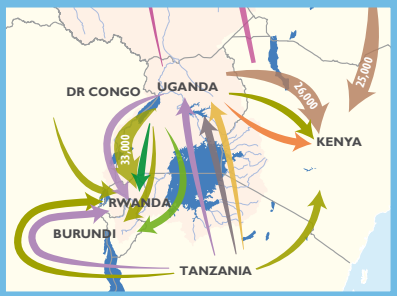
Chapter 5

Agriculture, Food Security, and Livelihoods in the Nile Basin



KEY MESSAGES

- The agricultural sector is of great importance to the Nile Basin countries as it is a major contributor to GDP, employment, and food security. Agriculture is also the largest water-consuming sector: irrigated agriculture alone uses the equivalent of about 78 per cent of the peak flow of the Nile at Aswan.
- Close to 90 per cent of the land currently used for agriculture is under rainfed farming systems. These systems are characterized by subsistence-level production and low yields of crops and livestock.
- There is about 5.6 million hectares of land under irrigation or equipped with irrigation facilities in the Nile Basin. A large proportion – 97 per cent – of the land is located in Egypt and The Sudan, with the remaining 3 per cent distributed among the upper riparian states. Productivity and water-use efficiency is high in the irrigation schemes in Egypt, and on commercial irrigation schemes in the rest of the basin, but generally low in the large smallholder irrigation schemes in The Sudan.
- Three countries – Egypt, Tanzania, and Uganda – produce large quantities of fish, but the freshwater fisheries resources of the basin are showing signs of being overfished.
- The potential of the agricultural sector is large, but it is held back by constraints in both the natural resource base and the policy, institutional, and economic environment.
- The agro-processing sector in the region – except for that in Egypt – is poorly developed.
- Production levels for food crops have been rising over the years, but food production in the Nile countries falls short of local demands, and all countries are net food importers.
- Trade volumes between Nile Basin countries are low, as none of them generates sufficient surpluses to support high-volume trade. Trade links between the downstream countries (Egypt and Sudan) and the rest of the basin states are very weak.
- To produce sufficient food to feed the basin population and generate surplus for regional trade, the basin countries need to concurrently implement a wide range of measures targeting the multiple constraints affecting the agricultural sector.
- The present situation of dominance of smallholder rainfed subsistence farming in the upper riparian countries is likely to persist to 2030 and beyond. To improve rural livelihoods and enhance food security in the region, it will be necessary, therefore, to improve the productivity of this farming system through, for example, introducing water and soil conservation techniques, providing quality seeds, and encouraging use of fertilizers.
- From the perspective of water management, interventions to increase agricultural productivity should include programmes to increase rainwater harvesting, expand irrigated areas, improve the water-retention properties of soil in the upstream countries, and improve productivity and water-use efficiency in the downstream countries.

Smallholder rainfed fields in Uganda.

AGRICULTURE: MAINSTAY OF THE REGION'S ECONOMY

Agriculture is important

The agricultural sector (the broader production sector that includes animal husbandry and fisheries) is of immense importance to all Nile Basin countries in terms of contribution to GDP (between 12% and 43%), employment (between 32% and 94% of the labour force), and food production. In addition, the agricultural sector sustains the agro-industrial sector, and contributes to the growth of non-farm activities (both in rural and urban areas) and to the strengthening of regional integration through trade in agricultural products. Over 60 per cent of the region's poor households derive their livelihood primarily from agriculture. For these households, increasing agricultural productivity and trade offer the best means of raising income, ensuring adequate food consumption, and accumulating the assets necessary to survive periodic shocks such as droughts and floods.

Farmers in Lira district, Uganda, weed sunflowers, grown as part of an IFAD-supported project to produce and sell vegetable oil.

Agriculture is the single-largest water consumer in the Nile Basin. Total withdrawals for irrigated agriculture are about 78 per cent of the peak flow of the Nile at Aswan. Food demand, and thus water demand for agriculture, increases with population growth, rising incomes, and changing diets. Therefore, competition between water for agriculture and water for other uses, such as domestic supply, industrial processes, and ecosystem needs, is expected to intensify in coming years as demand from the other sectors rises. Furthermore, negative impacts from agriculture on water and environmental resources such as surface and groundwater pollution, soil erosion, and salinity development, can be expected to increase with the expansion and intensification of agriculture. Thus, agriculture is expected to remain of critical concern to water-resources managers from two perspectives: it exerts a huge demand for freshwater resources that must be met in the face of growing water scarcity, and it pollutes water resources and degrades land and soil, which need to be controlled for sustainable development.

This chapter begins with a description of the farming systems in the Nile Basin, linking it with a discussion on agricultural production and the multiple constraints preventing realization of the full potential of agriculture. Some space is devoted to discussing how farmers in the region are coping with the challenge of climate variability and change, and examining the performance of the agro-processing sector. This is followed by a discussion on regional trade in agricultural products as a way of attaining regional food security and enhancing regional integration. The chapter ends with suggestions on how to increase agricultural productivity while improving water-use efficiency and minimizing harmful impacts on the environment.

MAIN AGRICULTURAL SYSTEMS

In Nile Basin

- mixed smallholder subsistence rainfed
- mixed highland smallholder subsistence rainfed
- forest based
- mechanized rainfed
- medium- to large-scale smallholder irrigation
- medium- to large-scale commercial irrigation
- nomadic & semi-nomadic
- lowland smallholder subsistence rainfed
- shifting rainfed cultivation/agro-pastoralist

Non-agricultural areas:

- hyper-arid: no utilization
- protected area

SYSTEMS NOT REPRESENTED ON MAP

Commercial livestock: Spread across basin. Exotic breeds, e.g. Friesian and Holstein, producing meat and milk. Large farms, professionally managed.

Small- to medium-scale irrigation: Gravity systems, 100–2,000 ha, with earth canals. Small holdings of 1–2 ha. Family labour. Crops with few livestock. Medium productivity.

Controlled environment (greenhouse): Mostly in the lower basin, though increasing in Ethiopia, Kenya, and Tanzania. Drip irrigation, producing vegetables, flower stems, cuttings, and potted plants for export. High productivity. Capital and knowledge intensive.

Urban and peri-urban: Urban areas, high-value enterprises, e.g. vegetables, poultry, and zero-grazing of dairy cattle. Uses agro-industrial byproducts, crop residues, and organic waste. Family labour and small scale, but with good access to markets.

Riverside cultivation: Subsistence fishing and recession agriculture along flood plains, with indigenous livestock. Productivity very low due to pests and soil-borne diseases. Small plots due to seasonal high concentration of people.

Smallholder fisheries: Artisanal fishing, processing, and trading in fish. Practised around the many lakes, wetlands, and rivers in the basin. Inland capture is dominated by Nile perch and tilapia. Fish production is characterized by low yields because of traditional equipment and inefficient catch techniques.

Aquaculture: Ranges from traditional village ponds and enclosed low-lying areas, to modern industrial fish farms. Egypt, using only drainage water, is the main producer, with 91% of total production. Expansion of the fish farming sector is hindered by shortage of quality feed for pond fertilization.

AGRICULTURAL SYSTEMS IN THE NILE BASIN

The wide range of ecologies, climates, human settlement patterns, and level of economic development across the basin combines to create a very diverse agricultural sector. Fifteen main farming systems have been identified in the Nile Basin, based on the criteria of available natural resources and dominant patterns of farm activities. Each system is an inevitable generalization of what are highly diverse production and livelihood systems that share a number of key common attributes. Some degree of generalization is unavoidable given the size of the basin. The characteristics and performance of the major farming systems will be described here.

31.2 million hectares

of the Nile Basin

are under

rainfed agriculture

(Source: FAO 2009)

Rainfed farming systems

Over 87 per cent of cultivated land in the Nile Basin is under rainfed agriculture, on which the livelihood of the large rural populations of the upper riparians depends. The most important rainfed production systems are as follows:

Mixed smallholder subsistence rainfed: This is found in the sub-humid and humid parts of the Nile Basin at altitudes between 500 and 1,500 metres above sea level (ASL). Farmers grow cereals and legumes primarily for household consumption, and some minor crops for cash. Usually, they also keep a few livestock to provide milk, meat, manure, hides, and draught power. Poultry are kept in the backyard as a source of cash to cover small household essentials.

Productivity for most crops is low – less than 2 ton/ha. Livestock productivity is also low. Typically, a family owns less than 1 hectare of land, but this varies considerably across the basin. The land is mostly worked by family members, using locally made hand tools. Inputs such as fertilizers or pesticides are used in a very limited way, if at all. Occasionally, simple small-scale supplementary irrigation is carried out.

Mixed highland smallholder subsistence rainfed: This is found in the highlands of Ethiopia and Eritrea, and in the Equatorial Lakes region above 1,500 metres altitude, where rainfall usually exceeds 1,000 mm/year. Deeply entrenched traditional crop and livestock husbandry practices under temperate climatic conditions produce a wide range of fruits, vegetables, cereals, and pulses, although productivity is low.

The livestock are mainly of indigenous breeds, with relatively few improved stocks and low productivity. Most of the labour is done by the family, using locally made hand tools. Supplementary irrigation is rare. Poverty is high, as markets for any excess produce are usually distant and unreachable because of poor transport infrastructure. The average human population density is high, and the land has become fragmented, with average farm sizes of less than 0.5 hectare. Years of continuous cultivation have depleted the soils of nutrients and led to advanced soil degradation. This is compounded by degradation resulting from overstocking of rangelands.

Forest based: This farming system, mainly found in southwestern Ethiopia, depends on the extraction of forest products from dense and intact forest ecosystems that receive rainfall almost all year round. Areas with forest-based farming systems are usually physically isolated and have low population and livestock densities. Shifting cultivation is practised, with new fields cleared annually.

