing crop and livestock productivity in the Nile Basin region:

Theoretical framework

The process of converting inputs into outputs can be described by means of a production (or response) function. In a livestock production system, for instance,

the following relationship between inputs and output has been proposed (McInerney, 1996):

$$Q = f(R/\overline{N}, \overline{K}) \qquad (1)$$

where Q is the quantity of output (e.g. milk, weight gain, etc) derived from the application of variable resources, R (e.g., feed, labour, etc) to an animal population, $\overline{N}$, and other fixed resources, $\overline{K}$ (e.g., land). The symbol f in equation (1) signifies the form of the relationship that transforms inputs into outputs and can take different functional forms.

Based on equation (1), livestock productivity can be defined as the amount of output, Q, divided by any factor on the right-hand side of the equation for a given time period. When it is defined this way, livestock productivity measures the efficiency of the production system and, as such, it is the ratio of units of output per unit of input to the system (James and Carles, 1996). However, because this definition focuses on a single input while ignoring others, it is often a poor measure of productivity (Coelli, 1996). The total factor productivity (TFP) obtained by dividing the total output by the units of all inputs used to produce that output gives a better measure of productivity. TFP approach is the most commonly and widely used measure of agricultural productivity in empirical studies.

This study uses the growth accounting approach to calculate TFP. For a more detailed account of other TPF estimations, see Hertel et al. (1999). The growth accounting approach uses index numbers based on detailed accounts of inputs and outputs, aggregating them into input and output indices, then using those indexes to calculate TFP indices. Although the index number approach makes some strong assumptions about the neutrality of technical change and scale returns, it has been extensively used in the analysis of agricultural productivity (Hertel et al., 1999). In this study, the TFP change was calculated as the geometric mean of two Malmquist productivity indexes (Färe et al., 1994).

Empirical estimation

In order to calculate the output-based Malmquist productivity index for country k' between t and $t+1$, we need to solve four linear programming (LP) problems: $\boldsymbol{D}_o^t(\boldsymbol{x}^t, \boldsymbol{y}^t)$, $\boldsymbol{D}_o^{t+1}(\boldsymbol{x}^t, \boldsymbol{y}^t)$, $\boldsymbol{D}_o^t(\boldsymbol{x}^{t+1}, \boldsymbol{y}^{t+1})$ and $\boldsymbol{D}_o^{t+1}(\boldsymbol{x}^{t+1}, \boldsymbol{y}^{t+1})$.

Thus for each $k' = 1, \ldots, K$,

$$(\boldsymbol{D}_o^t(\boldsymbol{x}^{k',t}, \boldsymbol{y}^{k',t}))^{-1} = \max \theta^{k'}$$

subject to:

$$\theta^{k'} \boldsymbol{y}_m^{k',t} \leq \sum_{k=1}^{K} \boldsymbol{z}^{k,t} \boldsymbol{y}_m^{k,t} \qquad m = 1, \ldots, M \quad \text{outputs}$$

$$\sum_{k=1}^{K} \boldsymbol{z}^{k,t} \boldsymbol{x}_n^{k,t} \leq \boldsymbol{x}_n^{k',t} \qquad n = 1, \ldots, N \quad \text{inputs}$$

$\boldsymbol{z}^{k,t} \geq 0$ $\quad k = 1, \ldots, K$ countries (2) where $\theta^{k'}$ refers to the efficiency score for the k^{th} country. The other three LP problems are a simple variant of (2). The four LP problems were solved using DEA computer programme assuming a constant returns to scale technology (Coelli, 1996). In total, N(3T-2) or 2990 LPs were estimated; where N = number of countries, T = time periods. Note that a Malmquist index greater than unity suggests improvements in productivity; the converse is true for an index of less than unity. Also note that the Malmquist index captures productivity of a particular country relative to the best performer in the sample. The best performer represents a "world frontier", where the "world" is defined as the countries in the sample, in this case, the five Nile Basin countries. The change in the TFP for each of the five Nile Basin countries was decomposed into technical and efficiency change components following Färe et al., (1994)

$$\boldsymbol{M}_o(\boldsymbol{x}^{t+1}, \boldsymbol{y}^{t+1}, \boldsymbol{x}^t, \boldsymbol{y}^t) = \boldsymbol{TECHCH} \times \boldsymbol{EFFCH} \qquad (3)$$

where TECHCH and EFFCH, respectively, refer to technical and efficiency change.

1.4 Data sources

To examine crop and livestock productivity in the region, the study uses crop and livestock production data for 1984 to 2006 from the FAOSTAT database (FAOSTAT, 2006) and other national databases where available (e.g KIPPRA/ Ministry of Agriculture Data Compendium, 2008).

Information on emerging and innovative approaches for enhancing food security is mainly derived from discussions with key informants, farmer case studies and secondary information.

2

Results

The section first presents the general trends in yield of food crops in the Nile Basin countries. This is followed by a discussion of factors that link observed productivity trends to food security in Sub-section 2.2. Sub-section 2.3 provides productivity estimates and trends of specific commodities. Sub-section 2.4 presents case studies of emerging and innovative approaches for enhancing food security.

2.1 General trends of food crop yields

The main cause of insufficiency in food supply and therefore food insecurity in much of the Nile Basin region is inadequate growth in agricultural output, probably arising from low levels of labour and land productivity (Figure 2.1 and Figure 2.2(a-c)). Only Egypt has made significant gain in labour productivity. Egypt is considered as an aspirator country within the region. Figure 2.2(a-c) shows the trends in land productivity for cereals, and pulses, and roots and tubers for the Nile Basin countries for the last 20 years. These are compared to those of South East Asia and the countries in West Africa and the SSA as whole. The yields have been virtually stagnant and far below those of South East Asia for all the three categories of food crops. Apart from pulses, the Nile Basin countries performance has been below West Africa and other SSA countries. West African countries have made substantial progress in productivity of roots and tubers, a factor that is largely responsible for decline in the region's hunger levels (Sanchez, et al., 2005). Indeed, roots and tubers are less tradable over long distances and hence are not highly vulnerable to wide price variations. Although the Nile Basin Initiatives are at par with West African countries in mid-1980s, the productivity of roots and tubers has over the years improved, mainly as a result of the adoption of high yielding technologies in indigenous crops.

Apart from improvement in the productivity of indigenous food crops in West Africa, the diversity of their food basket could also play an important role in enhancing food security and especially in buffering the effect of price volatility. A comparison of Figures 2.3 and 2.4 shows a lower spike in food price between March 2007 and June 2008 for those countries with a more diversified consumption pattern. Sub-section 2.2 provides other factors that may have influenced agricultural productivity and therefore food security in the Nile Basin region.

Figure 2.1: Agricultural labour productivity: Tonnes per worker: 1970-2004

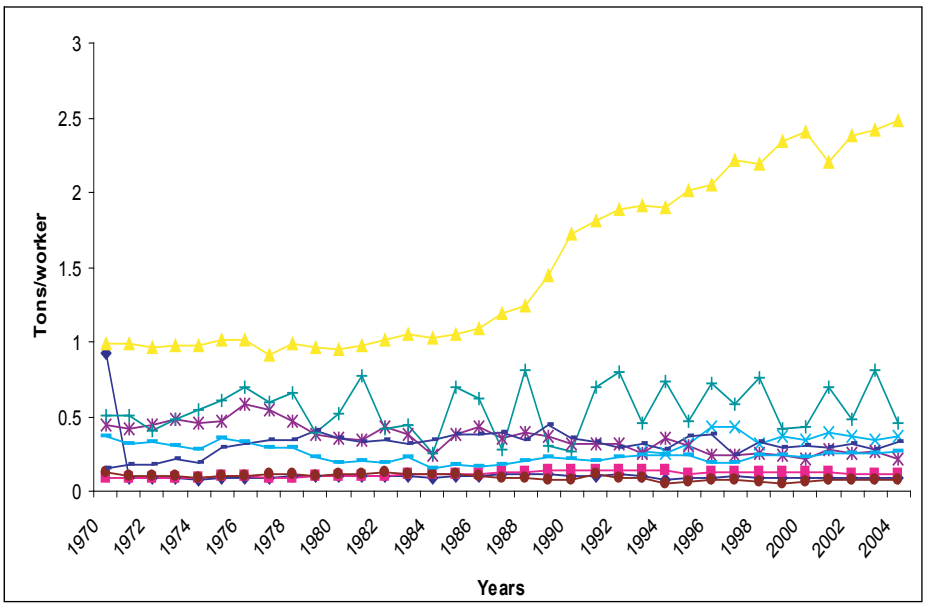
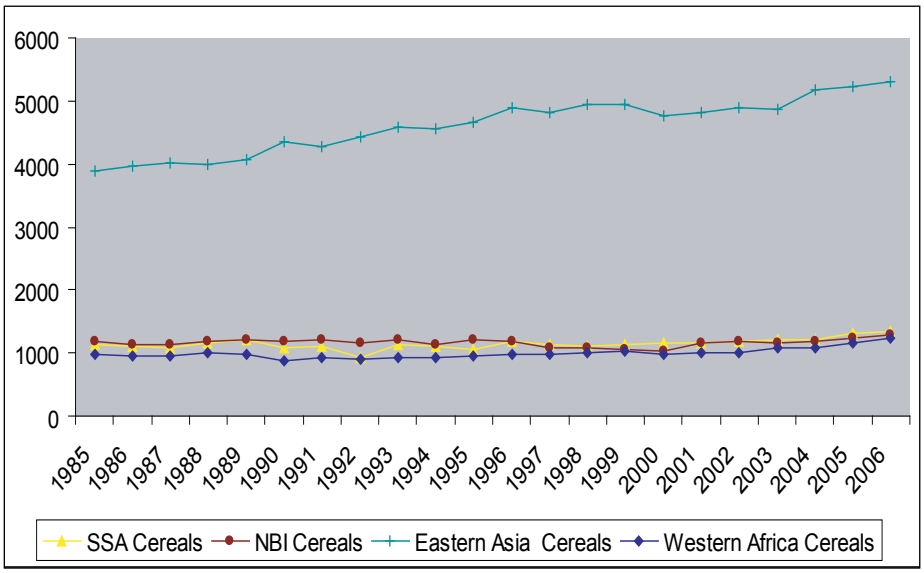
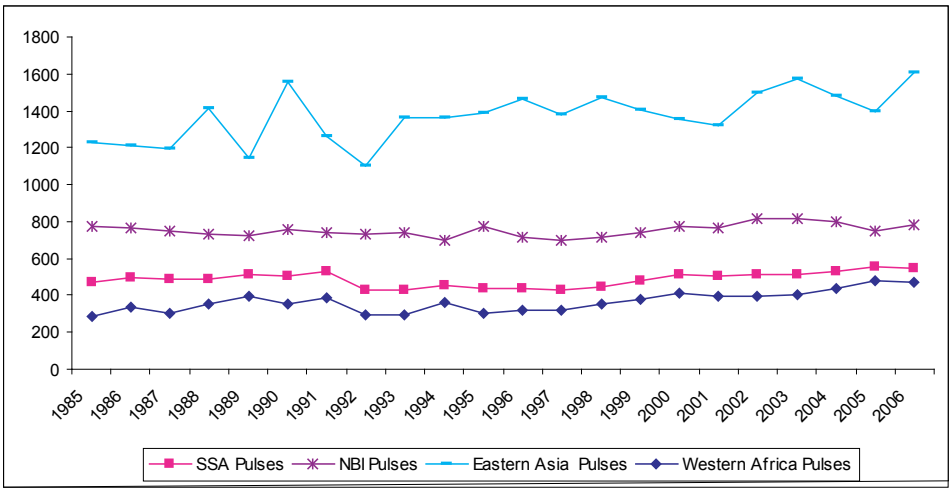


Figure 2.2a: Trends of cereal yields (kg/ha) for Nile Basin, W. Africa, SSA and South East Asia (1985-2006)



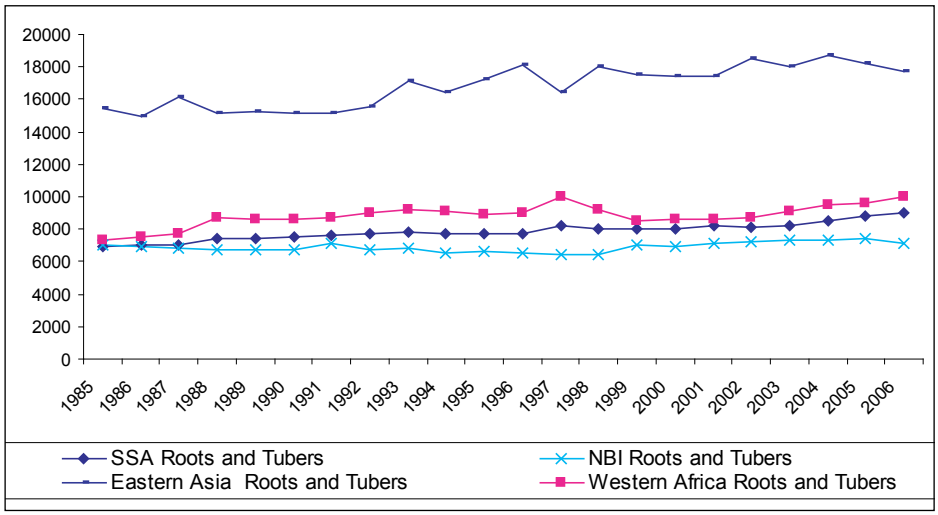
Source: *FAO Stat (2008), Nile Basin excluding Egypt*

Figure 2.2b: Trends of pulse yields (kg/ha) for Nile Basin, W. Africa, SSA and South East Asia (1985-2006)



Source: *FAO Stat (2008), Nile Basin excluding Egypt*

Figure 2.2c: Trends of roots and tubers yields (kg/ha) for Nile Basin, W. Africa, SSA and South East Asia (1985-2006



Source: *FAO Stat (2008), Nile Basin excluding Egypt*

Figure 2.3: Food consumption pattern of main food groups

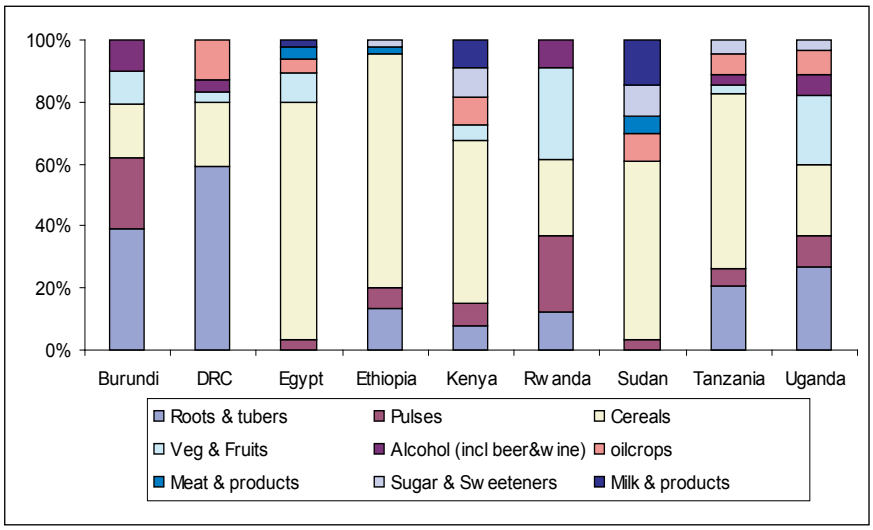
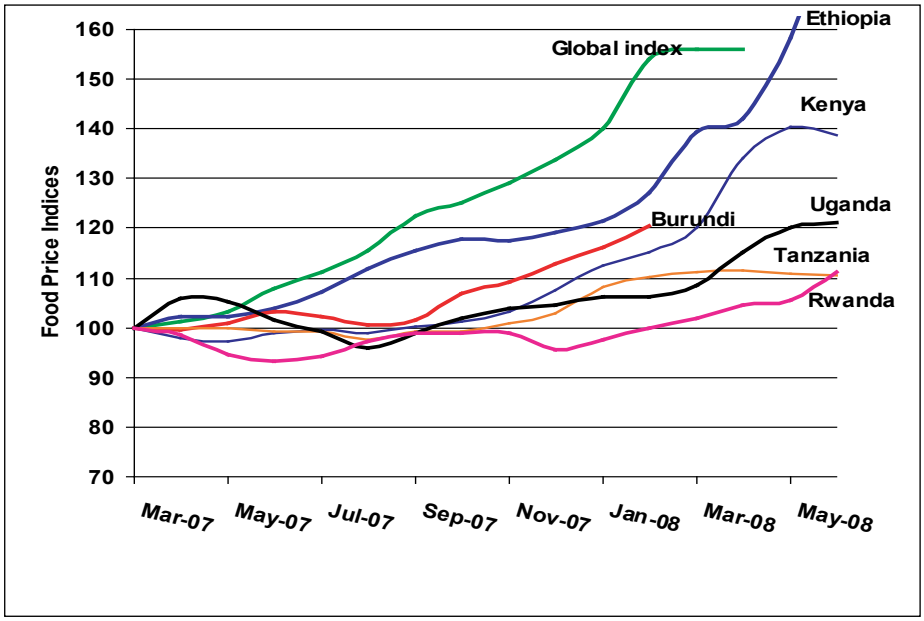


Figure 2.4: Trends of food price index: Global and selected Nile Basin countries (2007/08)



Source: *Karugia et al., forthcoming*

2.2 Factors linking agricultural productivity and food security

There are many complex and inter-related factors that explain linkages between agricultural productivity and food security in the Nile Basin countries. These factors are not unique to this region but offer interesting aspects in explaining inherent relationships, particularly pertaining to incidences of low agricultural productivity and situations characterized by chronic food insecurity. The significance of each of these causal factors may vary from place to place and from time to time. However, it is more of the degree of severity than whether a particular factor is important in the Nile Basin countries.

2.2.1 Factors influencing food production capacity

High dependence on rain-fed agriculture: Most of the countries in the Nile Basin rely on rain-fed agriculture. Available statistics show that growth in agricultural output is largely driven by the traditional factors of production

(land, labour and capital). For example, in the period 1965-2001, 89.7 percent of the growth in Kenya's agriculture was accounted for by the contribution of land, labour and capital while total factor productivity growth accounted for the remaining 10.3 percent. Labour accounted for 48.3 percent of the total agricultural growth while capital and labour contributed 27.6 and 13.8 percent, respectively. The results also indicate that rainfall (climate) and government expenditure were the most important determinants of agricultural productivity growth (Odhiambo et al., 2004). Under rain-fed circumstances and where farming operations depend on manual labour as in most Nile Basin countries, labour shortages during peak season for farm operations such as land cultivation and weeding become crucial in influencing crop yields and hence the food security status of many farming households (NEPAD, 2007).

Furthermore, dependence on rainfall exposes farmers to variable risks of production failure in both crop and livestock systems, which, in turn, affects the levels of consumption profiles as well as the volume of marketable surpluses. With the on-going debate on global climate change, effects of weather variability are likely to pose greater challenges for rain-fed agriculture in many countries. Mechanisms to mitigate, cope with or adapt to climate change are generally very weak or non-existent in most Nile Basin countries. The agriculture sector is facing a multitude of problems relating to water resources that will need to be addressed in order to promote food security in the Nile Basin countries.