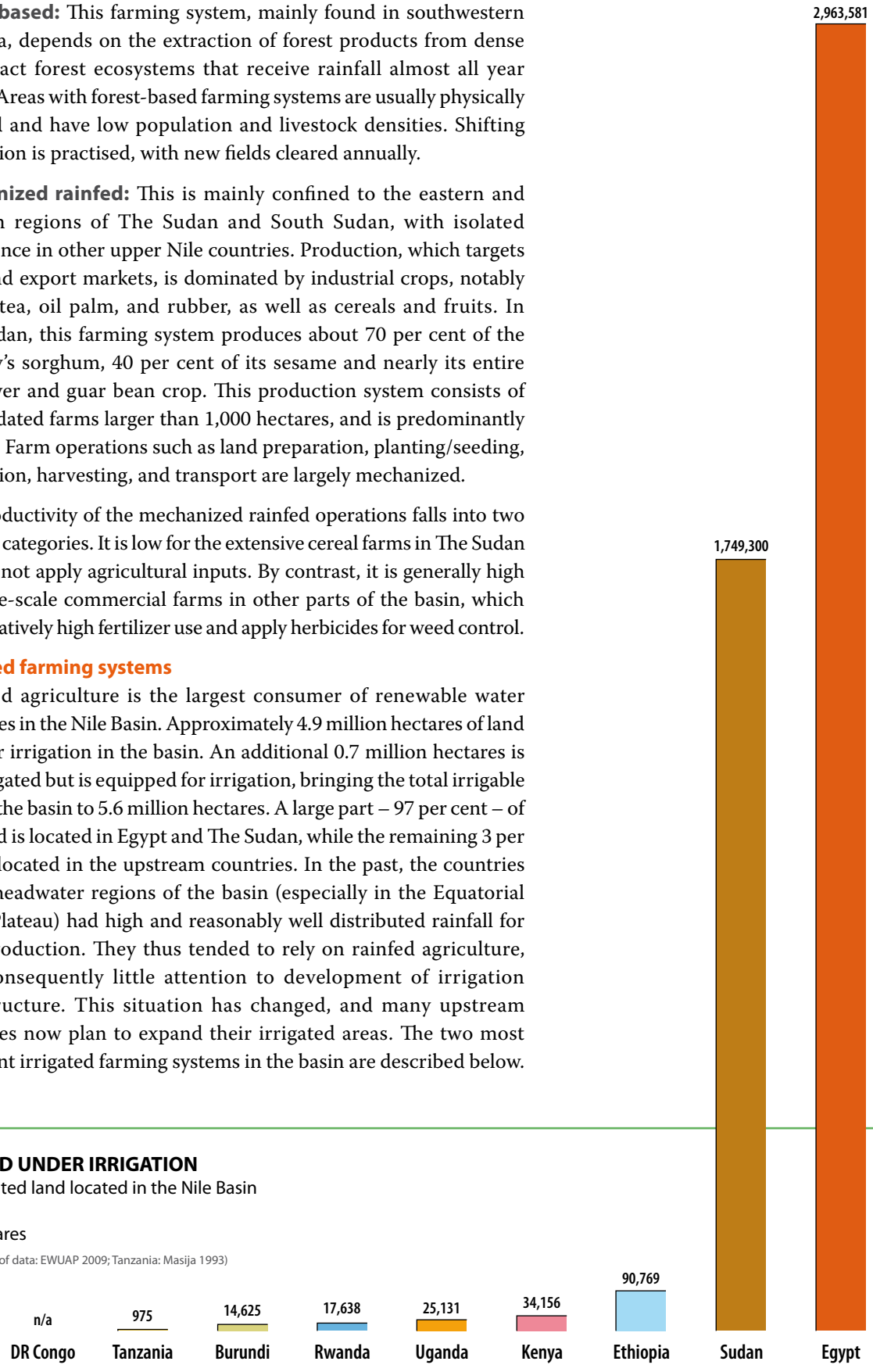
Mechanized rainfed: This is mainly confined to the eastern and western regions of The Sudan and South Sudan, with isolated occurrence in other upper Nile countries. Production, which targets local and export markets, is dominated by industrial crops, notably coffee, tea, oil palm, and rubber, as well as cereals and fruits. In The Sudan, this farming system produces about 70 per cent of the country's sorghum, 40 per cent of its sesame and nearly its entire sunflower and guar bean crop. This production system consists of consolidated farms larger than 1,000 hectares, and is predominantly rainfed. Farm operations such as land preparation, planting/seeding, cultivation, harvesting, and transport are largely mechanized.

The productivity of the mechanized rainfed operations falls into two distinct categories. It is low for the extensive cereal farms in The Sudan that do not apply agricultural inputs. By contrast, it is generally high for large-scale commercial farms in other parts of the basin, which have relatively high fertilizer use and apply herbicides for weed control.

Irrigated farming systems

Irrigated agriculture is the largest consumer of renewable water resources in the Nile Basin. Approximately 4.9 million hectares of land is under irrigation in the basin. An additional 0.7 million hectares is not irrigated but is equipped for irrigation, bringing the total irrigable land in the basin to 5.6 million hectares. A large part – 97 per cent – of this land is located in Egypt and The Sudan, while the remaining 3 per cent is located in the upstream countries. In the past, the countries in the headwater regions of the basin (especially in the Equatorial Lakes Plateau) had high and reasonably well distributed rainfall for crop production. They thus tended to rely on rainfed agriculture, with consequently little attention to development of irrigation infrastructure. This situation has changed, and many upstream countries now plan to expand their irrigated areas. The two most prevalent irrigated farming systems in the basin are described below.

LAND UNDER IRRIGATION
Irrigated land located in the Nile Basin
2009
hectares
(Source of data: EWUAP 2009; Tanzania: Masija 1993)



AGRICULTURAL POTENTIAL IN SOUTH SUDAN

South Sudan has enormous potential for agricultural development and for becoming the region's food basket. The country is looking to tap this potential to reduce its heavy reliance on oil revenues.

The country has several ecological zones: rainforest, savannah forest, flood plains, wetlands, and semi-desert. About 90 per cent of its land area is considered suitable for agriculture, with about half being prime agricultural land. At present, only 4 per cent of its land area is under cultivation. Most of the lands stretch along flood plains and are suitable for both rainfed and irrigated agriculture.

Soil and climate conditions allow for a wide variety of food and cash crops. Along rivers, tobacco and vegetables are irrigated during the dry season, while maize and cowpeas are planted in the moist and highly fertile soils left by receding flood waters. In the wet season, rice fields are supplied with flood waters, while sugarcane and banana are grown on dykes constructed to protect settlement areas from flooding. Productivity is typically low, with production of major foods falling far below national requirements. In 2009, for example, 660,000 tonnes of cereals was produced, 200,000 tonnes short of requirement. Major obstacles to improving agricultural productivity are pest and diseases, poor seed supply, and erratic rainfall.

Irrigated agriculture is poorly developed and at present accounts for only 3 per cent of the total cultivated area.

Women flailing rice in Aweil.

Traditional methods of irrigation are practised, but to a lesser extent. The importance of irrigation in accelerating the growth of agricultural production is well recognized. Rehabilitation of existing irrigation infrastructure – namely the pumped-irrigation schemes in Aweil and Renk – is underway, and development of an Irrigation Master Plan is under consideration.

Livestock production represents a significant proportion of food security, in addition to having fundamental cultural value. It is a major source of livelihoods, especially in the floodplains and the semi-arid pastoral areas.

Pump-irrigated rice fields of the Aweil Scheme.

Medium- to large-scale smallholder irrigation: This consists of traditional river diversions and gravity supply schemes, which can be very large in size. (The harvested area of Gezira in Sudan, for instance, is estimated at 700,000 hectares.) Pump irrigation (from water source to main canal) is increasing. Water is distributed to the fields via earth canals. Holdings vary from less than 1 hectare per household to 20 hectares. Cropping is intensive. Productivity varies per scheme and household. Yields are typically high in Egypt, but are quite low for a number of schemes in Sudan. Given the availability of water and fertile soils, there is considerable potential to increase agricultural productivity in these schemes.

Medium- to large-scale commercial irrigation: The Nile Basin has some of the best large-scale irrigation systems in the world. Holdings are typically 1,000 ha or more. Most are owned and managed by private commercial companies. High-value

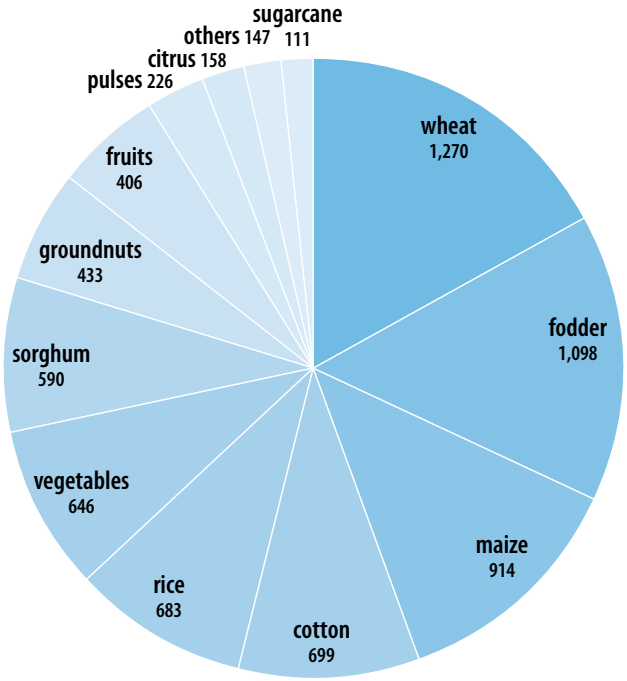
FARMING WITH IRRIGATION
In Nile Basin

- medium- to large-scale smallholder
- medium- to large-scale commercial
- irrigation > 5,000 ha
- irrigation > 250 ha

(Map prepared by the NBI; source of data: FAO Nile 2009)

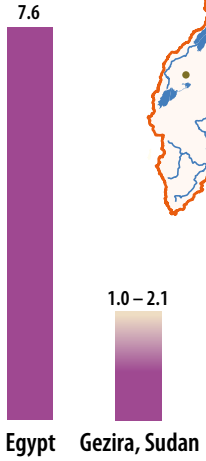
IRRIGATED CROPS
Area of crops grown on irrigated land
2012
thousand hectares

(Source of data: AQUASTAT 2012)



SMALLHOLDER IRRIGATION
Comparative crop yields
2008 & 2009
Tons per hectare

(Source of data: FAO Nile 2009)



vegetables, fruit crops, sugar, and fodder are grown, typically for export. Almost all farm operations are mechanized. Use of fertilizers and other yield-enhancing inputs is relatively high, as are yields.

Livestock production systems

There are a number of nomadic ethnic communities in the Nile Basin whose livelihoods are centered on livestock. The most prevalent livestock production systems are:

KENANA SUGAR ESTATE

The Kenana integrated sugar estate, located on the eastern bank of the White Nile in The Sudan, is an example of one of the large-scale commercial irrigated schemes in the Nile Basin. Other medium- to large-scale commercial irrigation systems include the Kagera Sugar Estate in northern Tanzania, Mumias Sugar Estate in western Kenya, and Fincha Sugar Plantation in western Ethiopia.

Kenana Sugar Estate is located 250 km south of Khartoum, and occupies an area of 40,500 ha in the floodplain belt between the White Nile and Blue Nile. The rich alluvial soils of the floodplain are favourable for sugarcane cultivation, and productivity is relatively high.

With insufficient rainfall to sustain sugarcane, Kenana pumps irrigation water 46 metres up from the White Nile into a 40-kilometre long main canal. Water is distributed by gravity to the plantation area and over the sugarcane fields. Processed sugar from the estate is mainly exported to African and Middle Eastern states, and to India and Bangladesh.

Apart from sugar, Kenana produces timber, ethanol, animal feed, and dairy products, and supports a substantial agricultural services industry. It is the main employer in the region, with nearly 100,000 people dependent on the project.

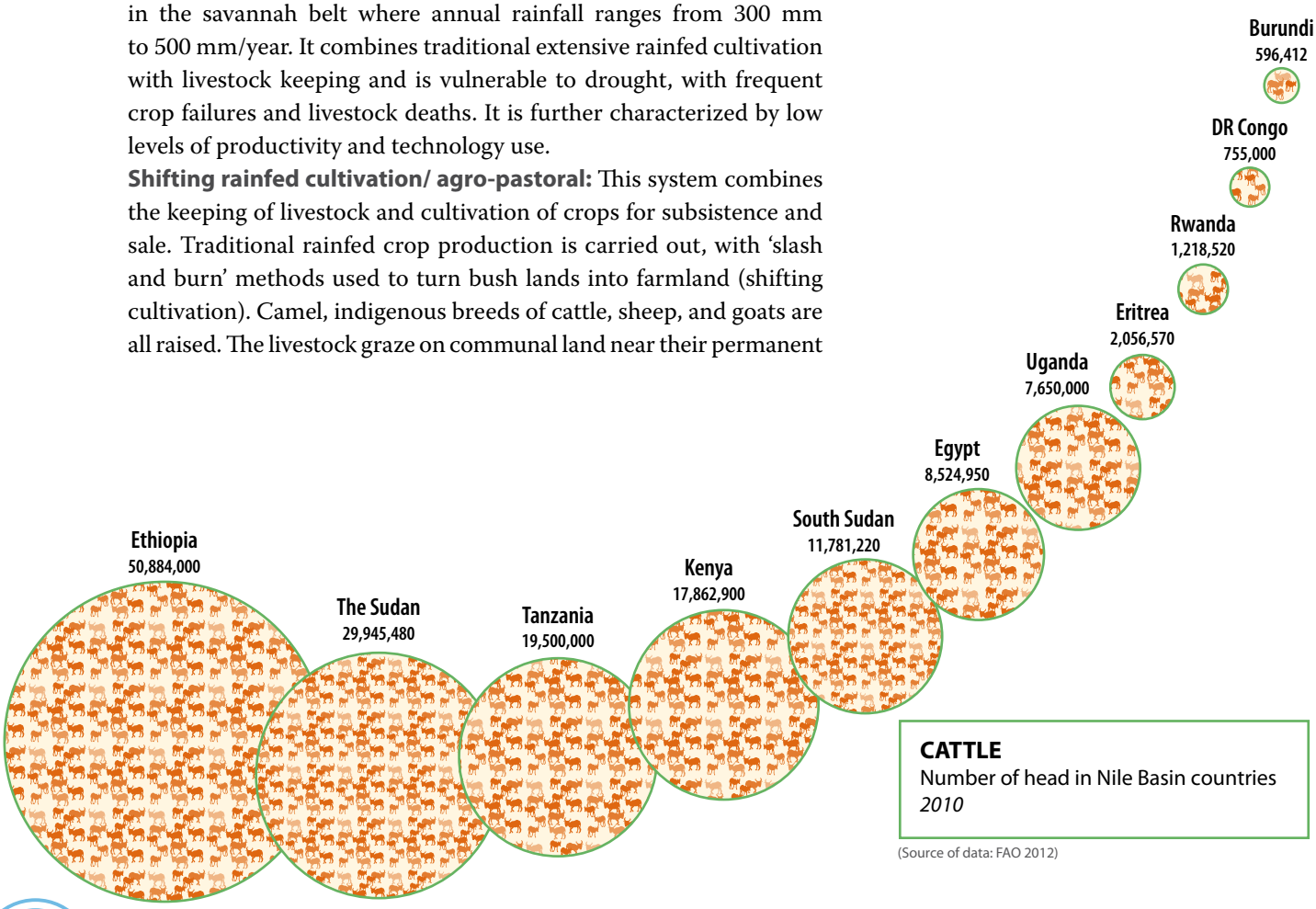
Nomadic and semi-nomadic: This describes the transhumance, pastoralist livelihood practised in areas under arid and semi-arid climatic conditions and sparse population. The rainfall in these areas ranges from 100 mm/year to 500 mm/year, while annual temperature ranges are between 26°C and 35°C, although in some areas it can go as high as 45°C. Other characteristics are sparse vegetation and scarce surface water. Areas under this farming system are prone to drought, and are therefore unsuitable for crop production. Different species of livestock are kept, and seasonal migration practised, in order to minimize risk. The livestock, mainly cattle, camels, and sheep, with some goats, are raised entirely on natural rangelands, which are communal resources with no legal land-tenure system. Water resources are mostly communally owned, although in some areas they belong to individuals or families.

Infrastructure development is weak, making transport and communication within these regions difficult. There are few livestock markets established in these remote areas. Livestock diseases are rampant in the Nile Basin, and affect all livestock types, rendering productivity and production low. There are frequent conflicts over forage and water among the different clans. Rainfall in the pastoral production regions is erratic and unreliable for fodder production.

Lowland smallholder subsistence rainfed: This system is found in the savannah belt where annual rainfall ranges from 300 mm to 500 mm/year. It combines traditional extensive rainfed cultivation with livestock keeping and is vulnerable to drought, with frequent crop failures and livestock deaths. It is further characterized by low levels of productivity and technology use.

Shifting rainfed cultivation/ agro-pastoral: This system combines the keeping of livestock and cultivation of crops for subsistence and sale. Traditional rainfed crop production is carried out, with 'slash and burn' methods used to turn bush lands into farmland (shifting cultivation). Camel, indigenous breeds of cattle, sheep, and goats are all raised. The livestock graze on communal land near their permanent

Mundari herdsmen at a cattle camp in Central Equatoria, South Sudan.



CATTLE
Number of head in Nile Basin countries
2010

(Source of data: FAO 2012)

cropping areas, on fallow land during winter, and throughout the area after crops have been harvested. This farming system is found predominantly in the cattle corridor of Uganda and parts of Ethiopia, South Sudan, and The Sudan. It also occurs in parts of Kenya and Tanzania. Loss of livestock due to stock theft is a common problem while soil and land degradation is on the increase from overstocking of communal rangelands.

Fisheries and aquaculture production systems

The fisheries resources of the region are an important source of protein and may provide an opportunity to some of the basin states as a future major source of foreign exchange. The fisheries in the Nile region are fairly diversified, ranging from established, export-orientated Nile perch fishery on Lake Victoria; through traditional fisheries on wetlands, and large and small water bodies; through tuna fisheries on the Indian Ocean coast; to fish production on small-scale fish ponds in the Equatorial Lakes region and Sudan; and to the young fish export industries on the Red Sea coast, and thriving semi-intensive fish farms in the Nile Delta.

Management of fisheries in the Nile region is supported by a number of regional fisheries bodies, notable among which are the Indian Ocean Tuna Commission (IOTC), Lake Victoria Fisheries Organization (LVFO), and the South West Indian Ocean Fisheries Commission (SWIOFC). These institutions are anchored to regional economic bodies such as East African Community (EAC), Southern Africa Development Community (SADC) and the Common Market for Eastern and Southern Africa (COMESA). Within the countries there are government ministries responsible for management of fisheries and aquaculture resources. However, the fisheries sector in most of the Nile countries has traditionally been deprived of significant financial support from national administrations increasingly under pressure to allocate funds to more visible means of poverty alleviation.

Almost 90 per cent of the fish produced in the region originates from freshwater sources, with only the remaining 10 per cent from the vast marine areas controlled by the basin states. As a consequence, most of the inland fisheries now show signs of being overfished, whereas offshore, marine resources are widely considered to have room for expansion under sustainable management regimes. In the areas where capture fishery by traditional methods is practised (the upstream areas), fish yields are usually low because the majority of the equipment used is primitive, and inefficient catch techniques are employed. Other constraints to the sector include weak policy, legal, and institutional frameworks; weak control and enforcement capacities with insufficient monitoring, control, and surveillance of fishing (and consequently inability to prevent use of destructive fishing gear); environmental degradation of water bodies and fish habitats; high post-harvest losses (about 10%–30% of the catch); inadequate scientific research to guide sustainable sector development; and lack of reliable, relevant, and timely information.

Residents of Kalangala island fish in Lake Victoria.

Aquaculture is emerging as a viable alternative to capture fisheries and as a means for meeting the region's growing demand for fish. Fish farming in the basin ranges from the traditional village type ponds and the hosha system (enclosed low-lying areas), to modern governmental and privately owned fish farms, such as in the Nile Delta. While the yields of the traditional systems are low, yields on the modern fish farms in the Nile Delta are high and economic returns good. Development of aquaculture in the basin is hindered by inadequate supply of quality seed (fry); shortage of appropriate feeds and feeding technologies; inadequate knowledge and information on economic and social feasibility of aquaculture, especially cage culture; poor pond siting and design; and limited access to credit.

THE OPPORTUNITIES OF AQUACULTURE

Aquaculture production in the Nile Basin has grown rapidly in recent years. This trend will likely continue. Export to the developed world is rising because of a drive towards more fish consumption for health reasons, while a rapidly growing population ensures sustained local and regional demand.

Aquaculture is most suited to regions that combine high temperatures with ample water resources. These conditions apply to the many lakes, reservoirs, and wetlands in the basin.

In particular, the Lake Victoria region has high potential for pond and cage aquaculture. Its comparative advantages include the constant annual (high) temperature and the existing processing plants and established export industry. Fishermen can become cage farmers, and the constant quality of aquaculture ensures that market specifications are met. The natural image of Africa provides yet another edge for the region's fish industry relative to its global competitors.

Pollution is a key environmental concern associated with aquaculture, and has to be carefully managed. In particular, cage culture at industrial scale is a source of both nitrogen and phosphorus pollution. It is important that sites are carefully selected to avoid deterioration in water quality.

Fish farming near Jinja, Uganda, Lake Victoria.

PRODUCTION

Food and cash crops

The major food crops grown in the Nile Basin include cereals (barley, maize, millet, rice, sorghum, wheat), pulses (beans, chickpeas, cowpeas, garden peas, pigeon peas), tubers (cassava, potatoes, Irish potatoes, yams), oil seeds (groundnut, sesame, soya bean, sunflower), and fruits and vegetables. Main cash crops include coffee, tea, sugarcane, cotton, and tobacco.

Production levels for 2010 are shown below, with the highest figures in each category shown in bold. This indicates that the major producers of food crops in the basin are Egypt, Ethiopia, Rwanda, Tanzania, and Uganda, while the major producers of cash crops are Egypt, Kenya, Sudan, and Tanzania.

PRODUCTION OF MAJOR CASH CROPS, *2010*, tonnes

Country	Tea	Coffee	Sugar cane	Cotton	Tobacco
Burundi	8,025	6,821	131,730	731	1,400
DR Congo	2,791	31,840	1,827,140	–	4,000
Egypt	–	–	**15,708,900**	**137,000**	–
Eritrea	–	–	–	–	–
Ethiopia	5,300	**270,000**	2,400,000	22,400	5,700
Kenya	**399,000**	42,000	**5,709,590**	958	14,156
Rwanda	24,500	25,980	63,000	–	7,500
Sudan	–	–	**7,526,700**	59,300	–
Tanzania	36,000	40,020	2,750,000	**110,000**	**65,000**
Uganda	40,800	162,000	2,400,000	25,500	25,700

(Source: FAOSTAT 2012)