Low soil fertility: In most of the Nile Basin countries, soils are generally deficient in critical nutrients to sustain high cereal yields. Increasing population has resulted in yield-reducing land-use practices such as more intensive use of land, shortening of fallow periods, abandonment of shifting cultivation, etc. Due to widespread dependence on rain-fed agriculture, few farmers use external inputs such as inorganic fertilizers and herbicides because of risk-aversion and financial considerations (Freeman and Omiti 2003; Mwangi 1997). In recent years, the increasing cost of external inputs [particularly fertiliser] is blamed on its declining application and hence low crop yields. In

some countries, there is evidence of conflicting policy intervention to assist farmers increase the use of such external inputs. For example, while there is some limited support in accessing fertiliser for maize farming, the same is not extended to other agricultural commodities which could help improve household food security. Nonetheless, with limited use of yield-enhancing inputs, many farmers generally obtain low yields and are trapped in chronic poverty. Indeed, cereal yields in the Nile Basin countries are among the lowest in the world, estimated at about one (1) tonne per hectare per year (FAOSTAT, 2006).

Collapse of breeding services: Public delivery systems of livestock breeding services in a number of countries collapsed due to financing hardships (on the exchequer). The private sector has not been very successful in replacing the role hitherto played by the public sector. For example, in Eastern Africa, artificial insemination (A.I.) services have become less reliable and more costly. As such, increasingly many farmers are abandoning their use of A.I. services, leading to increasing use of natural service which often results in spread of diseases and poor performance of the dairy herd (Wanyoike et al., 2002; Mogoa et al., 2004).

High cost and poor quality feeds: Cost and quality of feeds are essential in determining livestock production levels (productivity). There is great variation within and between countries in their capacity to manufacture animal feeds, which in turn leads to non-trivial differences in livestock performance in such quality-sensitive enterprises as dairy and poultry production, which in turn influences levels of consumable produce and marketable surpluses.

Prevalence of pests and disease: Pest and disease cause considerable damage or loss to both crops and livestock during the production or storage stages in the value chains. Depending on the commodity and the circumstances, pests and disease can account for as much as 90 percent of the post-harvest losses (Leonard, 2000). If such losses could be avoided or minimised, there is chance of increasing food production levels and therefore improving food security at household, country and regional levels (if traded).

However, it is important to appreciate that technologies to minimize pest or disease attack are often expensive and beyond the reach of most small-scale farmers. Public efforts to make drugs available to farmers often face many challenges. For example, communal livestock dips or sprays are poorly managed in many countries (Irungu et al., 2006; Umali et al., 1994). There are high incidences of drug misuse (e.g., under-dosing or selling illegally).

Weak agricultural extension and information services: In many countries, agricultural extension and advisory services have undergone through a variety of institutional reforms in order to make them more relevant to serving farmers perceived needs. With hindsight, extension services still experience many operational and financial challenges to adequately serve the contemporary needs of farmers. However, there are many promising avenues through public-private partnerships and external funding meant to improve delivery of extension and information services to farmers and traders.

Limited access to land and credit: Different countries in the Nile Basin have a variety of land tenure regimes that constrain productive and efficient use of land and therefore food production capacity. Appropriate policies that promote security of land tenure, especially for female farmers, are a pre-requisite for enhancing food production capacity as well as fostering efficient land markets that can trigger structural transformation processes, attract investments and protect economic livelihoods in most countries to raise agricultural productivity (UNECA, 2006).

2.2.2 Factors influencing agricultural marketing

Poor state of transportation: The state of transportation infrastructure (e.g, roads, rail, etc.) is generally poor in most countries, especially during the rainy seasons. This affects the cost of inputs as well as transportation charges on farm produce (Ruijs et al., 2004). In some cases, the transportation costs are so high that many farmers and traders opt not to engage in farming or trading business even if other resources were available. Both the state and length (i.e. distance to markets) of transportation infrastructure significantly influence

prices received by farmers and traders as well as the volume of produce that is spoiled or damaged during transportation. It is discernible that improvements in transportation networks will have significant knock-on effects on volumes traded, prices received and food security especially of poor households.

Limited domestic marketing infrastructure: The state of domestic marketing infrastructure (e.g., storage capacity, clean water, sewerage systems, energy, trading space, etc.) varies from country to country. This affects the volumes that are traded, the possibility for rent-seeking behaviour in the allocation of trading space, level of competition in the markets, etc; which ultimately influence producer and retail prices. Both the producer and retail prices have knock-on effects on household disposable incomes, which influence food security.

Limited market information services: The capacity and funding of the different channels (mobile, radio, television, newspaper, etc.) of communicating information to the farming and business community varies from one country to another in the Nile Basin depending on what (which issues) to report and in which format to report (text, pictures, etc.). This varies depending on the extent of geographical coverage, depth of coverage, target audience, intended impact (positive or negative), etc. The effectiveness of different channels is also influenced by the ability of users to access the information delivery channel such as owning a radio, a mobile phone, etc and literacy levels (Ferris et al., 2006; Swinnen et al., 2004). It is critical that relevant and timely information on production and marketing trends is made available to permit appropriate decisions on what amounts to hold onto for food security reasons as well as what volumes of which commodities are to be offered for sale; both in the domestic and regional markets (NEPAD, 2007).

Limited regional agricultural trade: Cross-border trade can increase food availability amongst Nile Basin countries that will go a long way to promote food security. However, there are several barriers of varying magnitude to cross-border trade between different countries which impede movement of tradable commodities. As such, there is anecdotal evidence of informal cross-

border trade between Nile Basin countries (Ackello-Ogutu and Echessah 1997). This demonstrates the existence of opportunities to promote intra-regional trade, especially in cereals, pulses (e.g. beans) and other less perishable commodities. There are some attractive aspects of promoting intra-regional agricultural trade that hinge on (i) stabilizing producer prices in the exporting country while reducing consumer prices in importing countries, and (ii) promoting regional integration since there are varying harvesting calendars for different commodities and hence not much competition between countries but learning to depend on each other.

2.2.3 Factors influencing access to food

Limited gainful employment: Price and income are major determinants of demand, besides population and taste preferences. For those segments of the population that are not engaged in food production, employment provides a major avenue of earning income which enables households to purchase food. However, in many countries of the Nile Basin, unemployment is widespread and has differing implications on household food security, particularly for the urban poor (Kijima et al., 2006; Juvan and Erjavec 2005; CBS 2003; Smith et al., 2000 and Mwabu et al., 2000). In a report to the House of Commons (UK Parliament), the World Food Programme reports on the consequences of spiralling food prices on the urban poor is now termed as 'the new face of hunger' (WFP, 2008), because it was unprecedented. Social protection measures have been applied to increase access to food by those who are unable to produce sufficient food for their families. These include food-for-work programmes, cash transfers, etc.

Insecurity and human conflicts: Insecurity and/or human conflicts impede farming and trading activities, which significantly affect the food security portfolios of those members of society whot cannot arrange for affordable means of accessing food supplies. Majority of the Nile Basin countries have experienced moments of heightened insecurity and human conflict during the last 10 years.

2.2.4 Equity and gender issues in food security

Almost all the Nile Basin countries are characterized by high inequalities in access to resources among social groups and gender, and therefore incomes. Since poor households are likely to spend a great proportion of their income on food, this perpetuates the inequalities, since those with surplus continue to add on their productive assets and productivity. High income inequalities therefore hinder progress towards achieving more equitable food access unless there are public efforts to support food schemes for the poorer and more vulnerable members of society. In the Nile Basin Egypt has a relatively comprehensive programme of food subsidies to the lower income households. However, rising food prices have seriously affected its efficacy leading to occasional food riots in the capital city (Cairo). Egypt has the lowest income Gini coefficient of about 28 percent (WIDER, 2007) - reflecting lesser income inequality - compared to the other countries, all of which have a Gini coefficient greater than 30 percent.

Equity in access to factors of production also impacts on food security. Given that food production systems are defined by the elements of land, labor, capital and technology as well as the market and non-market institutions governing their allocation, an equitable food production system involves improving poor people's access to these resources and institutions. In particular, although women may have the prime responsibility of food production, they often have limited rights to land. Their access often shrinks further where there are shifts from communal to private ownership of land as is happening in much of the Maasai community in Kenya and Tanzania. The exploitation of communal resources for wood fuel and water for domestic use, for example, is particularly important for poor households. Loss of communal resources means women in households with small plots have to spend more time in search of these resources impacting negatively on their productivity.

2.2.5 Factors affecting food utilisation

Access to clean water: Water is of central importance in industry, farming, forestry and fisheries. Availability of clean water is also essential for food preparation as well as drinking. In the Nile Basin countries, water is a finite

and dwindling resource that is under immense pressure because of increasing demand (due to increasing human ,livestock and wildlife populations) and climatic changes (Nile Conference 2002). Water availability patterns in semiarid regions are typically extremely variable. Even in basins with a highly developed infrastructure, users are subject to unreliable water supplies, incurring substantial economic losses during periods of scarcity (Calatrava and Garrido, 2005; Chakravorty and Zilberman, 2000). More flexible instruments are required to promote access to water.

Access to cooking energy: Energy is fundamental to fulfilling basic social needs (for providing water, food, health services, education, etc.), fuelling economic and social development and combating desertification. Cost and availability of cooking energy influences how food is prepared to meet the dietary requirements and cultural preferences of households in different parts of the Nile Basin. Per capita energy consumption in Africa is the lowest in the world: 0.3 to 0.6 tonne/person in sub-Saharan Africa compared to 7.5 to 9 in North America (a ratio of 1:30). With increasing fuel prices, an increasingly large proportion of households now depend on biomass (charcoal, fuelwood, etc) for preparing their meals. Indeed, Africa's energy profile continues to be dominated by biomass which, in its various forms, accounts for 2/3 of total domestic energy consumption (Hazell and Pachauri, 2006).

Knowledge on food preparation: Knowledge on diverse ways of food preparation, preservation and consumption is of vital importance in promoting utilisation of food amongst different age groups to meet dietary requirements (NEPAD 2007). This calls for training of those in food preparation on a range of ways to cook and preserve food for different age groups and occasions. Sharing of recipes between different cultures is another useful tool for promoting food utilisation across the region.

Promoting value addition: Due to dependence on rain-fed agriculture, many regions of the Nile Basin are characterized by seasons of gluts and deficits. Promoting simple and culturally acceptable ways of food preservation would go a long way in promoting food production and utilization. For example, it

is imperative to go beyond pasteurization of milk to make such products as butter, ghee, cheese, etc.

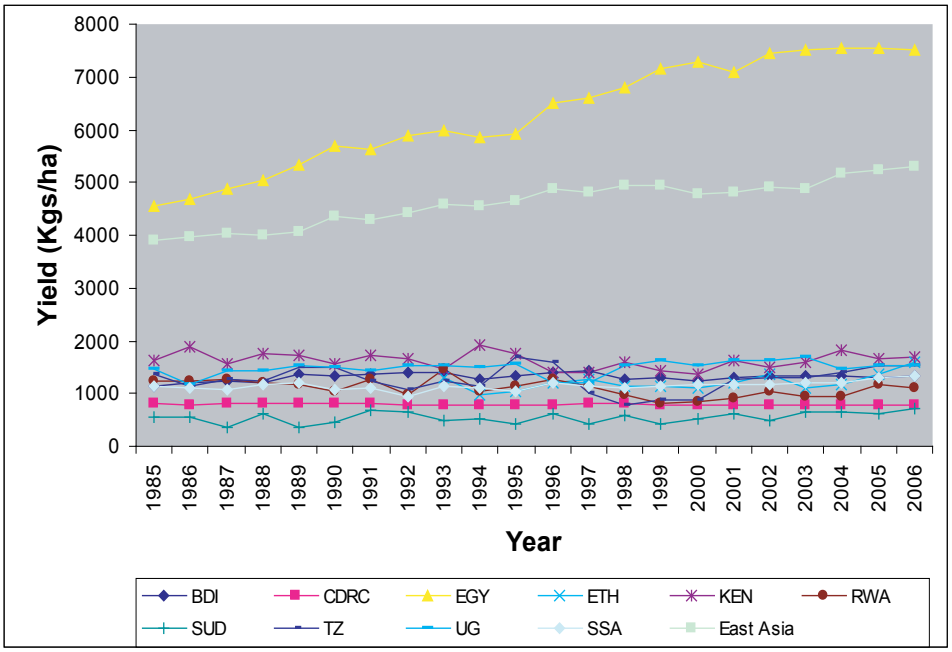
Promoting emerging enterprises: With increasing demand from the tourism industry, there are emerging livestock enterprises such as ostriches, guinea fowls, quails, crocodiles and elands which offer income-generating opportunities, for those able to invest in such ventures. However, there is some need to streamline regulations that govern the domestication, commercialisation and utilization of such non-conventional livestock species.

2.3 Partial factor productivity and total factor productivity for specific commodities

2.3.1 Cereal productivity in Nile Basin countries

Cereal productivity for Nile Basin countries and Eastern Asia is shown in Figure 2.5 for comparison purposes. It can be seen that Egypt has a high cereal productivity, much higher than Eastern Asia countries and the Nile Basin countries. Currently, the cereal productivity for Egypt is about 7.5 t/ha compared to 5.0 t/ha for Eastern Asia countries. Within the Nile Basin region, Kenya which has a low cereal productivity of about 1.6t/ha (almost five times lower than Egypt), is second to Egypt. Uganda and Tanzania then closely follow Kenya with cereal productivities of 1.59 t/ha and 1.35 t/ha respectively. Sudan and Democratic Republic of Congo have the lowest cereal productivities of 0.61 and 0.77 t/ha, respectively.

Figure 2.5: Trends in Cereal productivity in the Nile Basin (1985-2005)



Source: *FAOSTAT database*

Whereas the cereal productivity for Egypt has been increasing, that of other Nile Basin countries has generally either been stagnant or declining. This is best illustrated by comparative yield statistics, across 20 years, shown in Table 2.1.

Table 2.1: Comparative yield statistics in the Nile Basin Countries (1985/90 – 2001/05)

Country	Average Yields (Kgs/ha)				Change (%) in Yields
	1985 - 1990	1991 - 1995	1996 - 2000	2001 - 2005	(1985/90 & 2001/05)
Burundi	1251.0	1349.2	1331.3	1323.1	5.7
Congo DR	801.8	786.2	793.5	774.6	- 3.4
Egypt	5032.7	5854.3	6869.7	7433.8	47.7
Ethiopia	0.0	1107.3	1172.0	1240.9	12.1[1]
Kenya	1686.5	1701.2	1438.4	1634.9	- 3.1
Rwanda	1194.4	1169.1	1007.5	1005.8	- 15.8
Sudan	487.9	553.8	513.2	605.7	24.1
Tanzania	1330.5	1280.4	1028.8	1350.3	1.5
Uganda	1421.7	1514.3	1424.5	1591.5	11.9
SSA	1126.8	1065.4	1147.3	1216.3	7.9
Eastern Asia	4051.8	4503.3	4874.9	5001.9	23.5

Over the 1985/2005 period, Egypt recorded the highest increase in cereal yields of 47.7 per cent followed by Sudan (24.1%), and Ethiopia (12.1 %). Some countries such as Rwanda, Kenya and DR Congo recorded negative growth rates in cereal productivity. Since cereal production plays a crucial role in meeting the food security needs of almost all Nile Basin countries, it is therefore not surprising that while the food security situation has greatly improved in Egypt over the last two decades, the opposite has been happening in the rest of the Nile Basin region.

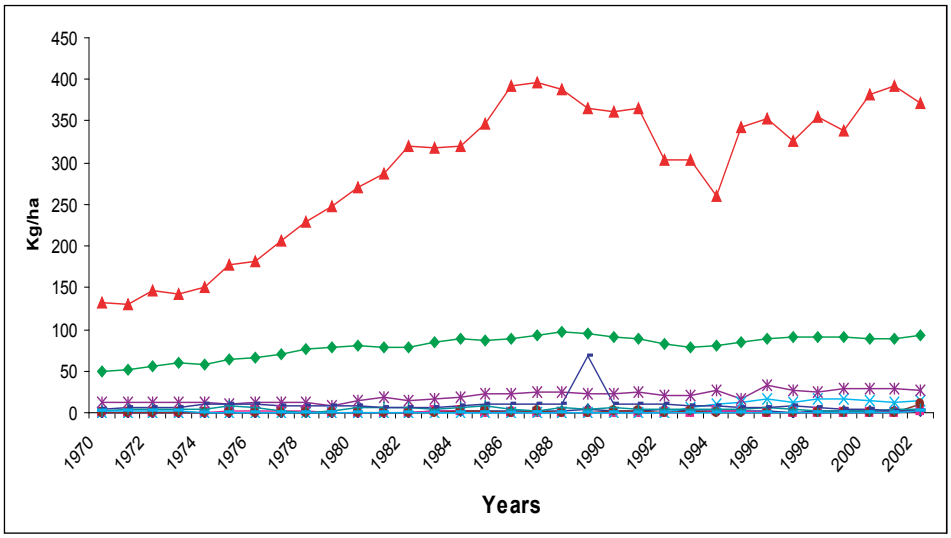
As observed in Table 2.1, Egypt has achieved considerable progress in increasing cereal productivity. This achievement reflects the success of the vertical expansion of agricultural development projects in Egypt. The progress included increases of both the productivity and the cropping area with the latter having increased from 10.3 million feddans (i.e. 4.23 million ha) in the 1960s to about 11.2 million feddans (i.e. 4.6 million ha) in the 1980s and 16 million feddans (i.e. 6.58 million ha) in 2004 (Egypt food security country report,

2007). In addition, yields have continually expanded over time, particularly for wheat, maize and vegetables, through improvements in irrigation and drainage, selection of high yield varieties and input use. Productivity per hectare of the old lands is quite high by international standards, even when compared with those of developed countries For instance, in 2004/2005, Egypt was ranked first on the world productivity per feddan (i.e. acre) for rice, sugarcane and Nile guinea corn, while it was ranked second in peanut productivity, and seventh in beetroot.

The low cereal productivity for other Nile Basin countries can partly be attributed to low intensification of input use as exemplified by fertilizer use (Figure 2.6). Only Egypt has recorded a substantial rise in both labour productivity and intensity of fertilizer use. At 371 kg/ha, Egypt fertilizer use is even higher than the world average approximated at about 92 kg/ha.

Some of the emerging issues from intensification of agriculture in Egypt revolve around the efficiency of water uses, evaporation losses, and the effectiveness of delivery channels under the different irrigation schemes, and pollution and salinisation due to intensive fertiliser use. It is now apparent that improvements will be required to increase efficiency in irrigation systems as water increasingly becomes a scarce commodity in the region and beyond.

Figure 2.6: Fertilizer use intensity in Nile Basin countries (1970-2002)



Source: *FAO stats*

2.3.2 Productivity of orphan crops in the Nile Basin countries

Orphan crops (e.g. sorghum, millets, pigeon pea, green gram etc.) and crops with unexploited potential (e.g. tubers and root crops) are major staples for millions of people in the marginal tropics of Africa and Asia. Sorghum and millet are the third most important food crops in the Nile Basin region, after maize and beans, and are cultivated in more than 13 million hectares of land. Sorghum and millet account for about 56 per cent of cereal acreage and 41 per cent of cereal production (Rohrbach, 2004). However, continued cultivation of these crops must be performed under changing conditions of climate, soils, land use, productivity of inputs, human health, urbanisation, international rules and standards, and consistent policy strategy for the development of these crops. Indeed, orphan crops with unexploited potential face major production, climatic and marketing risks as well as those related to loss of biodiversity and genetic materials.

About forty percent of the population in the Nile Basin countries (excluding Egypt) - about 100 million - live in dry areas where sorghum and millet are mostly cultivated. The sorghum sub-sector is more developed in Sudan where it accounts for about 70 per cent of cereal production. Sudan accounts for 21.4 per cent of Africa's sorghum production, being second to Nigeria, which produces 33.8 per cent. Ethiopia accounts for 7.3 per cent, Tanzania 3.5 per cent, Uganda 2 per cent, Rwanda 0.8 per cent, and Kenya 0.6 per cent [Taylor 2004; FAO 2004].