PRODUCTION OF MAJOR FOOD CROPS, *2010*, tonnes

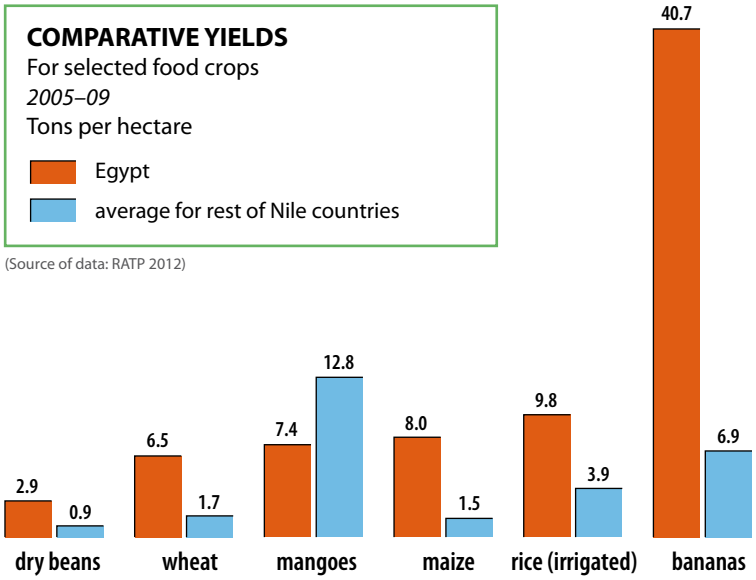
Country	Bananas	Cassava	Dry Beans	Maize	Potatoes	Rice (paddy)	Sorghum	Sweet potatoes	Vegetables (fresh)	Wheat
Burundi	136,564	187,901	201,551	126,412	9,320	83,019	83,023	303,432	403,000	9,034
DR Congo	316,472	**15,049,500**	115,247	**1,156,410**	94,826	317,231	6,140	247,011	370,000	8,841
Egypt	**1,028,950**	–	52,904	**7,041,100**	**3,643,220**	**4,329,500**	701,629	370,905	574,952	**7,177,400**
Eritrea	–	–	300	20,500	140	–	66,700	–	43,300	27,300
Ethiopia	171,700	–	263,100	**4,400,000**	785,800	25,200	**2,997,400**	401,600	682,800	**3,000,000**
Kenya	791,570	323,389	**390,598**	**3,222,000**	450,000	80,042	164,066	383,590	596,100	511,994
Rwanda	30	**2,377,210**	327,497	432,404	**1,789,400**	67,253	161,229	840,072	51,900	77,193
Sudan	85,300	13,500	16,000	35,000	315,000	23,350	**2,630,000**	225,000	741,900	403,000
Tanzania	**2,924,700**	**4,392,170**	**950,000**	**4,475,420**	750,000	**1,104,890**	788,800	**1,400,000**	**1,500,000**	62,130
Uganda	600,000	**5,282,000**	**460,000**	**1,373,000**	695,000	218,111	500,000	**2,838,000**	760,000	21,500

(Source: FAOSTAT 2012)

COMPARATIVE YIELDS
For selected food crops
2005–09
Tons per hectare

Egypt
average for rest of Nile countries

(Source of data: RATP 2012)



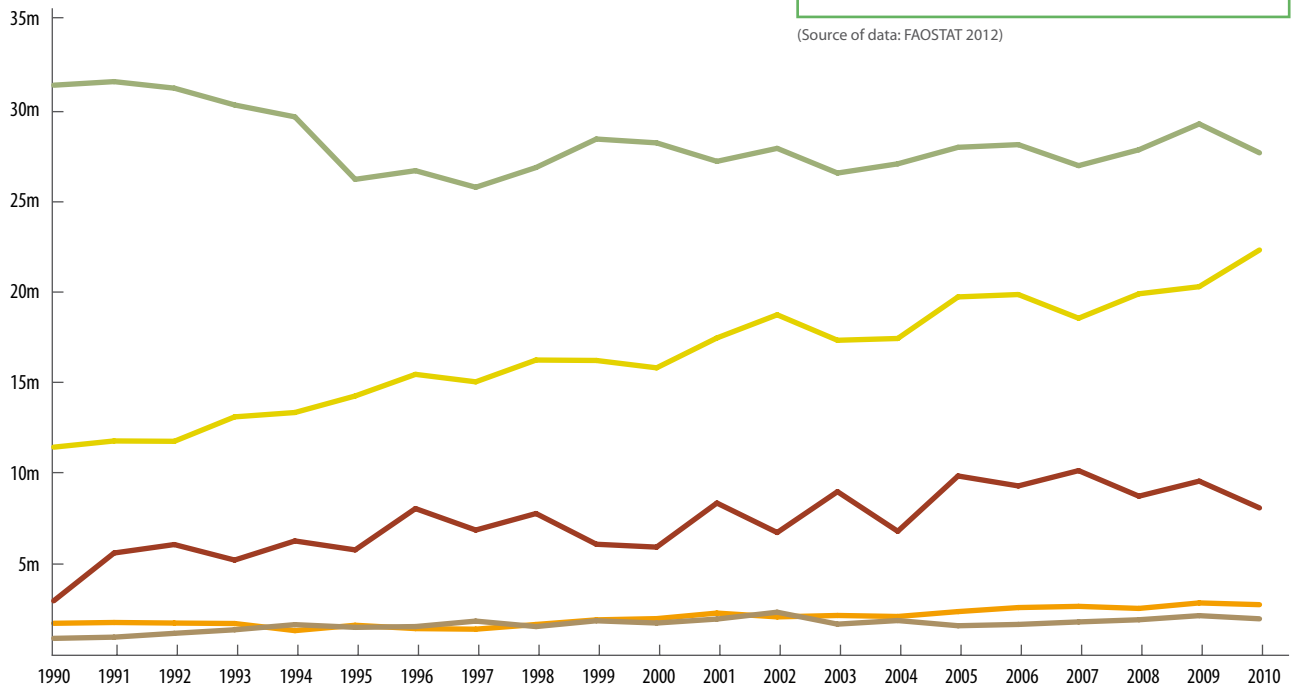
Yields for most crops in the upstream countries are low, typically one-sixth to one-half of the yields in Egypt.

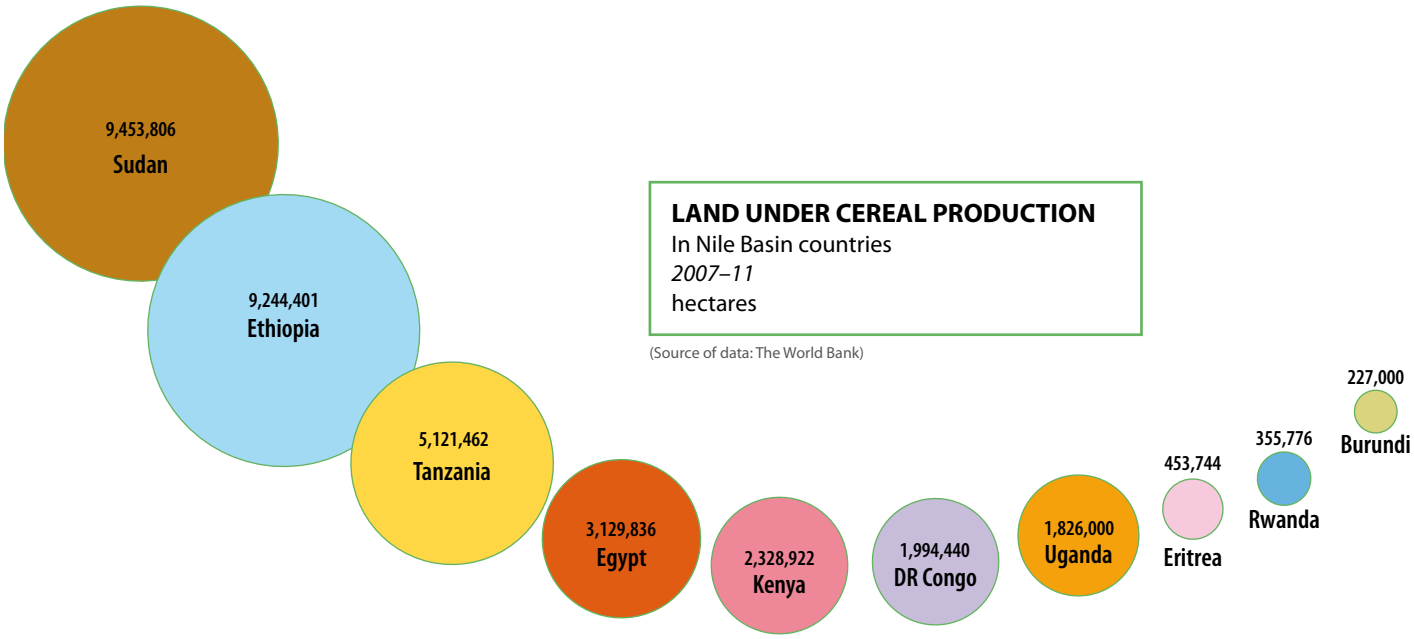
Although production levels for food and cash crops have been rising over the years, the rate of increase has not kept pace with the rate of population growth.

FOOD CROPS PRODUCTION TRENDS
Combined production by Nile countries of selected food crops
1990–2010
tonnes

cassava
maize
dry beans
sorghum
ground nuts

(Source of data: FAOSTAT 2012)



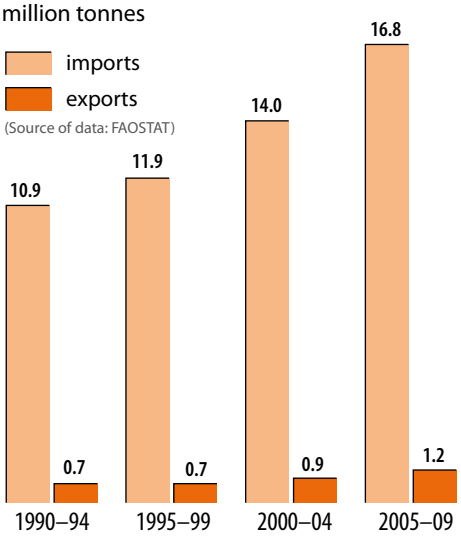


LAND UNDER CEREAL PRODUCTION
In Nile Basin countries
2007–11
hectares

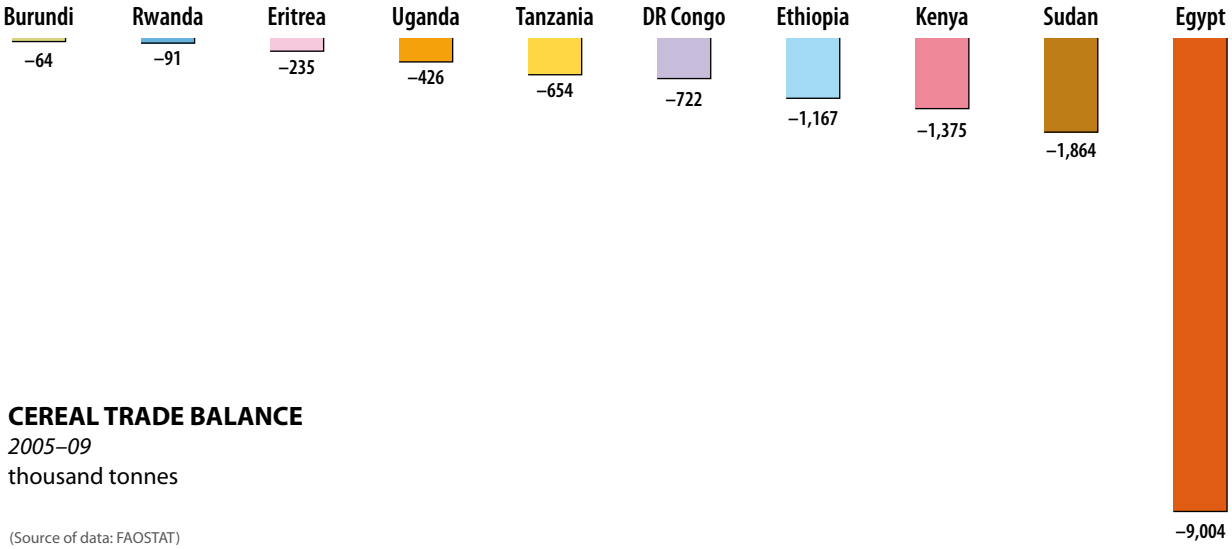
(Source of data: The World Bank)

The inadequacy in local food production is strikingly illustrated by the import–export balance for cereals. The cereal trade balance is a convenient (proxy) indicator for food surplus because cereals constitute a vital component of the diet in the Nile countries, and because they are predominantly traded across international boundaries in primary form. Analysis of the trade balance for the region over the past 20 years reveals that cereal imports are consistently greater than exports, and that the gap between imports and exports is large and increasing. In each Nile riparian country the domestic cereal production (and by inference food production) falls short of national demand.