Productivity of orphan crops is very low because of constraints encountered along the value chain. The average yield of sorghum and millet in Africa is about 800 Kg/ha, 1200 Kg/ha in Asia, 4000 Kg/ha in America and 5000 Kg/ha in Europe. In Nile Basin countries, sorghum and millet are grown without any significant use of external inputs such as fertilisers, improved seed, agro-chemicals and farm implements, perhaps unlike the other regions of the world. There is limited international trade in sorghum and millet, or even trade in domestic markets. Most of these constraints are common to all the countries in the region (ASARECA, 2004, Omiti, 2004; ICRISAT 2004).

The reasons for low productivity are many and contentious. The low productivity is associated with (i) traditional modes of production, (ii) low levels of technology adoption (e.g., seed, fertiliser), (iii) biophysical or environmental constraints such as droughts and other natural disasters, (iv) institutional bottlenecks such as research capacity and facilities, (v) high post-harvest handling losses, (vi) limited processing (value addition) and utilization, (vii) unfavourable policy framework and credit, and (viii) limited knowledge and information exchange and (ix) marketing hardships such as poor infrastructure (ASARECA 2004; Omiti 2004;).

Sorghum and millet (mainly pearl and finger millets) are consumed in many forms, of which the most important are leavened bread, porridge, non-alcoholic and alcoholic beverages. Limited quantities are used for animal feed or industrial production. Approximately 60 per cent of sorghum and millet production is consumed by farm households while 40 per cent is sold in domestic markets. These crops have great potential for industrial production of bread, beer and animal feeds, and also in nutrient cycling and construction (ASARECA, 2004). The actual level of utilisation to serve different uses depends on its relative competitiveness both as food and an industrial input. Industry tends to use those grains obtained at lowest cost, which are consistently available and meet consumer preferences. Generally, sorghum and millet lag considerably behind competing grains such as maize, barley and wheat.

2.3.3 Livestock productivity in selected Nile Basin countries

This section presents the results of the estimated partial factor and total factor productivity for livestock in Ethiopia, Kenya, Sudan, Tanzania and Uganda. Trends of livestock numbers and production are shown in appendix A.

Trends in partial factor productivity of livestock (1984-2004)

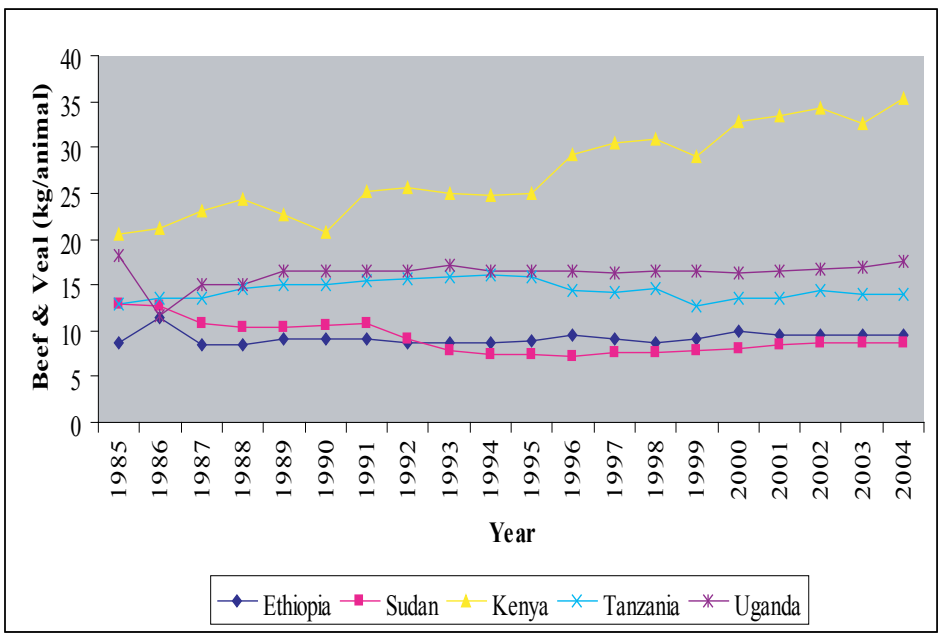
Although PFP measures the average product of a single factor of production and is therefore not a perfect measure of productivity, it is, however, important in indicating the efficiency of resource use in a production process. In this section the units of output are divided by the number of animals that

produced that output; hence, the reported PFP is expressed as units of output per animal.

(a) Partial factor productivity for beef and veal

Kenya has the highest beef and veal production per animal among the five Nile Basin countries (Figure 2.7). From appendix A, although Sudan and Ethiopia had the highest quantity of beef and veal produced, they had the lowest Partial Factor Productivity (PFP) meaning that they were least efficient in transforming their high beef cattle population into beef and veal. Following the same argument, Kenya had the highest production efficiency for beef and veal over the 1985-2004 period. Uganda was the second most efficient among the five countries.

Figure 2.7: Trends of partial factor productivity for beef and veal in Nile Basin countries (1985-2004)



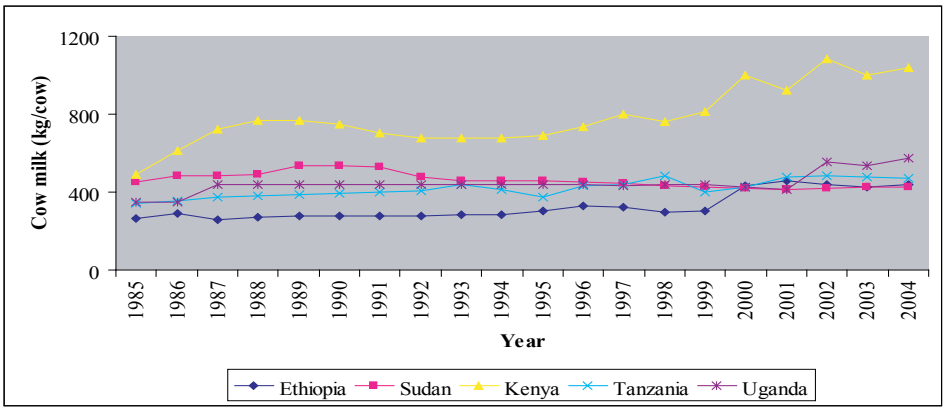
Source: *FAOSTAT (2006)*

(b) Quantity of cow milk per cow

Trends in milk output per cow in the five Nile Basin countries over the 1985-2004 period are shown in Figure 10. Kenya had the highest productivity averaging

1,041.5kg/cow per year with an increasing trend. The Sudan, Tanzania and Uganda stagnated around the 490kg/cow/yr mark during the same period. Over the 1985-1999 period, the average milk productivity in Ethiopia was 287.9kg/cow/yr but has been rising steadily since then (Figure 8).

Figure 2.8: Trends of partial factor productivity for cow milk in Nile Basin countries (1985-2004)

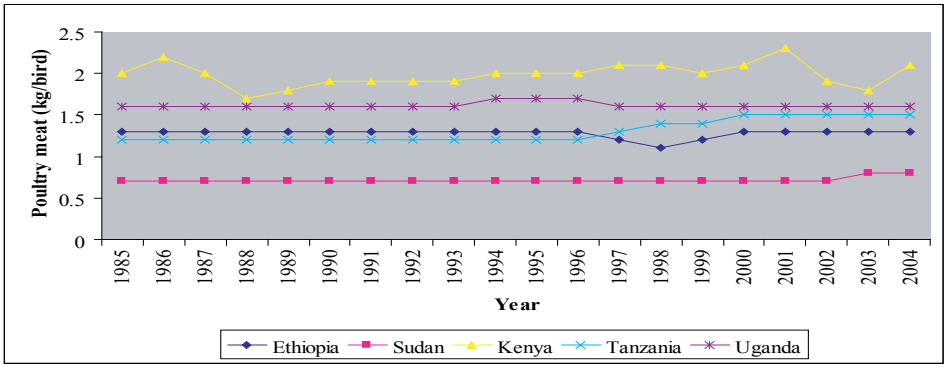


Source: *FAOSTAT (2006)*

(c) Quantity of poultry meat per bird

Except for Kenya, the quantity of poultry meat per bird produced in Ethiopia, Sudan, Tanzania and Uganda remained constant over the 1985-2004 period (Figure 2.9). On average, Kenya had the highest poultry meat productivity at 2kg/bird followed by Uganda at 1.6kg/bird. The Sudan had the lowest average productivity of 0.7kg/bird.

Figure 2.9: Trends of partial factor productivity for poultry meat in Nile Basin countries (1985-2004)

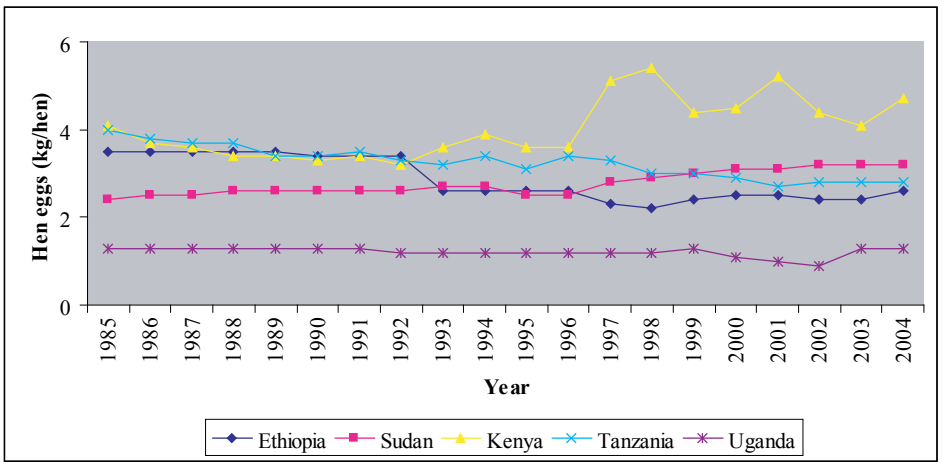


Source: *FAOSTAT (2006)*

(d) Quantity of eggs per hen

The productivity of hen's eggs declined over the 1985-2004 period in Ethiopia, Tanzania and Uganda (Figure 2.10). Since 1992, Kenya's hen's egg productivity has been rising although intermittently (probably due to data quality). Between 1996 and 2004, hen's egg productivity in the Sudan rose only slightly. Kenyan hens have the highest productivity in the region producing an average of 4kg of eggs per hen annually followed by Tanzania at 3.3kg/hen, Ethiopia at 2.9kg and the Sudan at 2.8kg/hen. Uganda had the lowest productivity at 1.2kg/hen annually.

Figure 2.10: Trends of partial factor productivity for hen eggs in Nile Basin countries (1985-2004)



Source: *FAOSTAT (2006)*

Total factor productivity for livestock in the Nile Basin countries (1984-2003)

The TFP approach evaluates the productivity of multiple inputs. In this study, there were three main inputs to beef and dairy production, i.e., animal stock, pasture and labor while poultry production had only two major inputs, i.e., animal stock and labor. The lack of data for other inputs necessitated the evaluation of the said inputs. As already mentioned, TFP was calculated for the 1984-2003 series because the input data for 2004 were missing.

Table 2.2 presents the results of the TFP calculation for beef & veal and cow milk. MALM stands for the Malmquist index which represents TFP change over 1984-2003 period. TECHCH is an index for the technical change while EFFCH is an index representing changes in efficiency. The average productivity of beef and veal in the five Nile Basin countries increased by 1.5 per cent annually. This growth was contributed by changes in both innovation and efficiency (both have identical indices). With regard to country-by-country productivities, Ethiopia had the highest productivity change for beef and veal at 5.1 per cent most of which was accounted for by increased efficiency. Kenya followed next at 1.6 per cent with the entire productivity growth being accounted for by technological change. The other three countries had negligible productivity growth for beef and veal.

There was an overall increase in the productivity of cow milk in the five Nile Basin countries amounting to an average of 3.3 per cent per annum (Table 2.2). A big chunk of this growth was due to technological change (3.7%) – due to adoption of improved cattle breeds, improved animal health management practices, and the adoption of fodder crops over the 1984-2003 period. The overall efficiency in dairy production deteriorated by at least 0.4 per cent due to poor or missing markets, poor road infrastructure and inadequate dairy policies in the five Nile Basin countries.

Table 2.2: Total factor productivity for beef and dairy in five Nile Basin countries (1984-2003)

Country	Beef & Veal			Cow milk		
	MALM	TECHCH	EFFCH	MALM	TECHCH	EFFCH
Ethiopia	1.051	1.013	1.038	1.041	1.042	0.998
Kenya	1.016	1.016	1.000	1.034	1.034	1.000
Sudan	1.000	1.000	1.000	1.033	1.031	1.002
Tanzania	1.002	1.002	1.000	1.02	1.043	0.978
Uganda	1.004	1.004	1.000	1.036	1.036	1.000
Mean	1.0146	1.007	1.0076	1.0328	1.0372	0.9956

Table 2.3 shows the TFP indices for poultry products (meat and eggs). There was a slight increase in productivity in poultry meat production between 1984 and 2003 of only 0.3 per cent. Although modest, the increase in productivity resulted from increased innovation and efficiency. Ethiopia's poultry meat productivity decreased, mainly due to decreased efficiency. On the other hand, Kenya's productivity remained unchanged while that of the Sudan increased marginally by 1.1 per cent mainly due to increased innovation. Tanzania's poultry meat productivity increased by 1 per cent mainly due to increased efficiency. However, this was counteracted by reduced innovation. In Uganda, poultry meat productivity increased due to increased innovation rather than efficiency.

Table 2.3: Total factor productivity in poultry in five Nile Basin countries (1984-2003)

Country	Poultry meat			Hen eggs		
	MALM	TECHCH	EFFCH	MALM	TECHCH	EFFCH
Ethiopia	0.993	1.005	0.988	0.981	1.007	0.974
Kenya	1.000	1.000	1.000	1.006	1.006	1.000
Sudan	1.011	1.006	1.005	1.017	1.012	1.005
Tanzania	1.010	0.993	1.017	0.984	1.000	0.984
Uganda	1.001	1.006	0.995	0.998	1.012	0.986
Mean	1.003	1.002	1.001	0.9972	1.0074	0.9898

The productivity of hen eggs deteriorated by about 0.3 per cent between 1984-2003 due to reduced production efficiency in five Nile Basin countries

between 1984 and 2003. In fact, apart from the Sudan whose efficiency increased, all the other countries' efficiency remained either static (the case of Kenya) or declined. Both the Sudan and Tanzania had changes in technology of 1.2 per cent during the same period.

2.4 Emerging enterprises/innovations with potential for up-scaling

2.4.1 Fish farming in the Nile Basin: Case study of Eastern Uganda and Western Kenya

With the declining capture of fish in Lake Victoria, as demonstrated by both size of captured fish and amount, there is increasing concern of ways about saving the Lake's fish population as well as finding alternative livelihood options for a population that relies heavily on fishing (Personal communication, Uganda and Kenya's Fisheries Officers and Officers from the Lake Basin Development Authority). The declining fish population combined with rising fish consumption has raised interest in aquaculture. Aquaculture can be a very productive use of land with the amount of food produced per hectare being considerably higher than arable farming or livestock rearing (FAO, 2006).

Recognising the great potential for aquaculture especially in the many wetlands and the high demand for fish, the Ugandan Government is encouraging people to invest in fish farming. The Nile Basin initiative has been investing on a pilot scale in fish pond farming in the Sio-Malaba-Malakisi basin. In Kenya, aquaculture potential is estimated at 50,000 MT per annum. Until the year 2000, aquaculture in Kenya had stagnated at an annual production of around 1,000 tonnes. Since 2000, various government policy documents have highlighted the potential and importance of aquaculture. The Ministry of Fisheries, especially, considers aquaculture as one of the means to alleviate poverty and hunger. During the preparation of the Poverty Reduction Strategy Paper in 2000, the government identified aquaculture as a core activity for funding through the Medium Term Expenditure Framework budgeting system. The Economic

Recovery Strategy for wealth and employment creation (ERS), the Strategy for Revitalizing Agriculture (SRA) and the first phase Medium Term Plan (2008-2012) for vision 2030 identify fisheries as a key sub-sector in the reduction of poverty and hunger in Kenya. Similarly, the plan for modernization of Agriculture (PMA) in Uganda.

The focus for the last seven years has been on encouraging the development of private, commercial large-scale aquaculture. This has led to production improvement with about 26,700 MT being recorded in 2006 (Ministry of Fisheries). Further development of the sector is hampered by inadequate extension support, a focus on academic research rather than development-oriented research, inadequate reporting and documentation; lack of readily commercial feeds and quality seeds.

Just like the rest of sub-Saharan Africa, the potential for Nile Basin aquaculture remains unexploited, contributing about 1 per cent of the total fish landed. So far only Egypt seems to have a viable fish-farming sector in Africa, having increased output by four-fold in ten years: from 85,000 tonnes in 1997 to 380,000 tonnes in 2006. Elsewhere, the potential is there as demonstrated by numerous pilot projects, but many of these pilot projects have borne disappointing expectations when scaled up.

Given rather disappointing outcomes in the past when pilot projects scaled up, it was considered prudent to assess the current profitability of fish farming at farm level, and seek views from key informants in the fish industry on potential risks if aquaculture is to be up-scaled.

The study uses Kenya as a case study and a model farm in Eastern Uganda. The Kenyan analysis uses data derived from a 2006 baseline survey on fish farming. From Figure 2.11 and Table 2.4, Western and Nyanza Provinces where the Lake basin lies contribute the most to aquaculture production in Kenya and also lead in aquaculture productivity.

Figure 2.11: Production by province as per cent of the national total

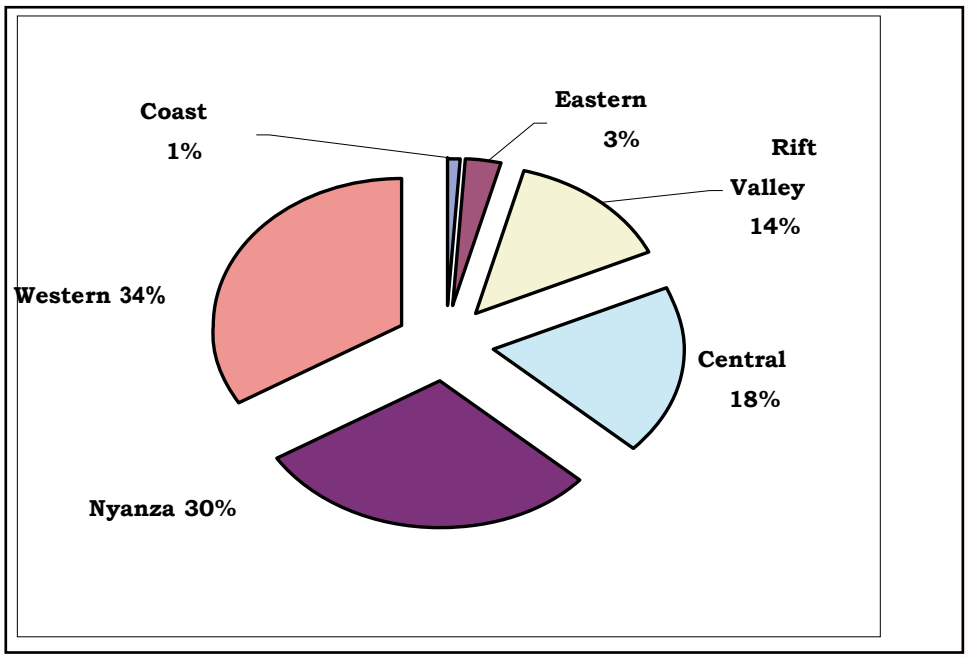


Table 2.4: Aquaculture productivity MT/Ha by province in Kenya (2007)

PROVINCE	MT tonnes /Ha
Rift Valley	0.20
Eastern	0.34
Central	0.44
Coast	1.99
Nyanza	3.79
Western	4.43
National Average	1.86

Figure 2.12 provides an indication of the cost of production and profits per unit kilogram. Western Province is a relatively low cost producer compared to the rest of the country. Farmers are able to make up to KSh 105 (US$ 1.50) per kilo of fish produced in fish ponds. Eastern Province records the highest return on shilling invested — KSh 0.48—followed by Central Province, compared to Western Province's return on 0.10 (Table 2.5). This could be

due to proximity to market centres with high purchasing power such as the capital city (Nairobi), along with the possibility of increasing awareness of the nutritional benefits of the consumption of white meat such as fish.

Figure 2.12: Cost of aquaculture production and profits (KSh/Kg) by province in Kenya

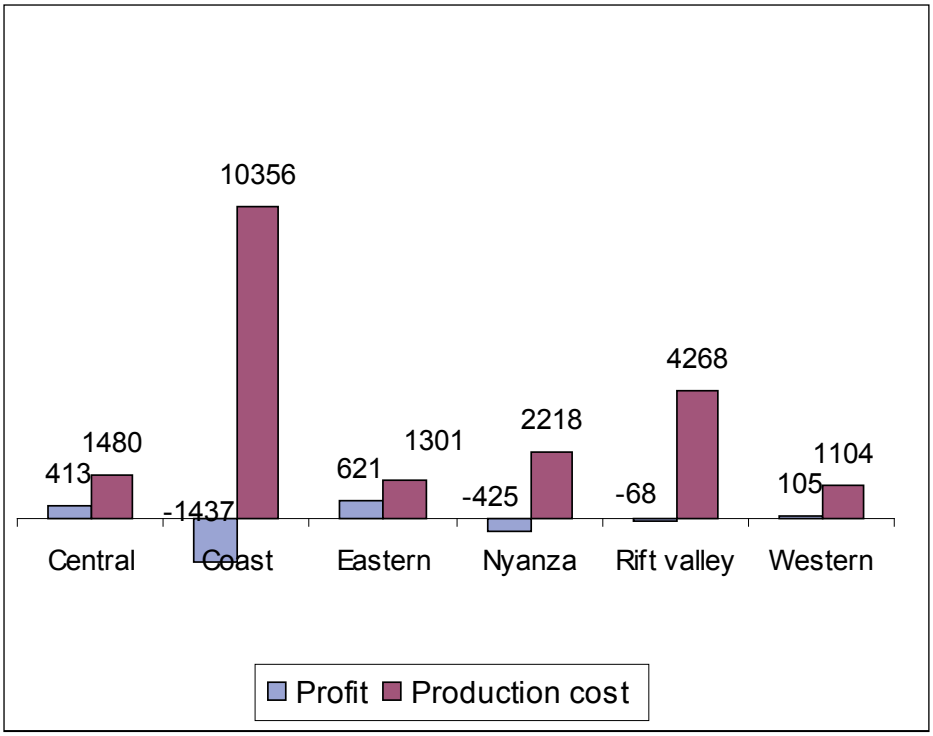


Table 2.5: Return per Kenya Shilling invested by province

Province	Return per unit shilling invested
Central	0.28
Coast	-0.14
Eastern	0.48
Nyanza	-0.19
Rift valley	-0.02
Western	0.10

Table 2.6: Return per Kenya Shilling invested in Western Kenya districts[1]

District	Return per unit shilling invested
Bungoma	0.29
Busia	-0.32
Kakamega	-0.09
Mt Elgon	-0.65
Vihiga	0.22

[1]Teso district omitted since data on sales was missing

A detailed analysis of Western Province districts shows that there is potential for improvements of farmer's returns (Table 2.6). Bungoma and Vihiga Districts achieve as high a return per shilling invested as that of Central Province. The cost of production seems to be a major factor as Figure 2.13 shows. The identification of cost components of fish pond farming in the western region is necessary as well as enhancing marketing efforts if the Nile Basin investment in the region is to makes meaningful gains on farmers' income. Table 2.7 presents cost benefit analysis for fish farming compared to other enterprises in two key districts in Nyanza with great potential for aquaculture: Kisii and Kisumu districts.

Figure 2.13: Cost of aquaculture production and profit (KSh/Kg) for Western Province districts

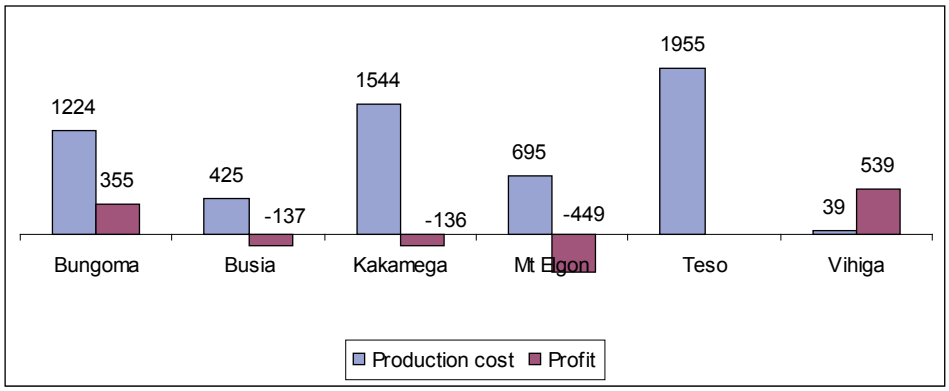


Table 2.7: Gross margins for fish farming and other farm enterprises in Western Kenya

Crop	Yield/acre	Farm gate price/unit (Kshs)	Market (Consumer) price/unit (Kshs)	Output		Production cost		GM at Farm gate Level (Kshs)	GM at Market level (Kshs)
				Farm gate	Market	Farm gate	Market		
Fish Farming	1,700 kg	120.00	180.00	204,000	306,000	105,000	165,000	99,000	175,000
Maize	10 bags	1200.00	1600.00	12,000	1,600	9,170	9,670	2,830	6,330
Beans	6 bags	2000.00	2800.00	12,000	16,800	6,240	6,540	5,760	10,260
Sorghum	6 bags	800.00	1600.00	4,800	9,600	3,930	4,230	870	5,370
Sweet potato	6500 kg	15.00	20.00	47,500	130,000	11,700	13,200	85,800	116,800
Cassava	3000 kg	10.00	15.00	30,000	45,000	8,540	9,540	21,460	35,460
Sunflower	3000 kg	16.00	16.00	48,000	48,000	31,640	31,640	16,360	16,360
Groundnut	270 kg	50.00	70.00	13,500	18,900	6,150	6,300	7,350	12,600
Banana	3 bunch/ stool	100.00	200.00	75,000	150,000	38,700	42,450	36,300	107,550
Mango	300 fruits/ tree	2 per fruit	5 per fruit	45,000	75,000	23,300	25,300	21,700	49,700
Kales	3200 kg	7	10.00	22,400	32,000	10,780	11,780	11,620	20,220
Onion	6000 kg	40.00	60.00	240,000	360,000	18,500	20,500	221,500	339,500
Tomato	8000 kg	15.00	40.00	120,000	320,000	17,940	19,940	102,060	300,060

Source: *Macharia (2006) & Abdi (2006).*

Section C of this report provides an investment proposal of aquaculture up-scaling in the Lake Victoria region, and the Sio-Malaba-Malakisi basin in particular.

2.4.2 Accelerating irrigation development for improved food security

Inadequate growth in food production and increasingly scarce water pose serious constraints to future agricultural and economic development in Africa, particularly in Sub-Saharan African (SSA) countries. Global food projections suggest that, unlike the rest of the world, the food security situation in Sub-Saharan Africa will worsen in the foreseeable future. Cereal imports are projected to triple in SSA, from 9 million metric tonnes in 1990 to 29 million metric tonnes in 2020. It is unlikely that SSA region will have the financial means to pay for these growing food imports (Rosegrant et al., 1997).

The growing food supply problems in the region are compounded by increasing water scarcity. Nearly one-half of the water resources in Africa are concentrated in Central Africa, while only about 4 per cent are in the Sudano-Sahelian area and about 1 per cent in North Africa. Several SSA countries are water scarce, including Burundi and Kenya, with 654 and 635 cubic metres of water per capita, against a global minimum of one thousand (1,000) cubic metres per person per year..

Although it is globally recognized that irrigation plays a vital role in achieving food security and sustainable livelihoods in developing countries, little has been done in Sub-Saharan Africa in terms of irrigation development. In 1999, only 4 per cent of arable land was irrigated compared to 42 per cent in Asia, 31 per cent in the Near East and North Africa and 14 per cent in Latin America and the Carribean (FAO, 2004). In Pakistan, 80 per cent of food is produced on irrigated land; in China, 70 per cent; and in India and Indonesia, more than 50 per cent; while in most SSA countries, the comparable amount is less than 2 per cent.

There is compelling evidence that irrigation agriculture leads to increased productivity. One acre of irrigated cropland is worth many more acres of

rain-fed cropland. Globally, 40 per cent of food is produced on irrigated land, which makes up only 17 per cent of the land being cultivated. It has been estimated that irrigation increases yields of most crops by 100 – 400 per cent (FAO, 2006). As discussed elsewhere, Egypt is able to achieve cereal yields at least five times higher than other Nile Basin countries mainly due to its well developed irrigated agriculture. In Kenya, it has been shown that irrigation increases yields by over 150 per cent (Waiyaki et al, forthcoming). Further, research has shown that increasing investments in irrigation could lead to the largest declines in poverty in Kenya (Thurlow *et al.* 2007). Through water storage and using appropriate irrigation practices, many farmers would be able to fetch much higher producer prices in addition to double or multiple cropping of their crop fields. Table 8, illustrates comparative statistics for some rain-fed and irrigated crops in Kenya.

Table 2.8: Comparative Statistics on Rain-fed and Irrigated Crop Production in Kenya

	Irrigated		Non-irrigated	
	Yields (t/ha)	Net Income (Kshs/Ha)	Yields (t/ha)	Net Income (Kshs/Ha)
Cotton	2.7	29,700	0.8	1,600
Rice	5.0	80,305	0.7	1,050
Sugarcane	124	172,970	30	42,010
Bananas	23.5	239,250	14.4	91,900

Source: *Waiyaki et al., forthcoming*

Several factors have hindered irrigation development in the region including:

(i) Proper land tenure systems: Proper land tenure arrangements are important for attracting and sustaining capital investments in the irrigation sector in many countries. In many countries, irrigation schemes occupy land that is owned mostly by the government and rented (often on lease terms) to farmers or commercial operators (or companies). It is sometimes the case that there are no clearly articulated land tenure policies which govern land use issues such as its inheritance and rental rates, leading to improper land markets (or market failure) and frequent social conflicts over water and land.

(ii) **Inadequate funding for irrigation development**. The governments of the Nile Basin region, except Egypt, have been allocating very low budgets to irrigation, and agricultural development in general.

(iii) **Poor performance of irrigation schemes**. Most irrigation schemes, particularly public ones, have generally had a poor record of performance. This is largely due to use of poor water abstraction technologies and minimal involvement of farmers/beneficiaries in the development and management of the schemes.

(iv) **Inefficient infrastructure:**Efficient road and communication infrastructure positively impact on the operations of irrigation schemes. Major and minor water canals require effective maintenance for the efficient distribution of water.

(v) **Lack of agricultural credit facilities**. The mjority of farmers in irrigation schemes are poor, and, like other small-scale farmers in the region, lack adequate access to credit facilities.

It is important that these constraints be addressed if irrigation is to play its rightful role in addressing food insecurity in the Nile Basin region. Greater effort needs to be placed on irrigation research and the identification of technologies that are more efficient in the utilization of irrigation water.

2.4.3 Improving food security through rain-fed rice production: The case of Nerica rice production

With the exception of Egypt, the Nile Basin is generally a rice deficit region. For instance, Kenya consumes about 220,000 tonnes of rice but produces about 50,000 tonnes annually. Due to increased urbanization and changing consumption patterns, rice has been recording the highest consumption growth rate of 12 per cent compared to 4 per cent for maize (Waiyaki et al, 2007). It is projected that rice may emerge to be the leading staple food for Kenya in the next thirty years (ibid). This may also be the case with a number of other Nile Basin countries.

With this hindsight, it is important that the Nile Basin countries develop strategies for promoting rice production in the region to avoid overdependence on imported rice for meeting the region's food security needs. It is unlikely that rice area in the region will increase substantially owing to limitations on land and water resources, and costs and environmental concerns related to traditional irrigated rice production. Since a number of countries in the region are also water scarce (e.g Kenya and Burundi), the promotion of rain-fed rice production provides a good strategy for addressing current and future food security needs. In Asia, rainfed lowland rice covers about 46 million hectares or almost 30 per cent of the total world rice area (Haefele et al., undated). It is estimated that about 1 billion people in South and South East Asia depend on rain-fed lowland rice (ibid).

New Rice for Africa (NERICA) is a rain-fed rice variety that has recently shown a lot of potential for raising rice production in Africa. NERICA, which is considered to be a superior strain of rice, was developed by the West African Rice Development Association (WARDA). It is a crossbreed of African rice (Oryza glaberrima) and Asian rice (Oryza sativa). Experiments are currently going on in several Nile Basin countries, including Kenya and Uganda, and findings, including from farmers' fields, have been very promising.

The new rice has shown several proven advantages. Firstly, upland varieties can often be grown without the elaborate and expensive irrigation systems that many traditional rice- growing areas normally require. It has also proven to be more resistant to weeds, drought, pests, and disease than many rice varieties currently grown in the region (JICA, 2006). Yields of up to 4–5 tonnes per hectare have also been recorded, which is almost equivalent to irrigated yields. There is little doubt that if NERICA eventually fulfils its potential, it could eliminate the regional rice deficit thus ensuring food security at household, national and regional level. It is instructive to note that Asian countries that have eliminated food insecurity have done so on the basis of improvements in rice production.

2.4.4 Sustainable solutions for combating malnutrition and food insecurity: The case of spirulina production

Malnutrition is a silent massacre in the Nile Basin region - currently, several millions of children needlessly die from malnutrition every year. Many more are victims of malnutrition with severe consequences for their physical and intellectual development. The World Bank has estimated that malnutrition is costing poor countries up to 3 per cent of their yearly GDP (Pediatr, 2000). The Bank has emphasised that "malnourished children can lose more than 10 per cent of their lifetime earnings potential ---" (ibid).

Combating malnutrition in the Nile Basin region requires innovative solutions. Spirulina production provides one such solution. It claims a sustainable and economic solution to malnutrition (Heirli, 2007).

What is Spirulina?

Spirulina is an aquatic micro-organism, sometimes referred to, incompletely, as micro-algae, with exceptional nutritional characteristics (Heirli, 2007). It is easy to harvest and process and has a very high content of micronutrients. The micro-organism has great potential for strengthening the immunity of weaker segments of the population such as HIV/AIDS- affected persons. Communities such as those living in the Kanembu region of Lake Chad discovered this magic food long ago. In his book on 'Sustainable Approaches to Combat Malnutrition', Heirli observes that despite the poor diets of people living in this region, they have not been known to suffer malnutrition for centuries, not even in lean times, when they rarely ate millet with sauces. The sauces contained dihé, their name for the spirulina naturally grown and harvested in Lake Chad. Later in the 1950s, the strange traditional food was 'discovered' in Lake Chad by a European scientific mission which identified the micro-organism, which is capable of photosynthesis and reproducing itself rapidly, to be Arthrospira platensis, known widely as 'Spirulina' because of its spiral filament-like appearance under the microscope.

Spirulina has exceptionally high protein content (60 – 70 % of its dry weight) and quality (balanced essential amino acid content). As a natural product, spirulina claims to provide a comprehensive solution to malnutrition.

The production process

Spirulina can be produced either on a large scale or small scale basis. Large production units exist in California, Ecuador, India and China. There are also promising prospects for small-scale production. For instance, in Madurai (Tamil Nadu State, India), there is a women's group that operates 40 tanks of 18 m^2 each. The tanks are stirred manually and harvested and fertilized once a day. Spirulina needs sunshine and temperature above 25 degrees Celsius. One tank of 18 m^2 yields about 150gm of dry spirulina every day.

The production process is quite labour-intensive – the women's project in India employs 15 women for a production of approximately 150kg per month from the 40 basins totalling 720 m^2. It should be noted that the entire process of spirulina production requires a good level of training in all levels of production, fertilization, processing, management and marketing.

In Kenya, spirulina production has recently been introduced in Lake Victoria basin near Kisumu and is considered a promising technology for addressing malnutrition and nutritional challenges posed by HIV/AIDS, malaria and hunger.

Economics of production

Spirulina production is land saving. The bulk of the production costs for spirulina are labour, nutrients, packaging and capital costs. One tank produces about 144 grams of dry spirulina a day, enough to feed 150 infants (One gram of (dried) spirulina per day can quickly and permanently reduce infant malnutrition, even in an advanced stage) (Heirli, 2007). For the women in Madurai, they produce one Kg of spirulina at a cost price of € 4 – 5. The group manages to provide a feeding programme of 2,000 children each day for a cost of only 0.44 Rupees per child per day (less than € 0.01).

Although there is a growing demand for spirulina, a major challenge that its producers may face regards marketing. To sell in the open market, the product is best packaged as pills or some form of biscuits or chikkies (some form of energy bars). This implies that women's groups or other producers will need to be trained in processing and packaging. For now, spirulina produced in Kenya is being sold to hospitals and individuals who can afford to buy it.

3

Conclusion and recommendations

3.1 Conclusion

The report presents productivity trends of specific commodities important for food security in the Nile Basin countries. In line with the SDBS goal of analysing and developing innovative ideas that enhance agricultural production and lead to trans-boundary food security, the report highlights a number of initiatives with technical capacity to enhance food security in the region.

A comparison of productivity trends between Nile Basin countries shows that other countries have a lot to learn from Egypt. Whereas productivity has been low and stagnant for all other countries, that of Egypt has been rising a fact attributed to the increased use of improved technology, such as fertilisers and irrigation. A comparison with other comparator countries in West Africa also shows dividends in improved food security indicators from investment in improved technology.

There is a strong case for increasing investment as a lever to stimulate crop and livestock supply response, especially given the rising food price trends. Although a curse for many households who are food net-buyers in the region, the rising food prices also offer an opportunity for the region to increase food production and intra-regional trade. But given a rising trend in the cost of farm inputs especially fertilisers, to achieve the desired supply response, a number of innovative approaches are identified, such as:

(i) Production of planting seeds and clean materials, especially for indigenous crops
(ii) Development of producer market groups,
(iii) Market information
(iv) Investments in small irrigation schemes to even out supply, and
(v) New-product market development for food crops.

On emerging and innovative approaches to enhance food security, the report presents case studies on aquaculture, irrigation development, promotion of rain-fed Nerica rice production and *Spirulina* production. The study concludes that these initiatives are promising and have good potential for up- and out-scaling. If implemented, their benefits would offer leverage for socio-economic development in the region.

3.2 Recommendations

Public expenditure on food security crops: Nile Basin governments have accorded insufficient attention to orphan crops, tubers and root crops. Greater budgetary support is required to encourage production of these crops through farmer education, research and industry participation. This proposal is in line with NEPAD, Comprehensive Africa Agricultural Development Programme's (CAADP) agreed target of 10 per cent share of the national budgets to agriculture, which is currently about 5 per cent in most countries. This support should be sustained for some time (say 15-20 years) to enable the various innovative approaches being undertaken to take root, enhance growth and be self-sustainable through market forces.