CEREAL IMPORTS AND EXPORTS
In the Nile Basin
1990–2009
million tonnes



(Source of data: FAOSTAT)



CEREAL TRADE BALANCE
2005–09
thousand tonnes

(Source of data: FAOSTAT)

Livestock, poultry, and fisheries

Poultry birds (mainly chicken) make up the largest proportion of farmed animals in the region, with approximately 340 million birds reared in the Nile countries annually, 40 per cent of which is reared in Egypt alone. The most populous types of livestock are cattle, goats, and sheep. The countries with highest livestock numbers are Ethiopia, South Sudan, The Sudan, and Kenya.

LIVESTOCK PRODUCTION, stocks/head, *2010*

	Poultry	Cattle	Goats	Sheep	Camel	Rabbits	Pigs
Burundi	5,050,000	596,412	2,162,800	295,739		135,000	244,791
DRC	20,500,000	755,000	4,150,000	905,000			967,000
Egypt	**133,750,000**	4,524,950	4,200,000	5,591,580	140,000	9,300,000	38,000
Eritrea	1,250,000	2,056,570	1,750,000	2,271,560	345,000		
Ethiopia	38,000,000	**50,884,000**	**21,960,700**	**25,979,900**	807,581		29,000
Kenya	30,398,000	**17,862,900**	**13,291,700**	9,899,300	**1,000,000**	490,000	347,400
Rwanda	2,883,000	1,218,520	2,735,480	743,201		790,000	602,324
Sudan	43,000,000	**41,726,700**	**43,441,000**	**52,014,100**	**4,645,330**		
Tanzania	34,820,000	**19,500,000**	**12,900,000**	4,200,000			495,000
Uganda	30,000,000	7,650,000	8,800,000	1,850,000			2,300,000
Total	**339,651,000**	**146,775,052**	**115,391,680**	**103,750,380**	**6,937,911**	**10,715,000**	**5,023,515**

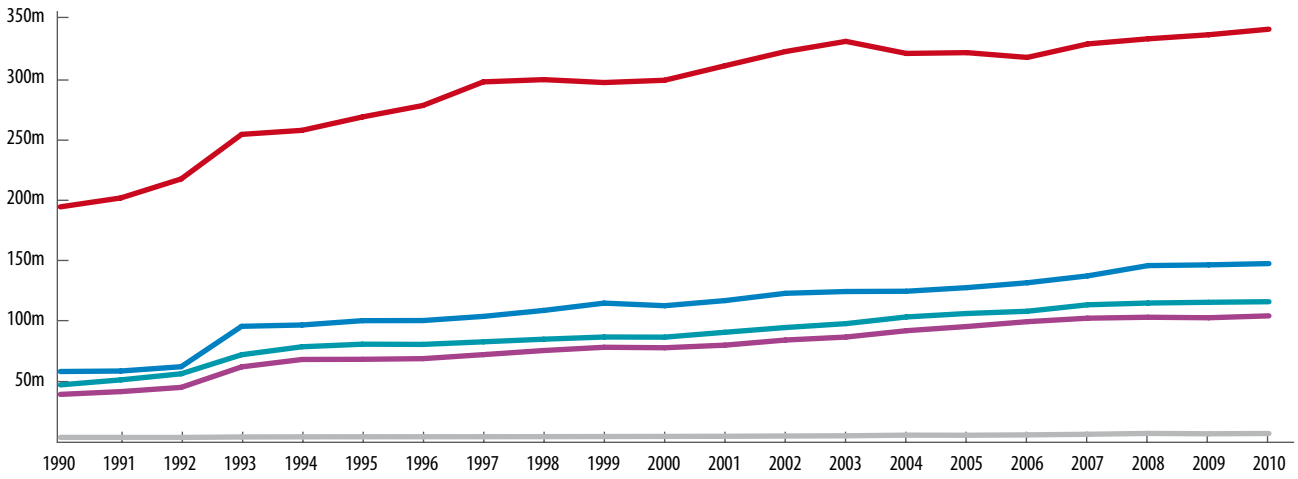
(Source: FAOSTAT 2012)

LIVESTOCK AND POULTRY PRODUCTION TRENDS

Number of stocks/head
in Nile Basin countries
2010

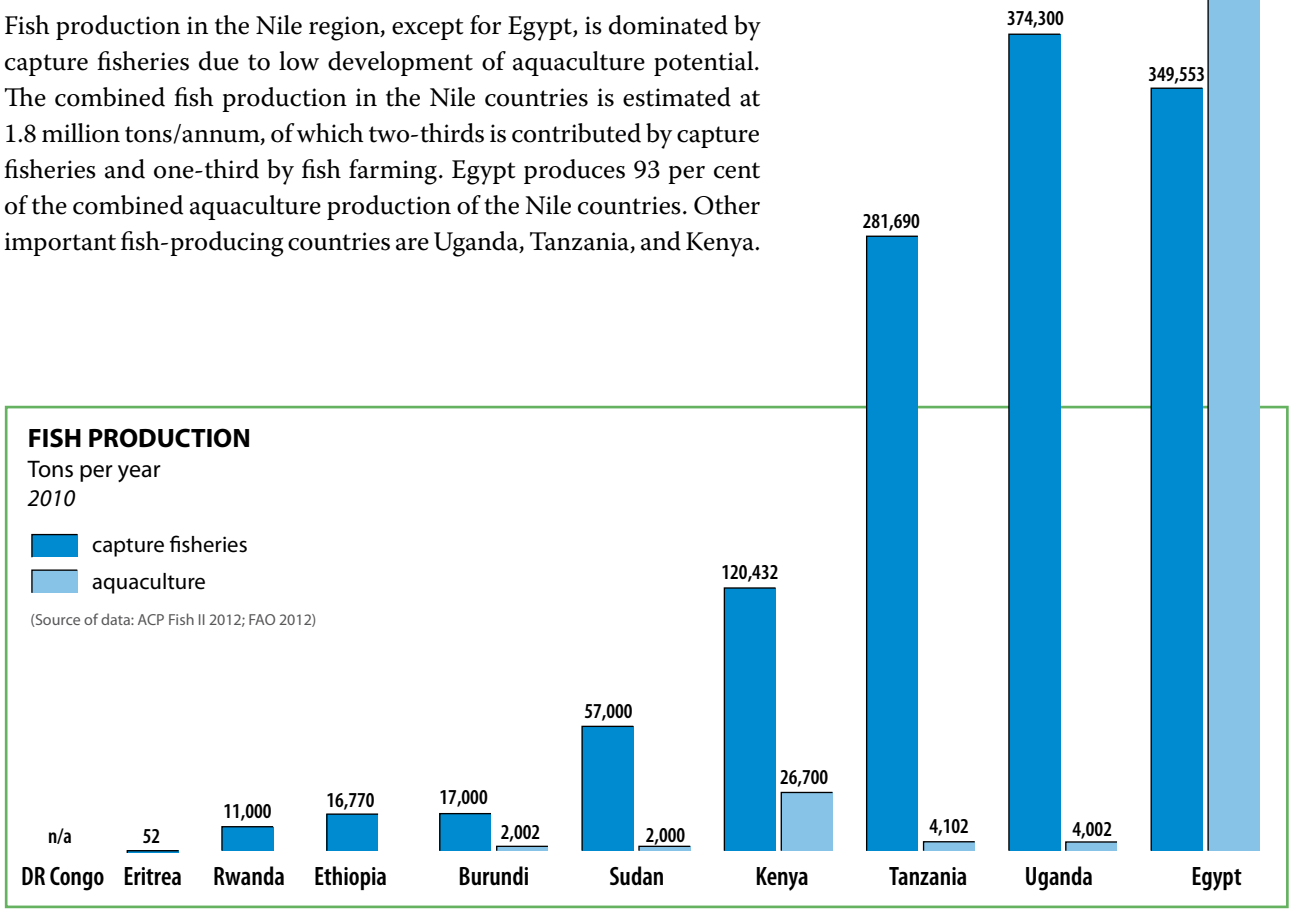
poultry
goats
cattle
sheep

(Source of data: FAOSTAT 2010)



Harvesting tilapia at the Egyptian Aquaculture Centre.

Fish production in the Nile region, except for Egypt, is dominated by capture fisheries due to low development of aquaculture potential. The combined fish production in the Nile countries is estimated at 1.8 million tons/annum, of which two-thirds is contributed by capture fisheries and one-third by fish farming. Egypt produces 93 per cent of the combined aquaculture production of the Nile countries. Other important fish-producing countries are Uganda, Tanzania, and Kenya.



Organic farming

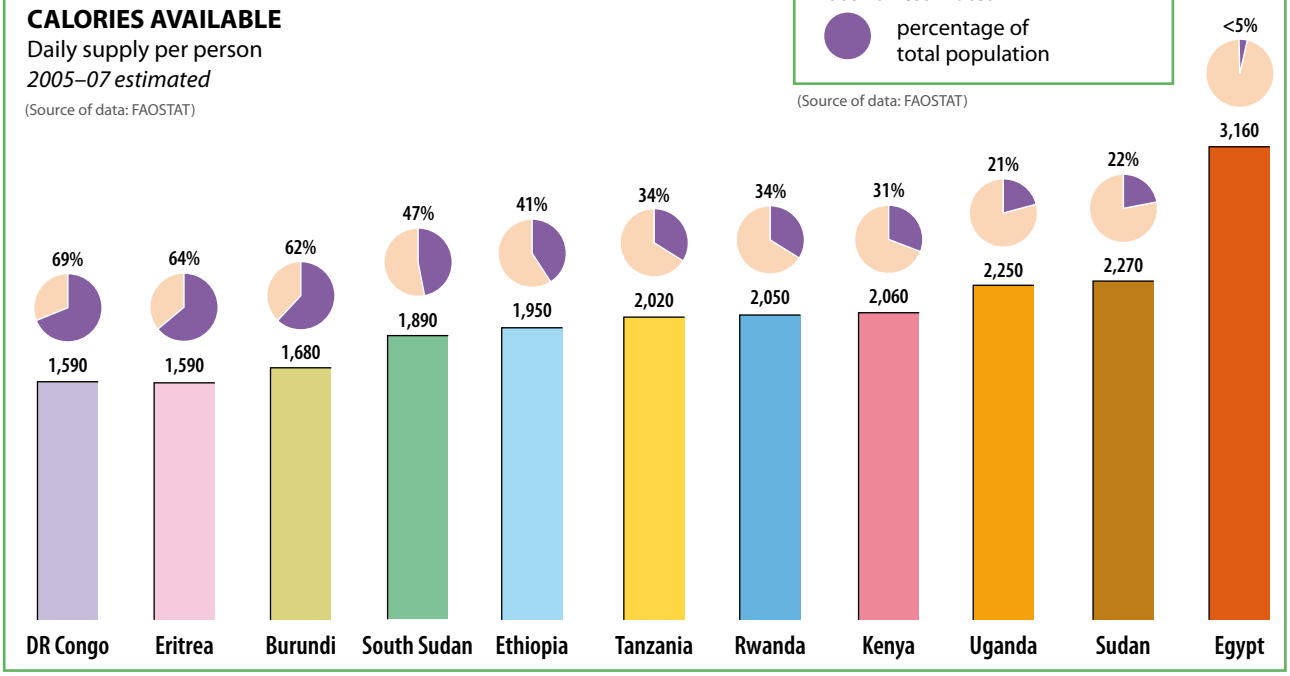
Organic produce is an emerging niche market that farmers in the Nile Basin could take advantage of to increase earnings from their farm produce. Organic farming is the form of agriculture that relies on techniques such as crop rotation, green manure, compost, and biological pest control. Organic farming uses fertilizers and pesticides but excludes or strictly limits the use of synthetic fertilizers, pesticides (which include herbicides, insecticides, and fungicides), plant growth regulators such as hormones, livestock antibiotics, food additives, genetically modified organisms, human sewage sludge, and nanomaterials. Many farmers in the Nile Basin operate 'low input' production systems due to the high cost/unavailability of agrochemicals, and so can relatively easily make the technical transition to organic production.