Close the "yield gap" for orphan crops: There is a "yield gap" which can be exploited to increase total production and productivity especially in the marginal zones. There is therefore need to allocate more resources on priority basis in terms of adequate funding, rationalisation of staff deployment and requisite support infrastructure (e.g. vehicles, operational expenses, etc.) to promote crop husbandry practices for food security purposes.

Production of planting seeds and clean materials: Availability of quality seeds and clean planting materials is one of the main constraints to production of food security crops in the marginal zones. Greater public support is required until market forces take over the seed bulking and distribution activities, so that they become self-sustaining in the long run.

Investment in irrigation farming and water-harvesting technologies: The challenge of price variability to collective marketing can be explained by supply variations and weak market linkages. Reduced supply in rain-fed agriculture is

generally occasioned by low rainfall or drought occurrences. Investment in water harvesting technologies e.g. watershed management, can be a suitable strategy to mitigate supply variations and subsequent price fluctuations.

Agricultural marketing extension and public infrastructure: The agricultural extension service has mainly concentrated in promoting production activities. However, there is now need for an extension paradigm shift to development and promotion for markets for orphan crops. Marketing extension should put emphasis on the creation of market-oriented organisations such producer market groups or a common interest groups.

New-product development*:* Various new-product recipes need to be promoted in the marginal and semi-arid areas of most Nile Basin countries to popularize these orphan crops. Since this sub-sector suffers "image" problems, sponsored media and education programs which would portray these commodity products in a positive way, perhaps connecting them with national pride, could help to increase consumption nationally and hence their demand. This will reduce existing information asymmetry about these crops implying that information about these commodities is not equal in both demand and supply sides of the market. Therefore, the information desk is meant to be a central point for market related information which can bring buyers and sellers together and enhance the exchange of information.

Policy framework for collective marketing arrangements*:* Market forces have failed to establish dynamic rural markets and the provision of effective services in the marginal areas. An appropriate policy environment that can spur growth and access to essential finance and credit facilities is necessary. There is need to review the existing legal frame-work under which self-help groups are registered in the rural areas.

Data management mechanism for Nile Basin: Obtaining quality data is a big challenge in the region even the FAOSTAT data series. It is therefore be important for the Nile Basin countries to develop a coordinated mechanism where quality data can be shared and updated.

Fish farming: Although aquaculture claims to have great potential in fighting poverty and hunger and the potential of the region is large, production levels are extremely low. The Nile Basin through its Subsidiary Action Programme (SAP)- the Sio-Malaba-Malakisi Basin- is already investing in aquaculture on a pilot basis. The study recommends its up-scaling. An investment plan is presented in Section D.

Irrigation development: It is important that constraints impacting on irrigation development be addressed if irrigation is to play its rightful role in addressing food insecurity in the Nile Basin region. More effort needs to be placed on irrigation research and identification of technologies that are more efficient in the utilization of irrigation water.

Promotion of Nerica rain-fed rice: Since evidence shows that this is a viable technology, there is need for the region to move with speed in terms of testing the out-scaling potential of Nerica rice.

Sustainable solutions for combating malnutrition: There is need for exploring local planting and animal material with proven ability for enhancing nutrition for vulnerable people, while using scarce resources like land sparingly, as the case of *Spirulina,* a micro-algae with origin from Lake Chad, shows.

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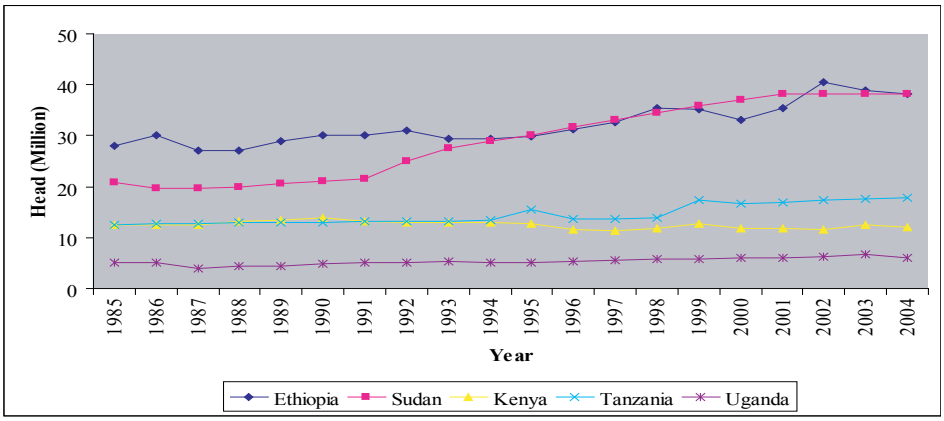
Appendix A

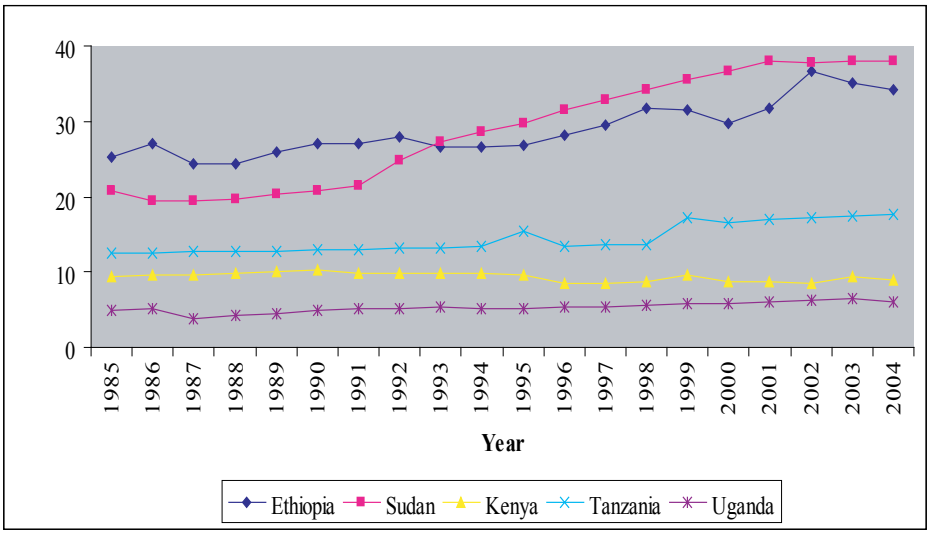
Trends in livestock numbers in the Nile Basin countries (1984-2003)

Figure A1: Trends of cattle population in five Nile Basin countries (1985-2004)



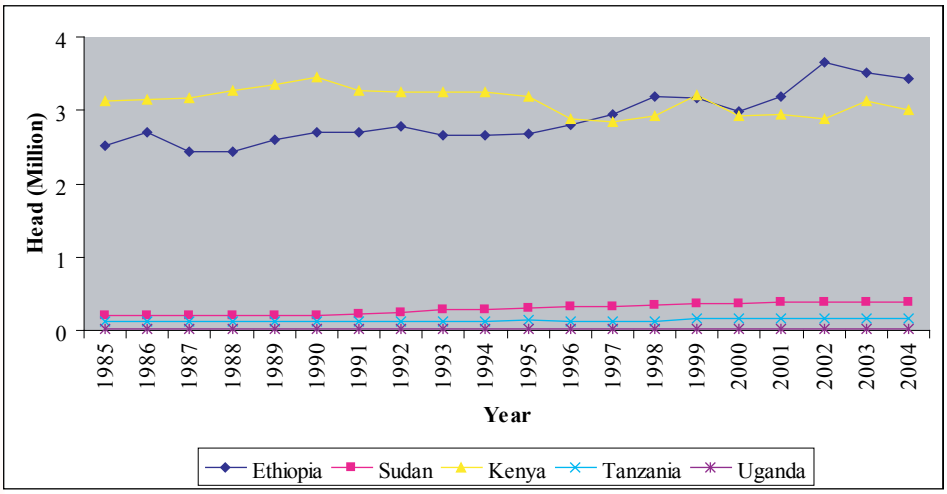
Source: *FAOSTAT (2006)*

Figure A2: Trends of beef cattle population in five Nile Basin countries (1985-2004)



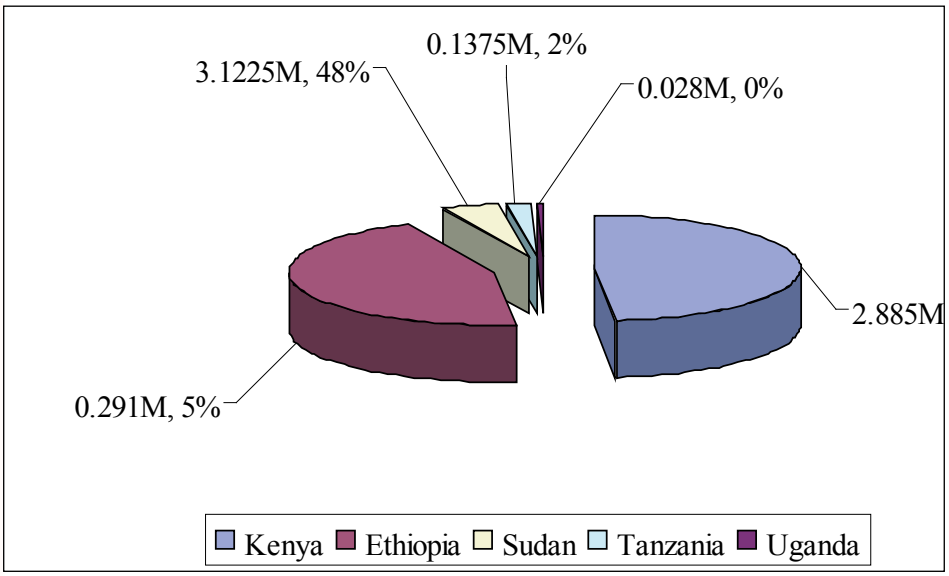
Source: *FAOSTAT (2006)*

Figure A3: Trends of dairy cattle population in five Nile Basin countries (1985-2004)



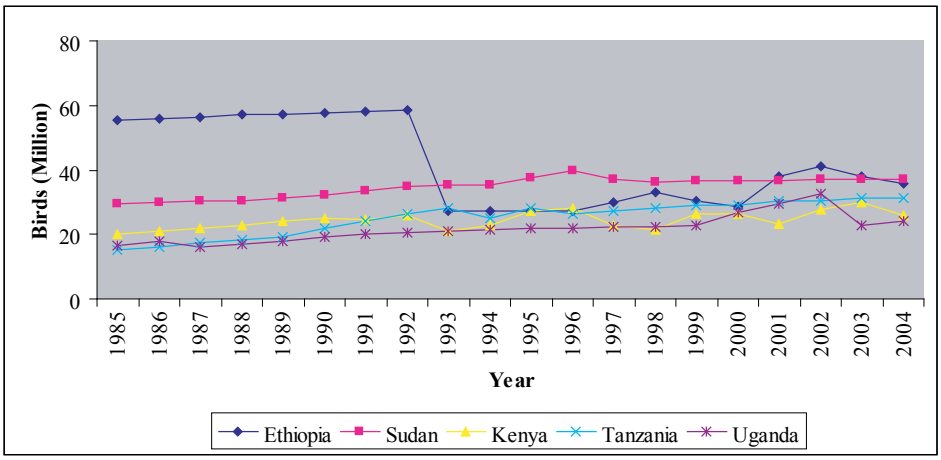
Source: *FAOSTAT (2006)*

Figure A4: Mean annual dairy cattle population in five Nile Basin countries (1985-2004)



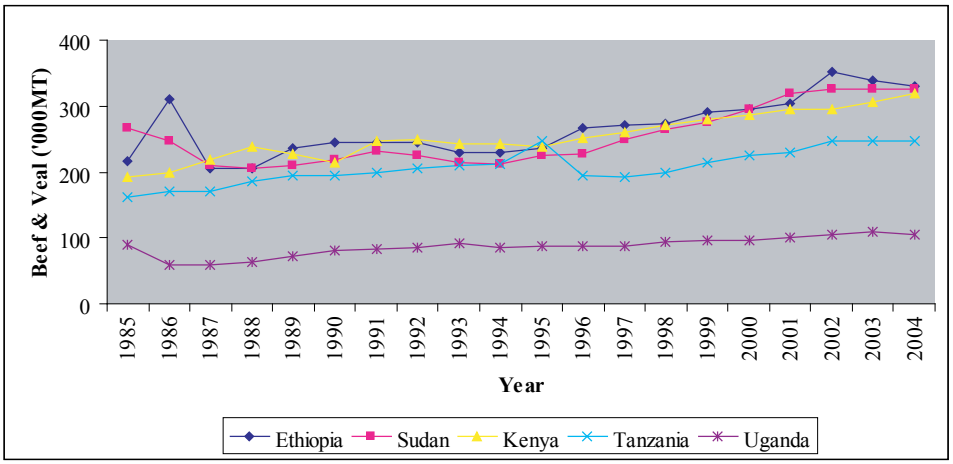
Source: *FAOSTAT (2006)*

Figure A5: Trends of poultry population in five Nile Basin countries (1985-2004)



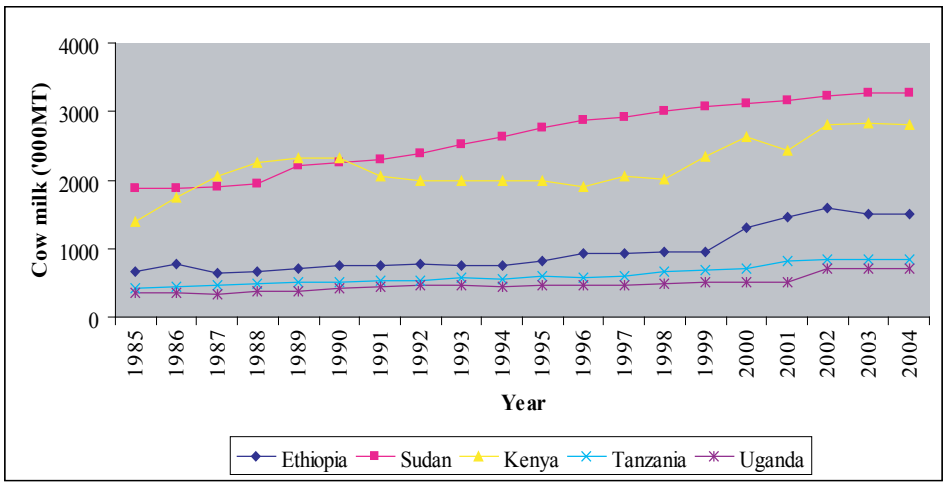
Source: *FAOSTAT (2006*

Figure A6: Trends of quantity of beef and veal produced in five Nile Basin countries (1985-2004)



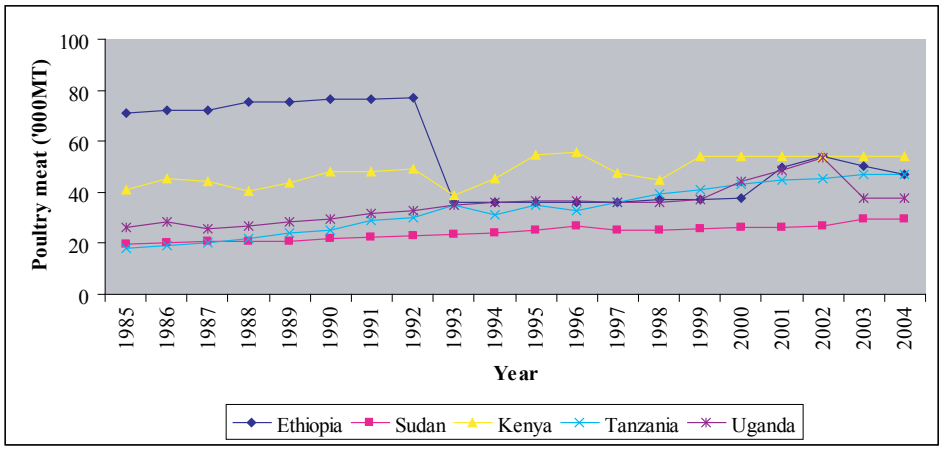
Source: *FAOSTAT (2006)*

Figure A7: Trends of quantity of cow milk produced in the five Nile Basin countries (1985-2004)



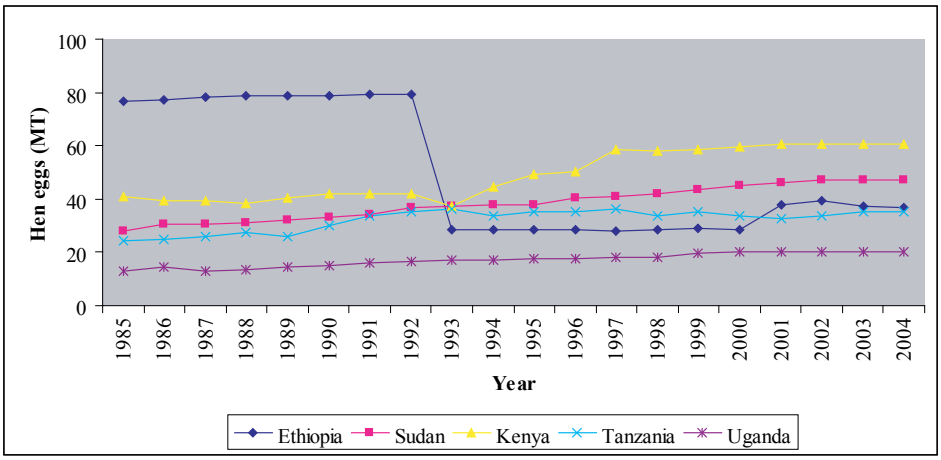
Source: *FAOSTAT (2006)*

Figure A8: Trends of quantity of poultry meat produced in the five Nile Basin countries (1985-2004)



Source: *FAOSTAT (2006)*

Figure A9: Trends of quantity of hen eggs produced in the five Nile Basin countries (1985-2004)



Source: *FAOSTAT (2006)*

Section B

Policy Brief on Low Agricultural Productivity and Food Insecurity

4

Enhancing Agricultural Productivity and Food Security in the Nile Basin

4.1 Background

The Nile Basin region houses close to 60 per cent of the undernourished in Sub-Saharan Africa (SSA). The recent world food inflation and farm input prices portend worse times for the rest of SSA where about 33 per cent of its population is malnourished.

The predominant cause of food insecurity among smallholders in the region is stagnating crop productivity; and among the nomadic pastoralists, the inherent low productivity of a livestock-production system that has remained out of mainstream development. Any strategy to improve food security depends fundamentally on the ability to improve the productivity of the domestic production systems.

Unlike other regions of the world where food production and food security depends on a limited number of farming systems, with the exception of Egypt, diversity is the norm in most of the Nile Basin countries, as it is for the rest of the SSA. The many farming systems make it difficult to single out a few with best opportunities for improvement as was possible in much of Asia. In line with the Socio-economic Development and Benefit Sharing (SDBS) project objective of analysing and developing innovative ideas that enhance agricultural production leading to trans-boundary food security, this study highlights a number of initiatives with the technical capacity to enhance food security, but which may require investment for up- and out-scaling.

4.2 Objectives

- To characterize productivity of farming systems considered important for food security needs within the Nile Basin countries.

- To identify specific farming initiatives which have potential for improved agricultural productivity but which may require investment for enhancing food security within the region.

4.3 Methodology

Trends in crop and livestock productivity for the Nile Basin countries are computed using data from the FAOSTAT database for the years 1984 to 2006. Other national databases, where available, were used to complement FAOSTAT e.g. KIPPRA/Ministry of Agriculture Data Compendium, 2008. Factors underlying agricultural productivity are delineated. Information on emerging and innovative approaches for enhancing food security is derived mainly from discussions with key informants, farmer case studies and secondary information.