A diversity of organic crops are produced by the farmers in the basin, including bananas, coffee, cocoa, tea, fruits, cotton, sesame, cereals, oils, nuts, honey, vegetables, and sugar. The level of production per country is difficult to ascertain due to limited availability and/or absence of systematic organic agriculture data collection system(s) in the Nile Basin countries. The scanty available information indicates that in 2007 Uganda had an estimated 250,000 ha with 60,000 farmers under certified organic production, Kenya had 181,500 ha with 35,000 farmers, Tanzania had 85,000 ha with 55,000 farmers, and Ethiopia had 150,000 ha with 148,812 farmers.

The challenges faced by organic farmers include vigorous weeds, low soil fertility, uncertain water availability, high costs of international inspection and certification, consistently raising volumes to meet market orders, and limited extension services for organic agriculture.

UNDERNOURISHED
2005–07 estimated
percentage of total population
(Source of data: FAOSTAT)

CALORIES AVAILABLE
Daily supply per person
2005–07 estimated
(Source of data: FAOSTAT)



Food deficits and the challenge of feeding the region's poor

Food security, which refers to the availability of food and its accessibility to individuals, households, nations, and regions, is a major concern of the basin states. Despite the production levels shown above, all Nile countries, with the exception of Egypt, are unable to provide adequate nutrition to their population. Daily calorie availability per person in the Nile countries (except Egypt) is below the 3,000 kcal per person threshold that is taken to imply the absence of undernourishment in a nation. About 140 million people in the basin (or 34 per cent of the population of the basin states) are undernourished, with the level of severity varying from country to country.

The Global Hunger Index, which is an aggregate proxy indicator combining undernourishment, child malnutrition, and child mortality statistics, shows that the situation with respect to hunger in three Nile countries (Burundi, DR Congo, and Eritrea) is extremely alarming. The challenge of feeding the basin's population is expected to get even tougher in coming years as it grows, and as improvements in economic conditions introduce changes in lifestyle and diet.

Clearly the Nile countries must boost food production if they are to avert major food crises, which have the potential to erode and wipe out past gains in socio-economic development. Under certain circumstances, enhancing regional and global trade could offer an opportunity for addressing deficits in national food production and attaining food security. In the case of the Nile countries, however, food self-sufficiency has continued to decline and the number of undernourished people has continued to rise as household incomes remain inadequate to afford purchased food.

Much of the food consumed in the Nile Basin is produced within the basin boundaries. In fact, most food is still grown in close vicinity to its actual consumers. Only Egypt imports a sizeable proportion of its annual nutrition requirements. The rural and urban poor typically spend between 50 per cent and 80 per cent of their income on food, and failure to provide sufficient food items at affordable prices could further marginalize this group. Thus, expanding production within each country to keep pace with population growth is important for protecting this vulnerable group (short of subsidizing the price of imported staple foods).

CONSTRAINTS TO AGRICULTURAL PRODUCTION

A wide range of obstacles

Agricultural growth is critical to poverty reduction and national economic growth. Yet agriculture in the region remains a largely subsistence activity, and production has not kept pace with population growth. The performance of the agricultural sector is held back by numerous factors, some of which have been enumerated above. Until these constraints are removed, crop and livestock production in the region will remain low, and will impact adversely on food security and the competitiveness of agri-businesses.

Soil as a factor of agricultural production

The agricultural potential of the Nile basin depends on a number of factors, one of which is soil which, in turn, is influenced by factors such as geology and type of parent material. Soils developed by weathering from volcanic rocks (such as the Ethiopian Highlands, Jebel Marra in Sudan, and Mount Elgon in Uganda and Kenya) are potentially very fertile. Although large parts of the Nile Basin are underlain by sedimentary rocks or by Basement Complex igneous and metamorphic rocks, some 40 per cent is covered by geologically young deposits, mainly alluvial silts and clay, and Aeolian sands.

Field pattern of small land holdings in Rwanda.

MAIN BIO-PHYSICAL CONSTRAINING FACTORS

High dependency on rainfed agriculture: The overall majority of farmers in the Nile Basin rely on rainfed agriculture, which, in both crop and livestock systems, carries with it the risk of production failure. The high temporal variability of rainfall combined with degraded soils results in occasional moisture deficits during the planting season that leads to low yields or even crop failure. Farmers have become risk averse in this environment, and do not invest in inputs or grow high-yield varieties that are vulnerable to drought.

Widespread watershed degradation: Rapid population growth coupled with inappropriate environmental and agricultural management practices have led to serious soil erosion and land degradation in many areas. It is manifested by a reduction in the water retention of soils that results in less water being available during dry spells and the dry season, increasing the vulnerability of agriculture to weather uncertainties and drought.

Low soil fertility: In many parts of the basin, soils are deficient in nutrients that are critical for sustained high-crop yields. Land scarcity, because of a growing population, has resulted in yield-reducing land-use practices, such as more intensive use of land, shortening or absence of fallow periods, and abandonment of shifting cultivation. Very few farmers use external inputs such as inorganic fertilizers because of high costs and risk aversion. Nutrient depletion has led to soil exhaustion and very low soil fertility.

Prevalence of pests and disease: These cause considerable damage during production of both crops and livestock, and during storage and processing. 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.

Small land holdings: Limited access to land in some parts of the basin – particularly in the Ethiopian Highlands, around Lake Victoria, and in Rwanda and Burundi – have led to very small land holdings and inefficient agricultural practices. Land scarcity is also forcing farmers to occupy steep slopes that are in fact unfit for agricultural production.

Irregular irrigation water supply: Crop yields are reduced by improper or non-functioning irrigation scheduling that impedes the timely availability of water in some irrigation schemes.

MAIN INSTITUTIONAL AND ECONOMIC CONSTRAINING FACTORS

Unpredictable prices: This means that producers are unable to plan investments in agricultural production. High transport costs and the central role of the middleman leads to (very) big differences between retail and farm-gate prices, and prevents smallholders from benefiting from high retail prices. Occasional dumping of agricultural produce distorts local prices. The combination of these factors creates an environment that discourages farming for commercial purposes.

Poor physical infrastructure: The generally poor state of transportation infrastructure in most Nile countries – but in particular in rural areas during the rainy seasons – prevents farmers from selling their produce, and also increases the cost of inputs. Farm-gate prices and transportation losses are directly influenced by the state of the road network and distance to markets. In some cases, transportation costs are so high that market players refrain from farming or trading. Improvements in transportation networks have discernible knock-on effects on volumes traded, prices received, and food security, especially of poor households. The very low rural electrification rate and high electricity prices hinder agro-processing and value addition. There is an absence of storage facilities, leading to very low prices during harvest.

Insecure land tenure: Different countries in the Nile Basin have a variety of land tenure regimes that constrain productive use of land and long-term investments in soil and water conservation. Appropriate policies that promote security of land tenure – also for female farmers – are a pre-requisite for enhancing agricultural productivity and sustainable land management, and for fostering efficient land markets that can trigger structural transformation processes and attract investments in the agricultural sector.

Lack of agricultural credit facilities: The majority of farmers are poor and lack adequate access to the credit facilities needed to procure agricultural inputs. Even where agricultural credit is available, interest rates are very high and therefore prohibitive.

High cost and poor quality of inputs: Given the uncertainties involved in agricultural production and low farm-gate prices, investment in agricultural inputs does not make sense from an economic perspective. Increasing oil prices make fertilizer and transport more expensive. In recent years, this has been blamed for declining fertilizer application, and hence for low crop yields.

Weak and limited agricultural extension services: In many countries, agricultural extension and advisory services experience many operational and financial challenges and are unable to adequately serve the contemporary needs of farmers.

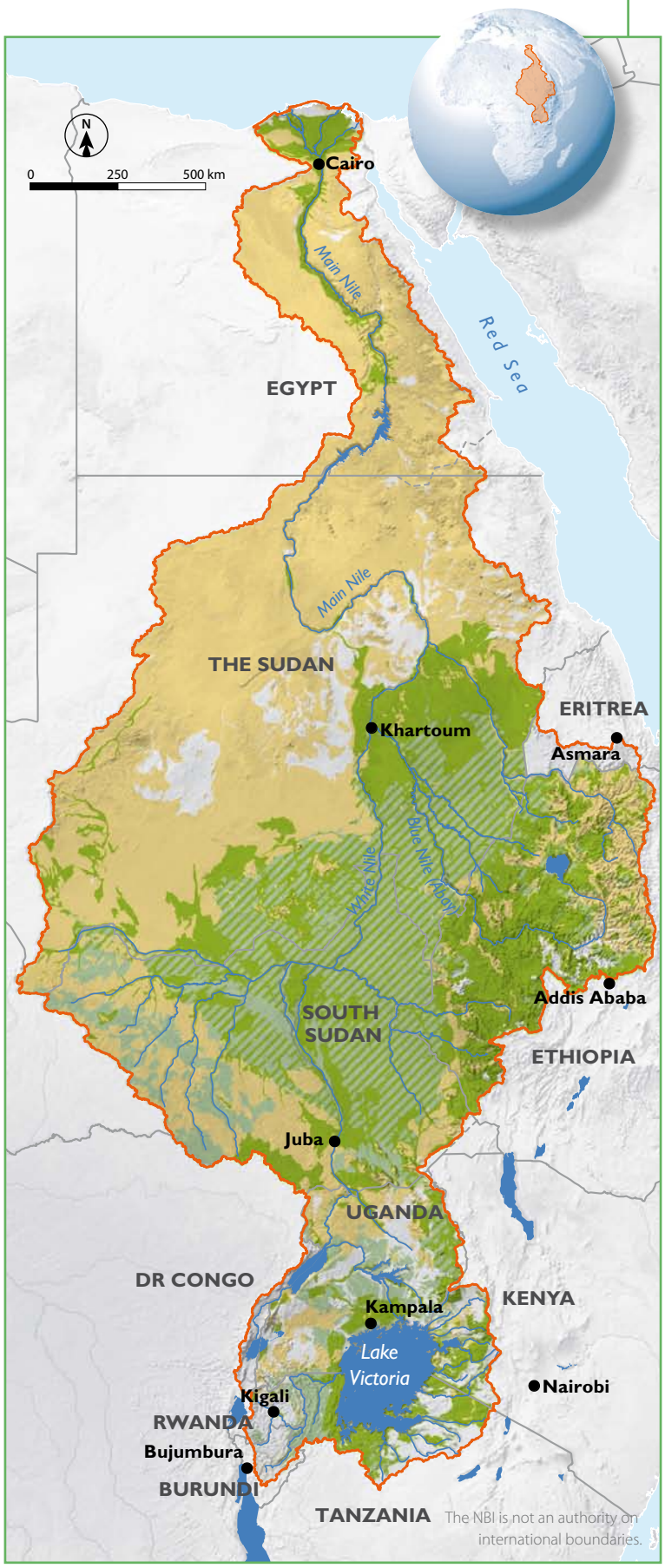
Insecurity: Conflict and insecurity impede farming and trading activities. A number of Nile countries have experienced periods of heightened insecurity and human conflict during the last 10 years.