4.4 Findings

Comparison of productivity trends between Nile Basin countries shows that other countries have a lot to learn from Egypt. Whereas productivity has been low and stagnant for all other countries, that of Egypt has been rising a fact attributed to increased use of improved technology, such as fertilisers and irrigation. Comparison with other comparator countries in West Africa also shows dividends in improved food security indicators from investment in improved technology for indigenous crops. Many of the indigenous crops like sorghum and millet are neglected in most Nile Basin countries. This is unfortunate since these crops are well suited to low rainfall areas. Close to 40 per cent of the Nile Basin population live in dry areas.

On livestock productivity, computations of total factor productivity show that there has been very little improvement in both innovation and efficiency during the period 2004-2006. The examined countries are Ethiopia, Kenya, Sudan, Tanzania and Uganda. Productivity for beef and veal grew at an annual rate of 1.5 per cent. Ethiopia had the highest productivity change at 5.1 per cent, most of which was accounted for by increased efficiency. On dairy production, productivity

rose by 3.3 per cent per annum on average. Much of this growth is attributed to technological change (3.7%) – perhaps due to the adoption of improved breeds, improved animal health management practices, and the adoption of fodder crops. Overall efficiency in dairy production deteriorated by about 0.4 per cent probably due to poor or missing markets, poor road infrastructure and inadequate dairy policies in the five countries. The poultry sector experienced a marginal change in productivity of about 0.3 per cent per year.

4.4.1 Factors influencing food production capacity in the Nile Basin countries

High dependence on rain-fed agriculture: Most of the countries in the Nile Basin rely on rain-fed agriculture. Available statistics show that growth in agricultural output is largely driven by the traditional factors of production (land, labour and capital). For example, in the period 1965-2001, 89.7 percent of the growth in Kenya's agriculture was accounted for by the contribution of land, labour and capital while total factor productivity growth accounted for the remaining 10.3 percent. Labour accounted for 48.3 percent of the total agricultural growth while capital and labour contributed 27.6 and 13.8 percent, respectively. The results also indicate that rainfall (climate) and government expenditure were the most important determinants of agricultural productivity growth. Under rain-fed circumstances and where farming operations depend on manual labour as in most Nile Basin countries, labour shortages during peak season may limit productivity with consequences on food security.

Furthermore, dependence on rainfall exposes farmers to variable risks of production failure in both crop and livestock systems, which in turn, affects levels of consumption profiles as well as the volume of marketable surpluses. With on-going debate on global climate change, effects of weather variability are likely to pose greater challenges for rain-fed agriculture in many countries. Mechanisms to mitigate, cope with or adapt to climate change are generally very weak or non-existent in most Nile Basin countries. The agriculture sector is facing a multitude of problems relating to water resources that will need to be addressed in order to promote food security in the Nile Basin countries.

Low soil fertility: In most of the Nile Basin countries, soils are generally deficient in critical nutrients to sustain high cereal yields. Increasing population has resulted in yield-reducing land use practices such as more intensive use of land, shortening of fallow periods, abandonment of shifting cultivation, etc. Due to widespread dependence on rain-fed agriculture, few farmers use external inputs such as inorganic fertilizers and herbicides because of risk-aversion and financial constraints. The increasing cost of external inputs [particularly fertiliser] is blamed for declining application and hence low crop yields. The high cost limits the ability of farmers to take advantage of improved world food prices.

Collapse of breeding services: This is largely responsible for the observed slow improvement in livestock productivity. Public delivery systems of livestock breeding services in a number of countries collapsed due to financing hardships on the exchequer. The private sector has not been very successful in replacing the role hitherto played by the public sector. For example, in Eastern Africa, artificial insemination (A.I.) services have become less reliable and more costly. As such, increasingly many farmers are abandoning their use of A.I. services, leading to the use of natural service which often results in the spread of diseases and poor performance of the dairy herd.

High cost and poor quality feeds: Cost and quality of feeds are essential in determining livestock productivity. There is great variation within and between countries in their capacity to manufacture animal feeds, which in turn leads to non-trivial differences in livestock performance in such quality-sensitive enterprises as dairy and poultry production.

Prevalence of pests and disease: Pest and disease cause considerable damage or loss to both crops and livestock during the production and/or storage stages in the value chains. Depending on the commodity and the circumstances, pests and disease can account for as much as 90 percent of the post-harvest losses. Technologies to minimize pest and diseases are often expensive and beyond the reach of most small-scale farmers. Public efforts to make drugs available to farmers often face many challenges. For example,

communal livestock dips or sprays are poorly managed in many countries.

Weak agricultural extension and information services: In many countries, agricultural extension and advisory services have undergone a variety of institutional reforms in order to make them more relevant to serving farmers' perceived needs. With hindsight on low levels of farmers' education, extension services still experience many operational and financial challenges to adequately serve contemporary needs of farmers. However, there are many promising avenues through public-private partnerships and external funding meant to improve delivery of extension and information services to farmers and traders.

Limited access to land and credit: Different countries in the Nile Basin have a variety of land tenure regimes that constrain productive and efficient use of land and therefore food production capacity. Appropriate policies that promote security of land tenure, especially for female farmers, are a pre-requisite for enhancing food production capacity as well as fostering efficient land markets that can trigger structural transformation processes, attract investments and protect economic livelihoods and raise agricultural productivity.

Insecurity and human conflicts: Insecurity and/or human conflicts impede farming and trading activities, which significantly affect the food security portfolios of those members of society that cannot arrange for affordable means of accessing food supplies. The majority of the Nile Basin countries have experienced moments of heightened insecurity and human conflict during the last 10 years.

Equity and gender issues in food security: Almost all the Nile Basin countries are characterized by high inequalities in access to resources among social groups and gender, and therefore incomes. Since poor households are likely to spend a great proportion of their income on food, this perpetuates the inequalities as those with surplus continue to add to their productive assets and productivity.

4.4.2 Factors influencing agricultural marketing

Poor state of transportation: The state of transportation infrastructure (e.g, roads, rail, etc.) is generally poor. Both the state and length (i.e. distance to markets) of transportation infrastructure significantly influence prices received by farmers and traders as well as the volumes of produce that is spoiled or damaged during transportation. It is discernible that improvements in transportation networks will have significant knock-on effects on volumes traded, prices received and food security especially of poor households.

Limited domestic marketing infrastructure: The state of domestic marketing infrastructure (e.g., storage capacity, clean water, sewerage systems, energy, trading space, etc.) varies from country to country. This affects the volumes that are traded, the possibility for rent-seeking behaviour in the allocation of trading space, level of competition in the markets, etc; ultimately influencing producer and retail prices. Both the producer and retail prices have knock-on effects on household disposable incomes, which influence food security.

Limited market information services: The capacity and funding of the different channels (mobile, radio, television, newspaper, etc.) of communicating information to the farming and business community varies from one country to another in the Nile Basin depending on what (which issues) to report and in which format to report (text, pictures, etc.). This varies depending on extent of geographical coverage, depth of coverage, target audience, intended impact (positive or negative), etc. The effectiveness of different channels is also influenced by the ability of users to access the information delivery channel such as owning a radio, a mobile phone, etc and literacy levels. It is critical that relevant and timely information on production and marketing trends is made available to permit appropriate decisions on what amounts to hold onto for food security reasons as well as what volumes of which commodities are to be offered for sale both in the domestic and regional markets.

Limited regional agricultural trade: Cross-border trade can increase food availability amongst Nile Basin countries that will go a long way to promote

food security. However, there are several barriers of varying magnitude, to cross-border trade between different countries which impede movement of tradable commodities. This demonstrates the existence of opportunities to promote intra-regional trade.

4.4.3 Initiatives to enhance food security in the Nile Basin

Fish farming: Although aquaculture claims to have great potential in fighting poverty and hunger and the potential of the region is large, production levels are extremely low. Aquaculture is also an important alternative to enable regeneration of capture fisheries in Lake Victoria Basin and an economic way of using the wetlands. The Nile Basin through its Subsidiary Action Programme (SAP)- the Sio-Malaba-Malakisi Basin- is already investing in aquaculture on a pilot basis. Based on secondary data analysis, information from key informants and a farmer case study in Uganda, this study recommends its up-scaling.

Irrigation development: It is important that constraints impacting on irrigation development be addressed if irrigation is to play its rightful role in addressing food insecurity in the Nile Basin region. More effort needs to be placed on irrigation research and identification of technologies that are more efficient in utilization of irrigation water.

Promotion of Nerica rain-fed rice: Since evidence shows that this is a viable technology, there is need for the region to move with speed in terms of testing the out-scaling potential of Nerica rice.

Sustainable solutions for combating malnutrition: There is need for exploring local planting and animal material with proven ability for enhancing nutrition for vulnerable people, while using scarce resources like land, sparingly, as the case of *Spirulina,* a micro-algae with origin from Lake Chad shows.

4.5 Conclusion and Recommendations

Although increased world food prices present a threat to Nile Basin countries which already have a food deficit, the new challenge is an opportunity for the

region whose productivity has remained stagnant for the last three decades. There is a strong case for increasing investment as a lever to stimulate crop and livestock supply response and intra-regional trade. But given a rising trend in farm inputs, prices especially fertilisers, to achieve the desired supply response, a number of interventions such as:

(i) The production of planting seeds and clean materials, especially for indigenous crops
(ii) The accelerated development of producer market groups,
(iii) Market information
(iv) Investments in small irrigation schemes to even out supply, and
(v) New-product market development for food security crops.

In line with the SDBS goal enhancing trans-boundary food security, a number of initiatives with technical capacity to enhance food security are noted. These include aquaculture, irrigation development, promotion of rain-fed Nerica rice production and *Spirulina* production. The study concludes that these initiatives are promising and have good potential for up- and out-scaling. If implemented, their benefits would offer leverage for socio-economic development through improved food security.

In the immediate term, this study recommends up-scaling of the Sio-Malaba-Malakisi aquaculture initiative. The declining fish production from Lake Victoria requires urgent action and aquaculture presents an alternative livelihood for the Lake region households. Furthermore, fish consumption trends are on the rise and so are the prices.

Section C

Aquaculture Development

5

Aquaculture Development in the Sio-Malaba-Malakisi Trans-boundary Basin

5.1 Introduction and potential

The Lake Victoria watershed basin has great potential for the development of aquaculture. This is because the basin is endowed with climatic conditions and natural features such as vast gentle sloping land, reliable sources of water that include springs, wetlands, rivers, water reservoirs and the temporary water bodies and soil resources that favour the culture of a wide variety of species. The high potential areas for aquaculture within the basin include the Kisii highlands; Vihiga, Kakamega, Bungoma and Busia Districts in Western Province. Uganda too has vast aquaculture potential whose development holds the key to increasing fish production. The country is rich in aquatic resources with about 18 per cent of its surface area covered by lakes, rivers and swamps.

Currently, less than 1 per cent of the total area with aquaculture potential is under utilization for aquaculture activities. The most common species cultured are tilapia, but there is a growing potential to profitably culture the African catfish Clarias gariepinus for both bait and food. The most common cultured tilapia species include; Oreochromis niloticus, Tilapia zilli, and Oreochromis mossambicus.

Very many studies have documented the decline of Lake Victoria Fishery (Ikiara 1999, Simonit and Perrings 2005, Okeyo-Owuor 1999; Odada et al. 2004). This has been attributed to over fishing as a result of many problems ranging from use of illegal gears, skyrocketing demand and inadequate capacity of the Fishery Department to manage the fishery. Rain-fed agriculture around Lake Victoria has also become increasingly unreliable due to erratic rainfall. These factors have contributed to the weakening economy of the area and the

impoverishment of rural communities, so that wetland seasonal cultivation has become relatively more important to supplement declining terrestrial production. Given this state of affairs, investing in aquaculture activities in the region would go a long way in relieving pressure on Lake Victoria fishery. The development of aquaculture is also critical in boosting food security in the region.

5.1.1 Fish Farming Production in the L. Victoria Basin

Aquaculture was introduced in the East Africa sub-region between 1940s and the 1960s as a subsistence activity for rural communities (Mwanja, 1996). It was then considered as part of rural development strategies largely promoted for subsistence and rural livelihood rather than productive and income generating enterprise (Mwanja, 2006).

Lake Victoria has a catchment area of 194,200 km^2 with extensive wetlands of various types (Balirwa, 1998), supporting a rapidly growing human population that is currently estimated at 30 million (Mushi et al., 2005). The average population density in the entire basin is about 165 persons/km^2. The average population density on the Kenyan, Tanzanian and Ugandan sides of the basin is 297 persons/ km^2, 97 persons/ km^2 and 635 persons / km^2 respectively. The basin has been leading in aquaculture production; however, aquaculture contributes only about 10 per cent of the total fish productions in the basin: the rest of the fish come from the capture fishery of Lake Victoria and the riverine systems within the basin.

Approximately 22,500 Kgs are harvested from about 3,683 small ponds owned by about 2,209 fish farmers on the Kenya side. The average size of ponds held by the farmers measure 280M^2. The total pond area is about 619,000 M^2. The current mean yield from small-scale fish farming is 1,000 kg/ha/year but from the on-farm trials, production levels of average 5,500kg/ha/yr and 5,800kg/ha/yr were realized for tilapia and catfish respectively. The total fish production in 2006 was estimated to be 147,132 metric tons (Appendix C1) with aquaculture production being 26,700 metric tons. This was approximately 18 per cent of the total fish production. Aquaculture production remained

below 1 per cent of the total until early 2002 when it started to rise. Since 2002 percentage contribution has remained above 15 per cent. This indicates a growing interest in aquaculture. Kakamega and Nyamira districts are the leading districts in aquaculture production (Appendix C2). Aquaculture fish production is more intensive in Nyamira than in Kakamega.

Aquaculture is not well developed in the Sio-Malaba-Malakisi region despite significant potential. It was vibrant in the 1940-1970s, but has since stagnated mainly due to poor fish farming practices. In recent years, aquaculture is slowly being embraced again in several parts of the catchment as an alternative source of food and revenue.

5.1.2 Aquaculture Systems

There are three aquaculture systems; intensive, semi-intensive and extensive systems. The intensive system is practised under flowing water. It requires a high level of management and the highest level of feeding since the development of Zoo and Phyto planktons is very low under flowing water. However, the system is advantageous in that there is no limitation of oxygen and stocking rates are high. Production per unit area in this system can be a high as 100 fish per square metre. Profits in the intensive system are high but the high costs of feeding and maintaining flow of water are high. The system is not practised in the Sio-Malaba-Malakisi region.

The semi-intensive is the most popular in the Sio-Malaba-Malakisi region. It is a system of ponds with stagnant water. The differentiating factor from the intensive system besides stagnant water is the feeding which is not all-intensive but as a supplement to the natural feed of Zoo and Phyto planktons that develop after the application of fertilizers. Oxygen levels are, however, a limiting factor to stocking rates which range between 2 and 6 fish per square metre. The production cycle lasts between 6 and 8 months, after which the ponds are drained and production cycle is started again.

The extensive system is the simplest system of aquaculture in which the fish are left to feed on natural feeds in a dam-like structure. There is no feeding

to the fish. The stocking rates are low in this system and profits could just be driven by the low costs of production.

5.1.3 The importance of aquaculture

Aquaculture has been identified as an important enterprise in the Sio-Malaba-Malakisi region. It is a source of income for the communities in the lake basin, important for food and nutritional security, employment creation, an important alternative to enable regeneration of capture fisheries in Lake Victoria Basin and it is also one of economic ways to put wetlands to use. In a recent study (Mwanja et al., 2006) fish farming was not a major production activity of farmers but rather the most important alternative or second option activity by rural farmers (41.9% of the respondents) in the Lake Victoria Basin. In the same study, about 44.1 per cent of the farmers practised fish farming for generation of income while 36.8 per cent used fish farming for supply of dietary animal protein for their families. The need for dietary animal protein and production for generation of income are the basis for the renewed interest in aquaculture (Mushi et al., 2005).

5.2 Returns to Aquaculture

5.2.1 A Model Fish Farm

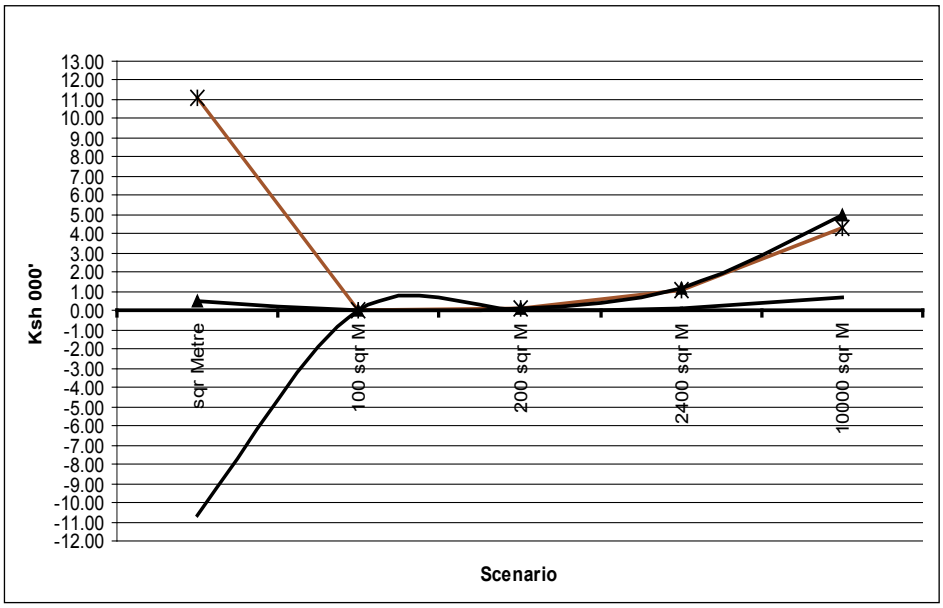
The important and significant component of cost is pond digging and compacting of the soil which is done for Ksh 250 for 1.5M^3 (Appendix C.3). As in all other enterprises, the market is the key driver of profits in the aquaculture enterprise. Estimating the profitability at a price of Ksh 100 per 300g fish, the aquaculture enterprise is economical above a pond size of 200 square metres (Figure 5.1). The current price of a Nile Perch is US$ 4 which translates to between Kshs 250 and 300. There are more returns on exports than from the domestic markets.

As the budget shows, farmers with less than 200 sq metres receive negative returns. For instance, the net revenue is Ksh -3, 368.67. The net returns at 200 sq. metres, 2400 Sq metres and 10,000 sq. metres are Ksh 3,962.67, Ksh

165,252.00 and Ksh 722,433 respectively. Some stakeholders are of the view that commercial viable fish ponds should be at least 2,400 sq. metres. The results are consistent with other studies that showed that returns increase with farm sizes (Kusumastanto et al., 1996).

Gross margins are also presented for Salama Farm in Uganda (see appendix C.4). Salama Farm, although originally concentrated on raising table size fish, is now focusing on selling fish fry. Raising fingerlings to sell as fish fry gives higher returns than for consumption. This is because feeding costs are considerably lower, crop cycle is shorter, and there are fewer problems of predation and cannibalism.

Figure 5.1: Trend of Profitability at different Scenarios



5.3 The challenges facing aquaculture

Development of aquaculture is faced with numerous challenges. Past aquaculture development efforts failed largely due to weak institutions, poor access to finance, and a heavy reliance on failing government extension services and seed production. Aquaculture rarely attained the critical mass needed to support segmentation (for

example, specialized seed producers) and the rise of service suppliers. Individual farmers were thus often dependent either on weak extension services, or, more frequently, on their own efforts for seeds, feeds, and technical and market advice. This renewed interest in aquaculture is however still faced with the same limitations that plagued it in earlier years, including underdeveloped 'water for production' infrastructure and the typical challenges to aquaculture of lack of quality fish seed, inadequate and poor extension services, inappropriate guidelines, and fast-changing development and economic policies (Mushi *et al.*, 2005; Mwanja, 2006).

Some of these constraints are briefly discussed below that emanate mainly from discussions with key stakeholders.

5.3.1 High costs of pond construction

This constitutes a major component of aquaculture development. Pond construction costs ranges from Ksh 200-Ksh 250 per cubic metre. The cost of constructing a commercially viable pond of $200M^2$ is about Kshs 40,000. This is a hindrance to small-holder poor farmers. Perhaps organization into communal groups or some seed public money may be helpful given that pond construction is a fixed cost and one time expenditure.

5.3.2 Lack of fish feeds

Aquaculture, depending on the system, requires different levels of feeds and feeding intensity. Availability of feeds is a major constraint to aquaculture in developing countries (World Bank, 2007). Peri-urban aquaculture benefits from the use of local wastes, while a wide range of polycultures and integrated agriculture-aquaculture systems (for example, fish in association with rice, pigs, or ducks) offer feed options for rural areas. With the exception of the Lake Basin Development Authority (LBDA), there is no industry that produces fish feeds in the country and farmers rely on locally-made feeds.

5.3.3 Lack of good quality fry (fingerlings)

The aquaculture enterprise suffers from lack of proper quality of fingerlings. The poor-quality seed undermines the livelihoods of poor farmers and the integrity

of the production chain and entire aquaculture economy. Production and supply of fingerlings has been a monopoly of the Government (Fisheries Department and LBDA) but has not been efficient due to poor funding and low technology. Most of the first fingerlings used in fish production are locally sourced from other farmers' hatcheries or are obtained from the capture fisheries. The situation is a bit different in Uganda which has the Aquaculture Research and Development Institute at Kajjansi to train technical staff for fry and extension[1].

5.3.4 Low funding for the sub-sector

Aquaculture has received little government and even private sector funding in the past. Even government support in human capacity has also been very low. Even though a Wildlife and Training Institute exists in Kenya, the Centre is largely associated with training the Wildlife staff. Facilitation for Fisheries staff has been neglected.

5.3.5 Inadequate Research and Extension services

This is largely linked to low funding of the sector. Interviews with key informants revealed that a weak extension service has hampered a more effective diffusion of technology, particularly to small farmers. The limited extension services (Fisheries Department and LBDA) focus more on capture fisheries.

Similarly, research on aquaculture is limited as the main research institute; the Kenya Marine and Fisheries Research Institute (KMFRI), concentrate more on capture fisheries. Moreover, there is more focus on academic than on development research. Uganda has the Ugandan Fisheries Research Institute located at Jinja in addition to the Aquaculture Research and Development Institute at Kajjansi. In general, inadequate extension facilities, poorly managed Government hatcheries and research stations, inconsistent extension packages, poor information and technology dissemination systems and sometimes poorly trained extension personnel have exacerbated the slow growth of aquaculture in Kenya. For over a decade, the government has not

1 http://www.ugandainvest.com/fishing.PDF, assessed on 14th October 2008

recruited fisheries officers. Natural attrition compounds the problem.

Nevertheless, Uganda also faces similar problems to Kenya. As Jagger and Pender (2001) argue, one of the biggest constraints facing aquaculture development in Uganda is lack of extension staff and infrastructure to deliver technical knowledge about aquaculture to rural smallholders. The situation may, however, be changing with the political will the sector is receiving in Uganda.

5.3.6 Land tenure systems

Land tenure within the Lake Victoria basin is a constraint to aquaculture development. Most of the land that is suitable for the development of aquaculture is trust land that is under county councils. While in some cases, it is communal or customary land. Thus property rights are either poorly developed or the land not yet titled which makes investments inherently risky and access to credit limited. Lease arrangements are frequently informal and insecure. Thus aquaculture requires clear title (for example, long-term lease) over land and water.

5.3.7 Inadequate fisheries/aquaculture legal and policy frameworks

A comprehensive aquaculture policy and legislation are yet to be developed. In Kenya, even the fishery draft policy that has been in various stages of development has not been finalized. There is need, therefore, to develop policies that integrate aquaculture in agricultural systems and in the key policy and strategy documents.

5.3.8 Tastes and preferences, coordination, water pollution, water use conflicts and political will

The final challenges in fish farming include tastes and preferences, coordination problems, water pollution, likely water use conflicts and political will. These are generally minor although still worthy of note.

The perception that fish grows naturally is still held in the areas surrounding Lake Victoria. This in particular is a cultural barrier to the adoption of

aquaculture. There is also a great preference for capture fish, supposedly due to good taste and size.

There are several stakeholders in the aquaculture sub-sector; KEMFRI, Ministry of Fisheries, Lake Basin Development Authority (LBDA), Ministry of Environment and Natural Resources, Ministry of Lands, Nile Basin region, farmers and other private stakeholders. However, there is no proper coordination among these stakeholders, resulting in confusion and duplication of activities. A proper coordination would reduce duplication of activities, encourage information-sharing among stakeholders and generally reduce wastage of resources (inefficiencies).

Aquaculture in the Sio-Malaba-Malakisi region is practised in wetlands along the rivers. Fertilization of the ponds is the main pollution causing activity since this adds nutrients to the water and, once released into the water bodies, causes eutrophication. These wetlands are also prone to floods and may cause the fish to escape. This may interfere with the gene pool of capture fisheries.

Extensive use of wetlands and waters will also trigger conflicts among the members of the communities who might also want to benefit from the exploitation of the resource.

Aquaculture practice is practised mostly in regions relatively far from Lake Victoria. In this case, aquaculture practice is observed to increase as distance away from the Lake increases. The challenge here is to make those people close to the Lake practice aquaculture while they can access the capture fisheries resources which have relatively lower investment requirements.

Currently there is poor political will towards aquaculture in Kenya. Compared to Uganda where the encouragement and incentives such as funding to the enterprise comes from the government, there is relatively little from the government in Kenya.

5.3.9 Lack of a standardized marketing system for the domestic market

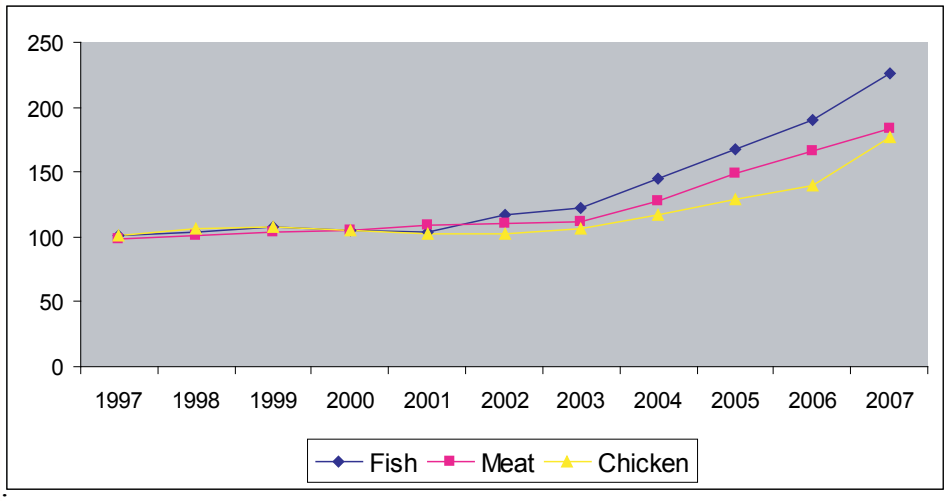
While market standards are well developed for the export market, they are poorly

developed for domestic market; whether by weight, per piece and in packages. According to one Senior Fisheries Officer, any paper (bag) it is all right! This raises health safety concerns. Lack of standards also leads to inefficient marketing system with large price variation between nearby market centres.

5.4 Strategies for Up-scaling Aquaculture

The rising demand for fish is driven by population growth, higher incomes, and urbanization in developing countries. With production from wild fish stocks at or near its limits, aquaculture is foreseen as the only major source of additional supplies (World Bank 2007). Thus one of the major factors favorable to up-scaling of aquaculture is the availability of market both locally and abroad. In Kenya, for instance, per capita consumption rose from 0.7kg in 1995 to about 4kg in 2007 (Ministry of Fisheries). However, as Jagger and Pender (2001) argue, the question of how much additional supply the market will bear, and how shifts in supply and demand will affect prices are not known with certainty. Figure 5.2 shows trend price index for fish and other meat products in the last 10 years.

Figure 5.2: Trends in Fish and other meats price indices: 1997-2007.



The aquaculture sub-sector requires strategies to thrust it to a momentous development phase (see Appendix C5). The key focus of the strategies will

be on the production, environment and markets. The overall objective of aquaculture adopted should be in line with the objectives of the Sio-Malaba-Malakisi project and in line with the overall national development objectives. The interventions to enhance aquaculture should include the following:

5.4.1 Strengthening the extension service to increase awareness on aquaculture

Awareness of aquaculture as a viable commercial undertaking in the public and private sector and among financial institutions will improve access to land, water, and financial resources. Thus sensitization initiatives should be undertaken among communities in the vicinity of capture fisheries. This would require strengthening the extension service. Besides, it should be emphasised that aquaculture offers the highest return when it is implemented as part of an integrated farming system. Aquaculture should therefore be part of the basic extension package that agricultural extension offers in areas where aquaculture has good potential. The message should also be simple that involves information on pond sitting and construction, information about the best feed stock, and how to feed and fertilize ponds. Thus budgetary support is needed to hire extension staff with the requisite knowledge in aquaculture.

In addition, one-stop Aqua Shops (OASs) service centers for farmers and fishers who are interested in aquaculture and the organization of farmers into producers' associations are also necessary. This organization can empower small farmers to effectively demand and benefit from technical assistance and services and can facilitate the government task of providing cost-effective services.

5.4.2 Capacity building for aquaculture development

The modern fish farm is an intensive knowledge-based enterprise and therefore to promote aquaculture farming and capacity building activities for farmers is essential. Capacity building should not only be for farmers but also include extension staff and other people along the value chain.

5.4.3 Provision of credit and financial services in aquaculture

Availing credit and financial services is important in the development of any enterprise. In Uganda some well-performing farmers in aquaculture have had financial access. This has enabled them to meet the costs of constructing commercially viable ponds. Both the Kenyan and Ugandan governments could set up an aquaculture fund run by trustees of high integrity. The fund could attract finance from the public, the private sector and NGOs. It may perhaps be prudent if a fraction of the envisaged 5 per cent fishing levy went towards boosting the aquaculture fund. Institutional support, in terms of initial support to new entrant farmers through advice and inputs—for example, extension and seed supply, is crucial.

5.4.4 Facilitate the development of fish feeds industry

Aquaculture development is grossly disadvantaged by lack of feeds. Development of the fish feed industry is thus imperative. The government should encourage the production of fish feeds through the creation of incentives such as tax exemptions on imported inputs for fish meal production, enhance research on fish meal production technologies, make credit and financial facilities, production available and encourage public private participation in feeds production.

5.4.5 Development of hatcheries

Timely and adequate supplies of quality seed have been a precondition for scaling up production and the adoption of aquaculture by new entrants. There is an increasing demand for fingerlings as aquaculture becomes more important and adopted by many. Currently the hatcheries which are available cannot satisfy demand because they also engage in the sale of fingerlings for baits in capture fishery. The government and stakeholders should focus on supporting the development of a catchment-wide hatcheries development programme to produce adequate fish fries to support the aquaculture industry.

5.4.6 Improvement of wetland Land tenure systems

Wetland land tenure system and ownership should be made favourable to encourage investment in these types of land. Review of land policy on wetlands in this case would be imperative.

5.4.7 Sustainable water management

Efforts and technologies to enhance water harvesting during rain season should be emphasised in those regions where water availability is a limiting factor to aquaculture development.

5.4.8 Development of marketing infrastructure

Once aquaculture potential is fully exploited, the market is likely to be oversupplied in the long-run. Thus the development of the marketing infrastructure such as processing, storage, transportation and enforcement mechanism for compliance to sanitary standards are crucial.

In the short and medium terms, suitable infrastructure is needed to bring high-value, highly perishable products to markets, often from relatively isolated aqua farms. This infrastructure includes not only the transport "hardware," but also a suite of information and communications infrastructure providing traceability, market price information, and information on disease outbreaks and changing aquatic environmental conditions, such as impending floods.

5.4.9 Environmental conservation

Use of less toxic inorganic substances which do not compromise on the fish nutrient requirement, particularly the use of organic manure rather than inorganic fertilizers, is a way to reduce the nutrient content of the pond water. A proper EIA before any serious fish farming is implemented should be mandatory. Setting up an optimal number of fish ponds that could still be environmentally sustainable is also crucial.

5.4.10 Finalising and implementation of the fisheries/aquaculture policy

Ideally, a **national aquaculture plan and strategy** that mainstream aquaculture into key planning and policy instruments are central. It is thus imperative to develop and finalize an aquaculture policy in Uganda and Kenya. These countries will then move fast to implement the policies which may be supported by legislation. The Abuja Declaration adopted by the Heads of State Meeting

of the NEPAD *Fish for All* Summit in 2005 that called for a range of actions to support aquaculture, emphasized aquaculture to be adequately reflected in the national and regional economic policies, strategies, plans, and investment portfolios, including poverty reduction and food security strategies.

5.5 Expected Risks and Constraints

While the objective of promoting aquaculture is noble, it is expected that some problems may emerge. Increased resource-use conflicts, mainly land and water are likely to be major. As discussed earlier, fish farming is a large water demand activity that may fuel potential conflicts with other water users, especially downstream farming and household activities. Up-scaling aquaculture may increase inequality as those with higher household incomes are more able to expand their enterprises than the poor.

One of the major impediments to aquaculture is how land is governed. Ownership of unalienated land in Kenya is vested in the state as government land while trust land is held by local authorities in trust for the local communities. Land tenure regimes in Kenya are fragmented, complex and pluralistic. As in the case of Trust Land (under Trust Land Act) land rights are quite indeterminate. Overlapping land rights and insecure tenure presents a problem for land management and lead to conflicts (Draft National Land Policy).

Given that land ownership, especially where aquaculture is viable is either unclear or under communal ownership, promotion of aquaculture is bound to increase land conflicts.

The structure of property rights and institutions underpins and determines the motivations under which unsustainable utilization of natural resources such as wetlands occur (Adger and Luttrell, 1998). Given that wetlands have the unique physical trait of being water dominated, this adds complexity to the property rights structures as they will include aspects of management of aquatic resources as well as systems which operate for land or terrestrial resources (Thomas and Adams, 1997). Thus wetlands exhibit nested rights

over a number of natural resource management situations. Furthermore, there is co-existence of customary and statutory systems of property rights in wetlands which is a potential for conflict due to overlapping property regimes (Adger and Luttrell, 1998).

Secondly, environmental sustainability is a cause of concern. The establishment of fish ponds especially in wetlands ought to be carried out with ecological effects in mind. The massive establishment of fish ponds may change radically the functioning ecosystem of the suggesting the crucial importance of integrated planning and environmental impact assessment. Clearing of wetlands vegetation, especially *cyperus papyrus* has adverse effects on the buffering role of wetlands ecosystems. This conversion has a profound ecological impact at local and global levels, as well as significant social and economic impact on resource users (Adger and Luttrell, 1998). Both semi-intensive and intensive fish farming systems release nutrient rich water into the environment that may cause algal blooms among other problems. As a result, a proper EIA should be carried out so that an optimal number of fish farms are established with the attendant measures to reduce environmental degradation. As the World Bank (2007) argues, under increasing regulation and using modern science, many production systems have become more environmentally friendly, reducing their environmental footprint and even contributing to environmental services.

Thirdly, there are health risks, often linked to water borne diseases such as malaria and bilharzia. Still waters often form a breeding-ground for mosquitos' vectors and thus become a serious health risk. As it has been argued, approximately 60 per cent of Kenya's sicknesses are due to preventable diseases, of which 50 per cent are related to sanitation, hygiene and water (IEA, 2007).

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Appendix C

Table C1: Total fish production and aquaculture fish production trends in Kenya from 1980 to 2006

Year	Total Fish Production (Metric Tons)	Aquaculture Production (Metric Tons)	Aquaculture % of the Total
1980	48218	596	1.24
1981	57372	421	0.73
1982	81133	440	0.54
1983	97461	585	0.60
1984	90796	711	0.73
1985	105973	1085	1.02
1986	119978	980	0.82
1987	131181	1094	0.83
1988	138132	1149	0.83
1989	146403	922	0.63
1990	201778	973	0.48
1991	198637	1009	0.51
1992	163139	1017	0.62
1993	183091	1014	0.55
1994	202890	1119	0.55
1995	193789	1083	0.56
1996	181084	970	0.54
1997	164044	1002	0.61
1998	172665	994	0.58
1999	214712	984	0.46
2000	202639	967	0.47
2001	164,261	998	0.61
2002	128,227	10,929	8.5
2003	103,592	17,214	16.6
2004	115,747	22,514	20.7
2005	133,526	23,953	17.9
2006	147,132	26,700	18.1

Source: *Fisheries Department 2007*

Table C2: Number of farmers, number and size of ponds and production level of aquaculture fish per districts within the Lake Victoria Basin-Kenya in 2003.