Other constraining factors include: labour shortage during harvest because of urban drift of young people, insufficient know-how, high costs and poor quality of feed for livestock, low levels of mechanization, health issues (HIV, malaria, etc.), and many more.

There are 22 main soil types and nearly twice as many soil sub-types in the Nile Basin according to the FAO-UNESCO soil categorization scheme (*see map opposite*). The FAO-UNESCO scheme groups soils based on their intrinsic properties (namely soil morphology, behaviour, and genesis). The 22 soil types can be clustered into new groups reflecting differential potential to support agricultural production. Physical properties considered in soil productivity include clay content, soil permeability, infiltration capacity, soil moisture-holding capacity, and soil structural ability, while chemical attributes include soil organic matter, salinity, alkalinity, cation exchange capacity, and trace elements. The reader is referred to the literature for a detailed treatment of soil classification and productivity.

The soil map for the Nile Basin prepared on the basis of productivity (*see map right*) shows that soils with high potential for agricultural production are mainly found in five locations: the areas surrounding Lake Victoria; the Sudd and flood plains of the Bahr el Jabal and Bahr el Ghazal; the Ethiopian Highlands; the land at the confluence of the principal Nile tributaries (the area sandwiched between the While Nile, Blue Nile, and Atbara rivers); and the Nile Valley and Nile Delta in Egypt. The map also shows that soils with low potential to support productivity cover close to 50 per cent of the basin (mainly overlaying the arid and hyper-arid parts of the basin).

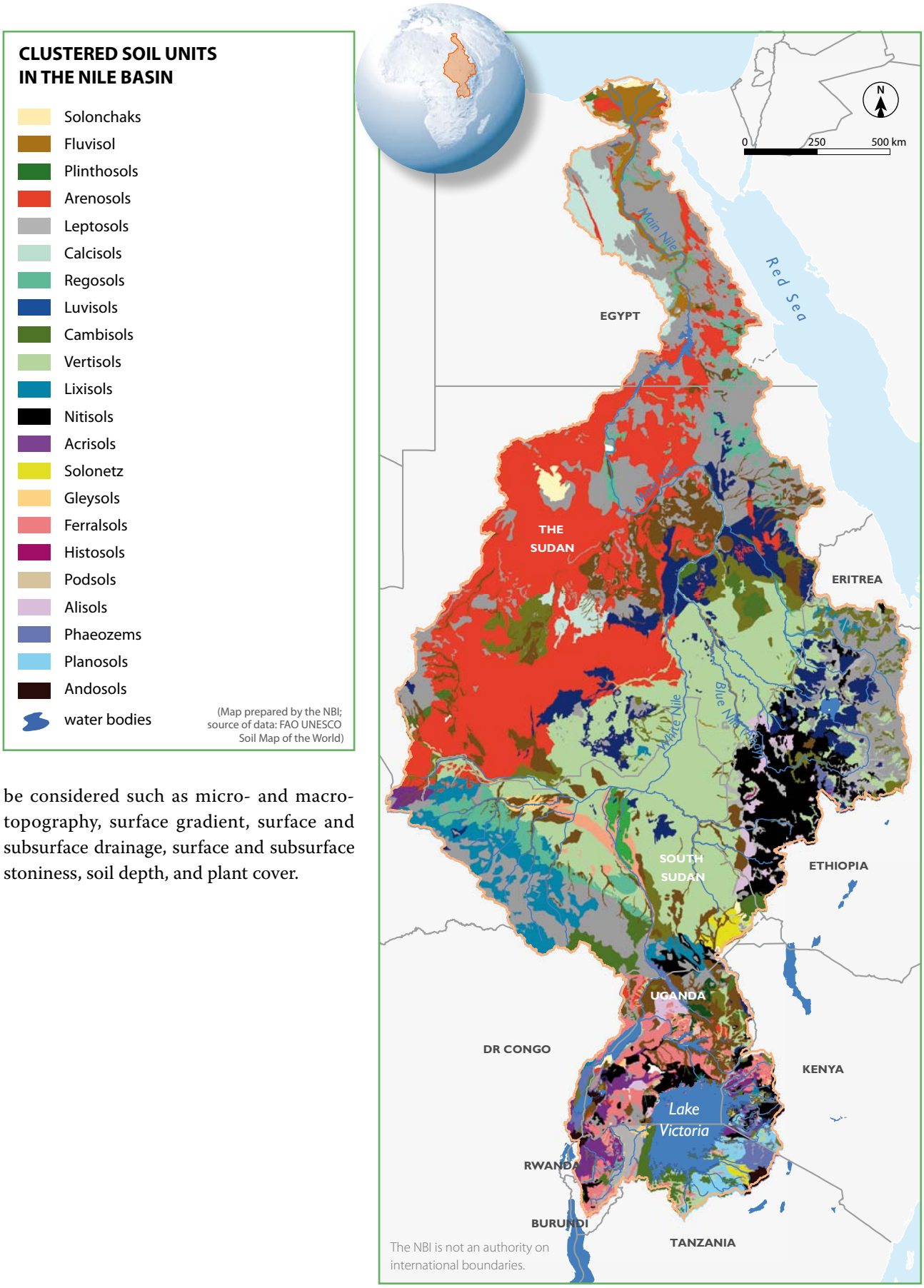
While the above approach provides a quick overview of soil suitability, it is unsuitable for use at local scales. For a more encompassing analysis of soil, additional factors must



POTENTIAL SOIL PRODUCTIVITY

- high
- moderate to high
- moderate
- low
- no data

(Map prepared by the NBI; source of data: FAO UNESCO Soil Map of the World)



be considered such as micro- and macro-topography, surface gradient, surface and subsurface drainage, surface and subsurface stoniness, soil depth, and plant cover.

AGRO-PROCESSING IN THE REGION

Adding value to agricultural products

Agro-processing, which refers to processing, preservation, and preparation of agricultural produce, post-harvest, for intermediary or final consumption, is of great importance to the region. Agro-processing increases the value of primary agricultural commodities, provides much-needed employment opportunities, creates predictable markets for raw agricultural produce, and is instrumental in reducing post-harvest losses. The output of this sector in the Nile Basin countries – apart from Egypt – is generally low. Indeed, it is mostly non-existent or very basic in rural areas in the upstream riparian countries.

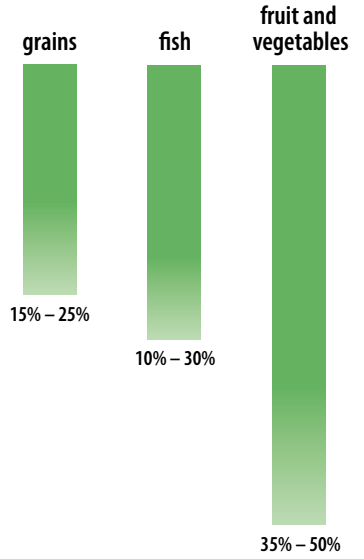
Given the large consumer base and the importance of agriculture in the Nile Basin, the potential of the agro-industrial sector is very significant and its development could constitute a key component for an effective agricultural modernization strategy. However, the sector is faced with multiple challenges that prevent realization of its full potential. Except for Egyptian firms, the majority of agribusinesses in the region face:

- high utility costs
- poor infrastructure (both transport and storage)
- high losses during transport from farm to factory
- inadequate and inconsistent supply of raw materials forcing them to operate at high excess capacities
- inappropriate or obsolete processing and ancillary equipment
- poor hygiene and sanitation practices
- low levels of vertical integration.

Due to the multiple constraints, abundant production during bumper seasons does not always translate to increased incomes for farmers. With high post-harvest losses, surpluses are often lost, while at the same time lack of storage creates gluts that exert a downward pressure on prices thereby reducing private-sector confidence in agricultural markets and commercialization.

POST-HARVEST PRODUCTION LOSSES
Estimated average loss
2012

(Source of data: African Development Bank Group)



Coffee farmers in Kasese, Uganda, dry beans they have collected.

Cleaning and filleting fish in a factory in Kampala. Fishing is a vital industry for Uganda, and the fish from Lake Victoria are exported all over the world as well as providing the staple local diet.

THE AGRO-INDUSTRIAL SECTOR IN THE NILE BASIN COUNTRIES

Burundi, DR Congo, Eritrea, Rwanda	Few processing industries of low-output volume for local markets; low vertical integration; public-private owned small operations; low level of technology relying on locally produced raw materials.
Egypt	Medium to large operations, medium- to high-volume output for local, regional, and international markets; medium to high vertical integration; 100 to 1,000 employees per factory in the delta and Nile valley, and more than 1,000 people in the reclaimed lands; level of mechanization is medium to high; majority privately owned, with a few public-sector entities; medium to advanced level of technology.
Kenya	Medium- to high-volume output for local, regional, and international markets, including disaster relief agencies; medium vertical integration; average of 500 factory workers; most operational inputs sourced locally. The textile industry is characterized by medium volume for principal domestic markets, and exports primarily to Uganda and Tanzania; privately owned. Although Kenya has the largest agro-processing sector in East Africa, few processing industries are located within the Kenya part of the Nile Basin.
Sudan and Ethiopia	The agro-industrial sector is characterized by low- to high-volume output for local, regional and international markets; low to medium vertical integration. In Ethiopia, food-processing leads the manufacturing sector in terms of establishments, employment, and market share.
Tanzania	Low- to medium-volume output for local and regional markets; low vertical integration; privately owned; small operations; level of technology varies in sophistication from automated processing machinery to manual tools. The horticultural industry is characterized by medium-volume output, exported primarily to Europe and South Africa, reliant on both large corporate-managed farms and networks of small out-grower farms, privately owned.
Uganda	Small- to medium-volume output for local and regional markets; low vertical integration; average of 150 factory workers; privately owned; small operation; medium level of technology reliant on locally produced raw materials. The floriculture industry is privately owned and has medium-volume output for local markets and export, and a medium level of technology.

AGRICULTURAL TRADE

The promise of regional agricultural trade

With a growing population and increasing calorie intake associated with rising prosperity, demand for food in the Nile Basin is set to increase rapidly. Natural resources and people are distributed unevenly across the region and, as discussed above, it is unlikely that all countries will be able to produce sufficient food to meet domestic demand. Therefore, they may have to rely to a lesser or greater extent on commercial food imports. Regional markets offer opportunities for exploiting economies of scale in production (and hence specialization) and economic efficiency through comparative advantage. Growing crops in the most favourable natural environments in the Nile Basin will improve water productivity, and reduce pressure on water resources.

Nile countries, however, have generally found it difficult to increase production to meet domestic demand. Without a sustainable food surplus in the Nile, very little intra-basin trade in agricultural produce can be expected, and the region will continue to be a net importer of food from the rest of the world. Such a situation will represent a lost opportunity for enhancing regional integration through trade. For trade to grow, production volumes have to increase substantially in countries with a potential surplus – such as Uganda – to make intra-basin trade of agricultural produce a viable proposition.