DISTRICT	NO OF FARMERS	NO OF PONDS	SIZE OF PONDS (M^2)	PRODUC-TION (KG)	AVERAGE SIZE OF POND PER FARMERS (M^2)
BONDO	14	31	4985	277	356.1
BUNGOMA	127	324	58,384	667	459.7
BUSIA	82	166	23,805	4062	290.3
GUCHA	117	135	1471	611	12.6
HOMABAY	22	43	42,133	213	1915.1
KAKAMEGA	528	812	125,280	2364	237.3
KERICHO	51	78	24,982	108	489.8
KISII CENTRAL	270	420	49,289	100	182.6
KISUMU	36	98	26,943	-	748.4
KURIA	57	119	13,818	-	242.4
MIGORI	7	20	5076	949	725.1
MT ELGON	23	53	12,320	-	535.7
NANDI	72	126	23,234	140	322.7
NYAMIRA	332	480	67,145	7282	202.2
NYANDO	33	75	13,306	-	403.2
RACHUONYO	28	76	2732	-	97.6
SIAYA	42	103	20226	268	481.6
SUBA	-	-	-	-	
TESO	47	91	13,858	46	294.9
TRANS NZOIA	146	170	45,293	605	310.2
UASIN GISHU	54	95	15,259	490	282.6
VIHIGA	121	168	28570	4332	236.1
TOTAL	2209	3683	619,057	22,514	280.2

Source: *Fisheries Department 2004*

Table C3: Aquaculture Enterprise Budget in different scenarios

Construction costs								
Component of cost	Rate	Quantity	Unit Cost	M^2	100 M^2	200 M^2	2400 M^2	10000 M^2
Digging and Soil Compacting	1.5 M^2	1.0	250 Ksh per M^2	166.67	16666.67	33333.3	400000	1666666
Liming	200g/ M^2	200	6ksh per Kg	1.2	120.00	240	2880	12000
Fertilization								
DAP	2g/ M^2per week for 7 Months	56	Ksh 87per Kg	4.872	487.20	974.4	11692.8	48720
Urea	3g/ M^2/week for 7 Months	84	Ksh 87per Kg	7.308	730.80	1461.6	17539.2	73080
Farm Yard Manure	5Kgs/100 M^2 applied once				0.00	0	0	0
Stocking-semi-Intensive	6 per M^2	6	5 Ksh per fingerling	180	18000.00	36000	432000	1800000
Feed Cost	Conversion ratio 2:1	2.832	20 Kshs per Kg		0.00	0	0	0
Mortality rate	20%				0.00	0	0	0
Fingerling weight	5kgs				0.00	0	0	0
Total feed				56.64	5664.00	11328	135936	566400
Labour cost					0.00	0	0	0
Feeding	1/4 Man day		200 Ksh per man-day	10500	10500.00	10500	10500	10500
Harvesting cost					0.00	0	0	0
Rental Net for harvesting			200 per day	200	200.00	200	200	200

Labour cost	5 people per day	5	200 per person per day	10	1000.00	2000	24000	100000
					0.00	0	0	0
Total Cost				11126	53368	96037	1034748	4277566
Gross Revenue					0.00	0	0	0
Price of fish at the market		5	Ksh 100	500	50000.00	100000	1200000	5000000
Net Revenue				-10,626.69	-3,368.67	3,962.67	165,252.00	722,433
Assumptions Fingerling weight 5g, Total weight at harvest 300g, Labour cost at the highest bound Ksh 250 per 1.5 M^2								

Table C4: Gross margins for Salama Fish Farm, Uganda

SALAMA FARM (6000 Sq M)	Description (Price in UG Shs Unless specified otherwise)	Quantity	Unit cost	Clarius	Tilapia
Construction costs					
Component of cost					
Digging and Soil Compacting	1000 M^2 @ 5million Ug shs	6	50,000	300000	300000
Liming	100,000 per season	1	100,000	100,000	100,000
Fertilization					
DAP	1 M^2 @30g @85 Kshs per Kg applied 2 per season (Exchange 23)	360	1955	703800	703,800
Urea				0	
Farm Yard Manure	Chicken manure 30g/ M^2 70kg @50,000 Ug Shs once/ season	180	70	12600	
Stocking-semi-Intensive	6/m @100Ugshs for Tilapia	36000	100	0	3600000
	11/asr M @ 150 Ugshs for Clarius	66000	150	9900000	
Feed Cost					
Mortality rate	Assumption --20%				
Fingerling weight	5g				

Total feed	65:25:5:5 (Maize bran: Omena: bloodmeal: sunflower)			5,000,000	5,000,000
Labour cost	20 casual and 10 permanent staff			1,000,000	1,000,000
Harvesting cost					
Rental Net for harvesting	Sampling Net @ 1.2 million, Lifespan 2yrs, harvesting net 800,000			1,200,000	1,200,000
Total Cost				**18216400**	**11903800**
Revenue (fingerlings)					
Revenue (table Fish)					
Price of fish at the market	1000 Per piece				
Gross Revenue	Clarius pieces (assuming 20% mortality of the stocking rate)	52800	1000	52800000	
	tilapia pieces (assuming 20% mortality of the stocking rate)	28800	1000		28800000
Reported Revenues in SALAMA FARM					
Net Revenue (fingerlings)	5 m for clarius for 6 months			5,000,000	1,000,000
	1 million for tilapia for 6 months				
Net Revenue (Table fish)	500,000 for clarius			500,000	100,000

Table C5: Implementation Action Plan

Goal	Aquaculture up-scaling in the Sio Malaba-Malakisi region					
	Strategies	**Responsibility**	**Means of implementation**	**Performance indicators**	**Time frame**	**Assumptions**
Improvement of Research and Extension	• Recruitment of extension staff • Increased research on aquaculture • R&D	Fisheries Dept, LBDA, KMFRI, FRI	Public-private partnerships	Number of staff, number of papers and projects	5 Yrs	Availability of funds
Capacity Building	• Increased awareness and sensitization • Formation of local aquaculture groups • Establishment of farmer field school	Fisheries Department, LBDA, NGOs, Ministry of Fisheries	Public-private partnerships	Number of sensitization workshops/seminars, number of short courses, number of groups formed, number of demonstration fields/days, field visits	5 Yrs	Availability of funds
Development of hatcheries /provision of fish fry	• Increasing the supply of fish fry • Increase the number of hatcheries	LBDA, Fisheries department, individual farmers	Public-private partnerships Tax incentives/ subsidies	Number of fingerlings, number of hatcheries	5 Yrs	Availability of funds
Credit availability	• Increasing access to credit	AFC, microfinance institutions, commercial banks	Public-private partnerships Gov guarantees	Number of farmers with access to credit	5 Yrs	Availability of funds
Development of marketing infrastructure	• Establishment of cold stores • Formation of marketing groups			Number of cold stores established Number of groups formed	5 Yrs	Availability of funds

Development of policy and regulatory framework	• Development and finalization of aquaculture policy • Development and finalization of aquaculture regulations	Fisheries department, Ministry of fisheries	Public policy making process	Finalization of policy, finalization of regulations, formation of aquaculture development institutions	5 Yrs	Availability of funds, Political will

Section D

Cluster Report

6

Introduction

6.1 Background

In 1996, the World Food Summit (WFS) set its objective to reduce by half the number of chronically undernourished people by the year 2015. Five years later, the United Nations Millennium Development Goals (MDG) reiterated this goal. Progress towards these goals has, however, been dismal in most of the Nile Basin countries. With the exception of Egypt and to a certain extent Uganda, the other Nile Basin countries are classified as food insecure. The food security situation is threatened not only by demographic growth which is estimated at about 2.5 percent, but also shortage of land, water, limited capacity to absorb natural shocks such as droughts and floods as well as civil conflicts.

Chronic food shortages and frequent food crisis continue to be a way of five for many people in the Nile Basin despite the region having considerable potential to feed its own population and many others. Food insecurity is now increasingly seen as the result of failure of the livelihood systems not to provide sufficient food for all and not only arising from crop and livestock production failures. An additional challenge for the region is the global climate change which is set to increase the uncertainty of the current production and distribution systems.

Given the coexistence of abundance of production and famines within some countries such as Kenya and Sudan, the causes of food insecurity in the region can be seen as mainly structural and policy related. The natural calamities in many cases just serve to trigger and aggravate the negative effects of these structural causes which cause famines in the extreme. The ensuring climatic change will likely magnify these structural and policy failures unless systems are put in place to enhance the adaptive capacity of nations.

In the food security scoping study conducted in 2007, six broad areas of sources of food insecurity within the Nile Basin countries were identified (Table 6.1).

Table 6.1: Sources of food insecurity: Areas of commonality and differences for the Nile Basin countries

Source of food insecurity	Burundi	DRC	Egypt	Ethiopia	Kenya	Rwanda	Sudan	Tanzania	Uganda
Low agricultural productivity	***	***	*	***	***	***	**	***	*
Environmental degradation									
- Soil erosion	***	**	**	***	***	***	**	***	**
- Pollution									
• Water	**	**		*					
• Soil									
			***	**	***	**	***	**	**
			***		***	**	***	**	**
Market access									
• Poor infrastructure	***	***	*	***	***	***	**	***	***
• Unstable food prices	***	***	*	***	***	***	***	***	***
Drought	**	*	*	***	**	*	**	**	*
Conflicts	***	***	*	**	**	***	***	*	**
Health (e.g. malaria,HIV/AIDS) and nutritional insecurity	***	***	*	***	***	**	**	***	***

***Severe problem ** moderate * Not serious

From these, it emerged that the most severe courses of food insecurity are:

i. Market access, the most serious problem for the region as it is ranked most severe by eight of the nine countries and severe in ninth (Egypt).

ii. Low agricultural productivity, and;

iii. Health problems follow, with six countries ranking them most severe.

6.2 Purpose of cluster group and scope of work

The food security cluster group aims at undertaking cross-country studies to identify workable strategies for addressing food insecurity in the region. The group is undertaking three studies which, as discussed above, relate to low agricultural productivity, infrastructure and vulnerability to poverty. The three studies focus on the areas highlighted below:

a) Low agricultural productivity and food insecurity in the Nile Basin Region (KIPPRA, Kenya)

This study aims at characterizing productivity of farming systems within the Nile Basin which are considered important for meeting food security needs. It also aims at identifying other farming systems with potential for improved agricultural productivity but which may require investment for enhancing food security within the region.

The specific objectives of the study are:

- Description of the major farming systems within Kenya, Ethiopia and Sudan and examination of the productivity trends of dominant food crops;
- Determination of the factors influencing observed productivity;
- Identification of emerging/innovative farming activities that have enhanced productivity but which may require investment for up- and out-scaling.

b) Poverty alleviation problem: composite vulnerability index analysis (DSRI, Sudan)

The study objective was to analyze the poverty vulnerability index across the Nile Basin region from a shared vision perspective. The specific objectives of the study are:

- To create a common platform for analysis of poverty from a regional perspective,
- To identify common features, causes, spread, directional vector of poverty in the region,
- To identify common poverty combat strategy for the region.

6.3 Highlights of the Reports

6.3.1 Scoping study for food security cluster

The food security scoping study was mainly undertaken through desktop reviews and secondary data analysis. It describes the performance of agri-food systems from production to food access and utilization.

Some of the key findings of the study are

1. In general, Nile Basin countries have either stagnating or declining growth in crop and livestock production and productivity. This is mainly attributed to high reliance on erratic rainfall, safe for Egypt and to some extent Sudan; low soil fertility due to low intensity of input use and environmental degradation including pollution of water bodies through agricultural inputs, soil loss and industrial waste.
2. The region has limited basic infrastructure in terms of distribution and storage, which results in high post-harvest losses, poor market integration, low and unstable producer prices and uncompetitive food systems.
3. There is low economic access to food due to high poverty prevalence
4. The Nile Basin region has high absolute and relative malnutrition levels
5. The region is also highly vulnerable and unable to respond to economic, social (e.g. conflict, health) and natural shocks, hence
6. There is high dependency on food aid

Based on this, the study identified trans-boundary interventions in conflict areas and the enhancement of market access for smallholder farmers and traders as priority areas for interventions under the Nile Basin Initiative. The study therefore recommended further research in the following areas:

(a) Prioritization of farming systems for improved productivity and food security

While in many other regions of the world food production and food security depend on a limited number of farming systems, diversity is the norm in most of the Nile Basin countries. Due to limited resources, there is need

for identification of farming systems and nascent initiatives within the region that have technical opportunities for enhancing productivity but which may require investment for up- and out-scaling. Such investment may be at the micro, meso or macro level.

(b) Inventorising inputs' and outputs' market infrastructure

This research area was recommended on the basis of the fact that efficient management of post-harvest activities is a necessary prerequisite to marketing and trading activities that add value to a production system. Currently, post-harvest losses in the region are high while input and output markets are poorly integrated with much of the installed capacity, during the period of market controls, being largely underutilized. In-depth country studies were therefore necessary to take stock of the status of roads, storage and processing facilities. Improvements in roads, storage, and input and output markets are considered vital in raising competitiveness of regional food production.

C) Improving performance of agricultural market

The long-run ability of households to achieve food security not only depends on farm productivity but also on the efficiency of input and output markets. This is because nearly all rural households participate in markets, either as sellers or buyers of products and services. Any strategy to improve food security must therefore address simultaneously the productivity of the domestic agricultural production and marketing system. Furthermore, an efficient internal marketing is a precursor to successful regional and international external trade, with internal inefficiencies likely to spill over to external trade. This research builds into the Regional Trade and Agricultural Productivity project of the Nile Equatorial Lakes Subsidiary Action Programme

d) Environment, climate change and livelihoods

There is need for studies that assess the full impact of climate change on individual crops and livestock, particularly in the vulnerable regions of arid and semi-arid areas. Studies that addresses research gaps in research so far undertaken on climate change are desirable for the Nile Basin countries as this

would assist in establishing sustainable food systems or livelihoods, especially in those segments of society that are chronically prone to food insecurity.

e) Poverty reduction and conflict management in the Nile Basin

Poverty, hunger and conflict are closely linked. Once a country has fallen into a conflict, it is difficult for it to climb out—as the ongoing catastrophe in DRC has shown with most people today being killed not by weapons but by easily preventable and treatable diseases. Violent conflict also produces considerable economic spill over for neighboring countries, as refugees flow in, investment pulls out and supply chains and trade routes are disrupted. Studies under this theme would aim at finding out how the region can systematically integrate conflict-sensitive interventions in poverty reduction polices for enhancement of food security.

It is on the basis of these findings and recommendations that the studies discussed in section 2.0 and highlighted in the subsequent sections were selected.

6.3.2 Study on low agricultural productivity and food insecurity in the Nile Basin Region (KIPPRA, Kenya)

The report presents productivity trends of specific commodities important for food security in the Nile Basin countries. In line with the SBDS goal of analysing and developing innovative ideas that enhance agricultural production and leading to trans-boundary food security, the report highlights a number of initiatives with technical capacity to enhance food security for the region.

Comparison of productivity trends between Nile Basin countries shows that other countries have a lot to learn from Egypt. Whereas productivity has been low and stagnant for all other countries, that of Egypt has been rising a fact attributed to increased use of improved technology, such as fertiliser and irrigation. Comparison with other comparator countries in West Africa also shows dividends in improved food security indicators from investment in improved technology.

There is a strong case for increasing investment as a lever to stimulate crop and

livestock supply response, especially given the rising food price trends. Although a curse for many households who are food net-buyers in the region, the rising food prices also offer an opportunity for the region to increase food production and intra-regional trade. But given a rising trend in farm inputs especially fertilisers, to achieve the desired supply response, a number of innovative approaches are identified as (i) the production of planting seeds and clean materials, especially for indigenous crops (ii) the development of producer market groups, (iii) market information (iv) investments in small irrigation schemes to even out supply, and (v) new-product market development for food security crops.

On emerging and innovative approaches to enhance food security, the report presents case studies on aquaculture, irrigation development, promotion of rain-fed Nerica rice production and *Spirulina* production. The study concludes that these initiatives are promising and have good potential for up- and out-scaling. If implemented, their benefits would offer leverage for socio-economic development through improved food security.

The report recommends that:

6.3.3 Orphan Crops

(i) To **encourage production of orphan crops**, Nile Basin governments increase budgetary support through farmer education, research and industry participation.

(ii) Close the "yield gap" for orphan crops, particularly in marginal zones by allocating more resources to promote crop husbandry practices for food security purposes.

(iii Production of planting seeds and clean materials: Availability of quality seeds and clean planting materials is one of the main constraints to the production of food security crops in the marginal zones. Greater public support is required until market forces take over the seed bulking and distribution activities, so that it becomes self sustaining in the long run.

(iv) Promotion of irrigated farming and water harvesting technologies: Investment in water harvesting technologies e.g. watershed management

can be a suitable strategy to mitigate supply variations and subsequent price fluctuations.

(v) Agricultural marketing extension and public infrastructure: There is need for an extension paradigm shift to development and promotion for markets for orphan crops. Marketing extension should put emphasis on the creation of market-oriented organisations such as producer market groups or common interest groups.

(vi) New-product development*:* Various new-product recipes need to be promoted in the marginal and semi-arid areas of most Nile Basin countries to popularize orphan crops.

(vii) Policy framework for collective marketing arrangements*:* Market forces have failed to establish dynamic rural markets and provision of effective services in the marginal areas. An appropriate policy environment that can spur growth and access to essential finance and credit facilities by growers of orphan crops is necessary.

(viii) Incorporating orphan crops into the strategic food reserves*:* There is a strong case to partially substitute maize with sorghum and millets in the strategic food reserves in order to spur greater interest in the production and marketing of orphan crops.

6.3.4 Fish farming

Although aquaculture is touted as having great potential in fighting poverty and hunger and the potential of the region is large, production levels are extremely low. The NBI through its Subsidiary Action Programme (SAP)- the Sio-Malaba-Malakisi Basin- is already investing in aquaculture on a pilot basis. The study recommends its up-scaling.

6.3.5 Irrigation Development

It is important that constraints impacting on irrigation development be addressed if irrigation is to play its rightful role in addressing food insecurity in the Nile Basin region. More effort needs to be placed on irrigation research and identification of technologies that are more efficient in the utilization of irrigation water.

6.3.6 NERICA Rain-fed Rice

Since evidence shows that this is a viable technology, there is need for the region to move with speed in terms of testing the out-scaling potential of Nerica rice.

6.3.7 Sustainable Solutions for Combating Malnutrition

There is need for exploring local planting and animal material with proven ability for enhancing nutrition for vulnerable people, while using scarce resources like land, sparingly, as the case of *Spirulina,* a micro-algae with origin from Lake Chad, shows.

6.3.8 Infrastructure and Food Security in Ethiopia and the Nile Region (Research Team Addis Ababa University-, Institute of Development Research (IDR)

Since the majority of poor people in the Nile Basin live in rural areas and depend on agriculture for their livelihoods, there are very close linkages between infrastructure and food security. Access to sufficient infrastructure on a sustainable basis will help in the various dimensions of food security, i.e. reducing vulnerability to shocks (drought, erratic rainfall, rainfall variability); increasing food availability and access (increasing productivity and total production); and enhancing the utilization components by improving the health and sanitation situations

This study gathers empirical evidence which focus on infrastructure and food security; the status of water supply and sanitation, the health and road infrastructures in Ethiopia and the socioeconomic characteristics of other countries in the Nile Region.

The study employed different descriptive and inferential statistical techniques in analyzing variables considered and measured at nominal, ordinal, interval and ratio-scales. Key findings of the study include:

- The fact that communities, both those with access to water schemes and those without, believed in the pivotal role water plays in their livelihoods
- Almost all of those interviewed were convinced that lack of access

to sufficient water adversely affects the food security status of their households

- A total of 92 per cent of the households who lack access to water schemes believe that the absence of water makes them vulnerable to drought; 93 per cent attributed water as a factor lowering their agricultural production and productivity and all of them think that the dire search for water consumes their time and energy
- Conversely, about 88 per cent of the members of households who have access to water schemes in their vicinity asserted that their food security status and livelihoods have improved following water supply interventions, most particularly in terms of improving the household health situations and in diversifying their sources of income
- About 64 per cent of the community members who have access to water schemes and 86 per cent of the sampled members have not faced shortages in food items for a longer period in the year

6.3.9 Poverty alleviation problem: composite vulnerability index analysis (DSRI-University of Khartoum, Sudan)

The study objective was to analyze the poverty vulnerability index across the Nile Basin region from a shared vision perspective. The specific objectives of the study are to create a common platform for the analysis of poverty from a regional perspective and to identify common features, causes, spread and directional vector of poverty in the region with the aim of identifying common poverty combat strategy for the region.

Staple crops for Northern Sudan are sorghum, millet and Sesame while for Southern Sudan the staples are sorghum, maize, sesame, cassava and household vegetable gardens. In the North, 60 per cent of the population depend on food purchase as opposed to the south where 40 per cent depend on food purchase and another 40 per cent on their own farm.

The study examines the vulnerability of households to drought in various regions in Sudan and the level of crop yield variability. It further examines

the food security status and the poverty index, depth and severity in rural Sudan while also analysing the poverty causes in traditional farms.

Key findings of the study are:

- Food insecurity in Sudan is a result of fluctuation in food crops production, food consumption, and household income.
- Despite almost full self-sufficiency in staple crops (sorghum and millet), high variability in domestic production and consumption and the low incomes were responsible for high levels of food insecurity during the period 1970-1996.
- The key coping strategies of households rests upon:
  - obtaining sufficient food
  - increasing the wealth and assets of households
  - social networks and access to forest resources
- Generating extra income, including credit or reducing expenses: migration, working for money, purchasing food on credit, borrowing food and reducing health/education expenses
- Own household resources, for instance, using savings or selling livestock and other assets

Figure 6.1: Workshop Participants at KIPPRA-NBI/SVP/SDBS Food Security (IDR, DSRI, KIPPRA)-Cluster Nairobi-Kenya 14th August 2008.

Appendix D

Table D1: List of Participants, Food Security Cluster Workshop, April 2-3, 2007. Silver Springs, Nairobi, Kenya

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Notes:

1 Comparison between 1993/95 and 2001/05. Yield data for previous years were not currently available