Regional trade organizations

The main thrust for promoting intraregional trade in the Nile Basin is through the East African Community (EAC) and Common Market for Eastern and Southern Africa (COMESA). With respect to livestock, the body responsible for transboundary livestock issues (mainly diseases/animal health) is the African Union Inter-African Bureau for Animal Resources (AU-IBAR). With the exception of Tanzania, all countries in the region are members of COMESA. In the spirit of the Cairo Declaration of 2005, COMESA has been actively pursuing a regional approach to food security by promoting infrastructure development and harmonization of policies to enable free flow of food staples from surplus to deficit areas driven primarily by price incentives and market forces. The gradual move towards fully functioning customs unions for East African Community (EAC) and COMESA promises to bring down tariffs and minimize non-tariff trade barriers (NTBs) relating largely to sanitary and phyto-sanitary standards, vehicle axle load and weight limits, insurance requirements, trade administration, suspended taxes, and rules of origin.

Tariffs in the basin have been drastically reduced under the EAC customs union and the COMESA/FTA, with the ultimate aim of reaching levels that pose minimal impediments to agricultural trade. Notwithstanding, a number of commodities still remain exempt from zero-rating and are thus subject to protection under various safeguard measures. The administration of the safeguard measures (for example

GENDER AND YOUTH DIMENSIONS IN CROSS-BORDER TRADE

There are some common features relating to gender and youth involvement in cross-border trade in the Nile region. These include:

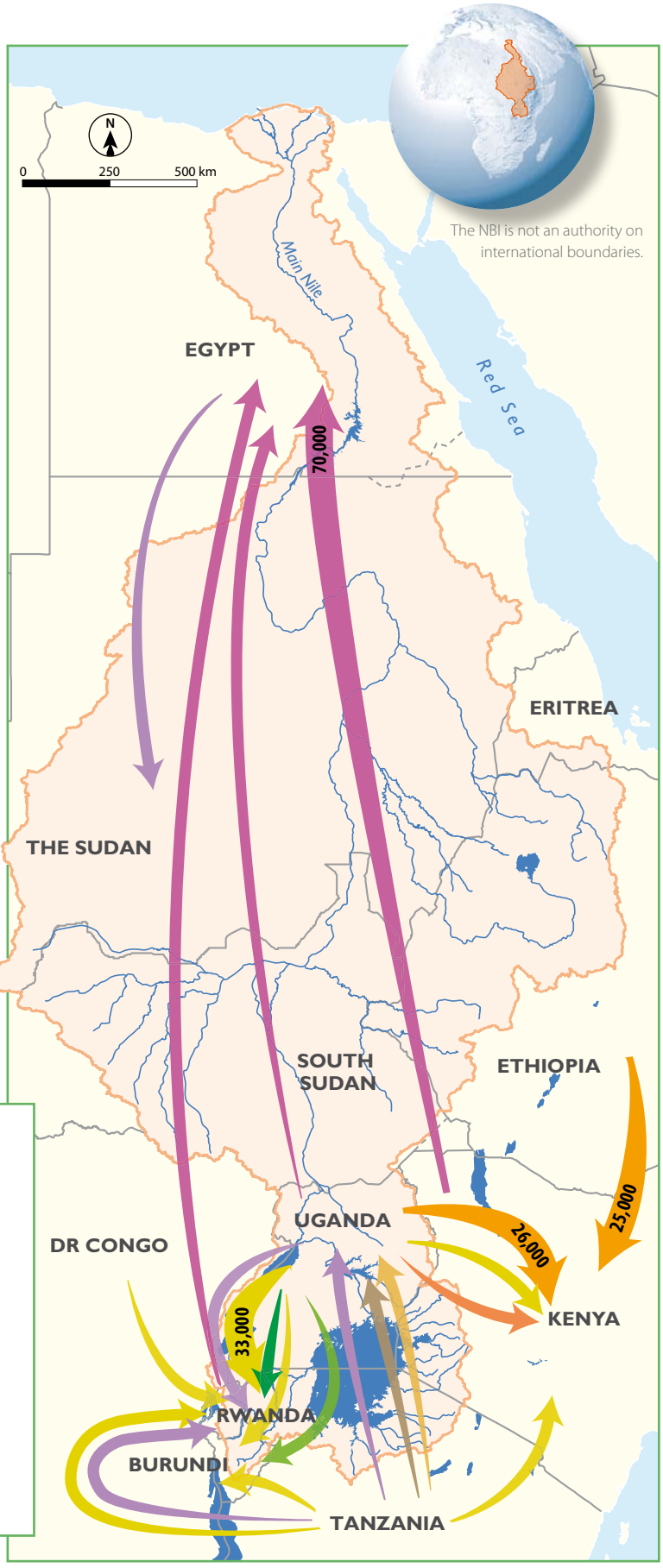
- Production of most crops is undertaken by both male and female farmers, with the proportion of males and females varying from crop to crop, and country to country.
- Young women constitute the largest proportion of informal traders in the grains and pulses corridors.
- Dry beans are generally a woman's commodity. Women also dominate the retailing business of fruits and vegetables in all markets in the upstream countries.
- Most youth traders do not own the businesses they run but are employed by older people.
- Brokers in most of the markets are mainly men.
- Women traders commonly suffer violence, threats, and sexual harassment from border officials and fellow traders.
- Lifting and short-distance transportation of commodities is done almost exclusively by male youths of 25–35 years due to the physical requirements of the job.
- In the livestock sub-sector, gender roles are very clearly defined. Grazing and watering of young livestock is carried out by young boys, young girls, and women, while tending to older stock is the work of young men. Selection of stock for sale, trekking to livestock markets, and selling off of livestock is almost exclusively done by men. Trading in cattle and camel is mostly done by men, while trading in goats and sheep is done by both women and men. Retailing of livestock products such as milk and skins is mostly done by women.

(Source: RATP 2012b)

those protecting the sugar industry in Kenya) is usually *ad hoc*, thus creating unnecessary risks and uncertainties for the private sector, and encouraging rent-seeking behaviour among public officials. Protectionist trade policies also cause price/efficiency distortions in the regional markets as well as avoidable inequalities in the domestic markets.

Regional trade corridors

Although trade volumes among Nile countries are small, trade is steadily growing, encouraged by the improving climate of regional policies, and simultaneous co-existence of pockets of surplus and demand in the region. The main trading activities take place in the upstream countries, where Uganda is the largest exporter. Intra-basin agricultural trade between the upper and lower Nile regions is virtually non-existent, save for exports of tea from Kenya, Rwanda, and Uganda to Egypt. This is partially explained by the Sahara desert and Sudd wetlands in the northern and central parts of the basin respectively, which act as natural barriers to movement of goods and people.



AGRICULTURAL TRADE
Between Nile Basin countries
2009
tonnes

- maize
- rice
- wheat
- dry beans
- groundnuts
- green beans
- soy beans
- sugar (refined)
- tea

1,000 – 24,999 tonnes

25,000 or more (number given)

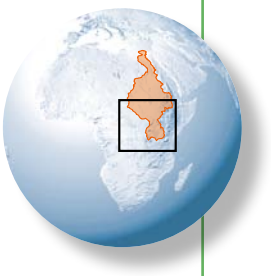
(Source of data: FAOSTAT)

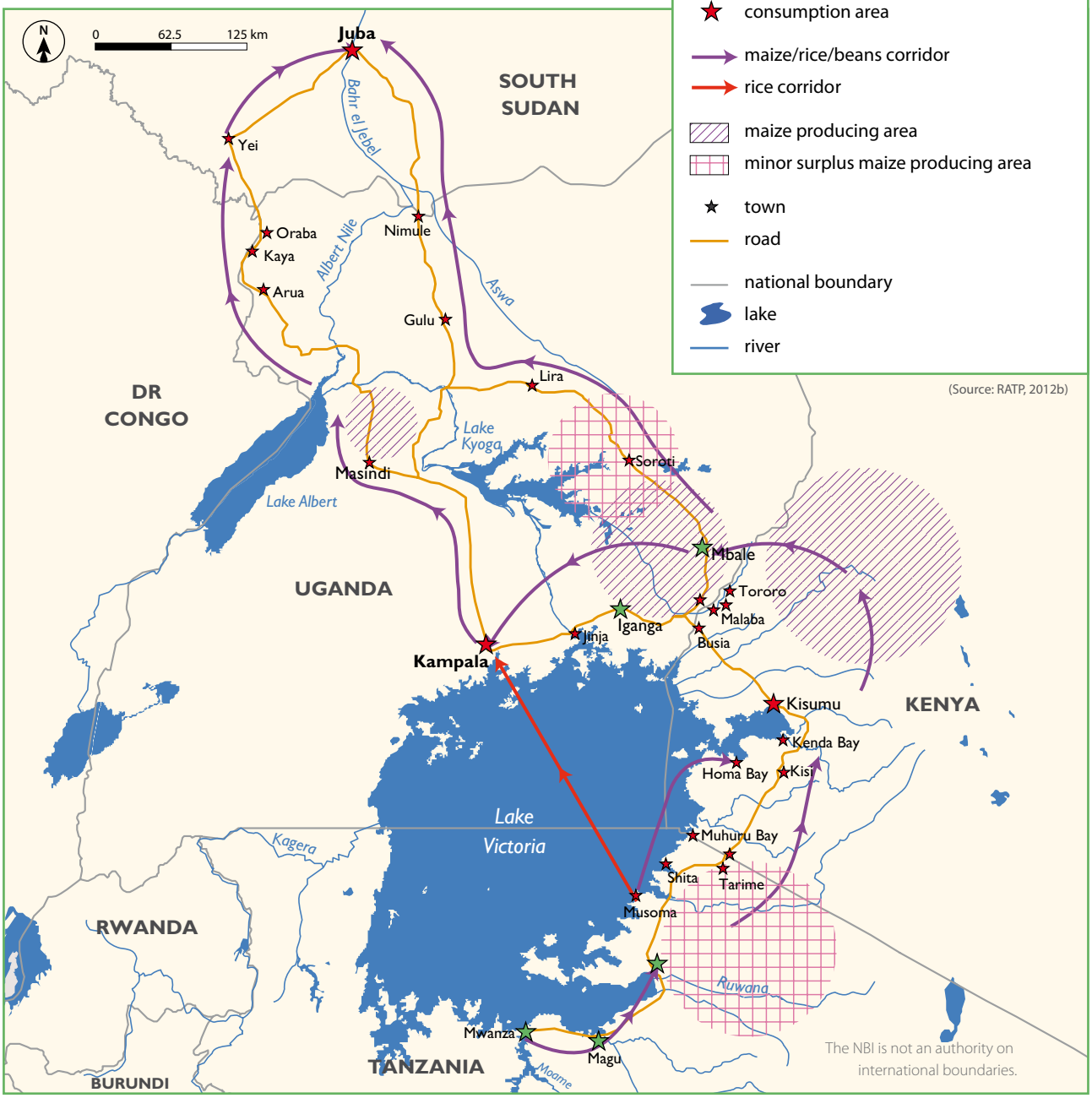
Some of the main trade corridors are:

South-to-central grain and pulses corridor: Begins in the Shinyanga region of northern Tanzania and covers three main borders: Tanzania/Kenya; Kenya/Uganda; and, Uganda/South Sudan.

Southwestern grain and pulses corridor: Begins in the region of Kigoma in Western Tanzania where a surplus maize and beans is produced, and connects with Burundi and DRC by land and lake.

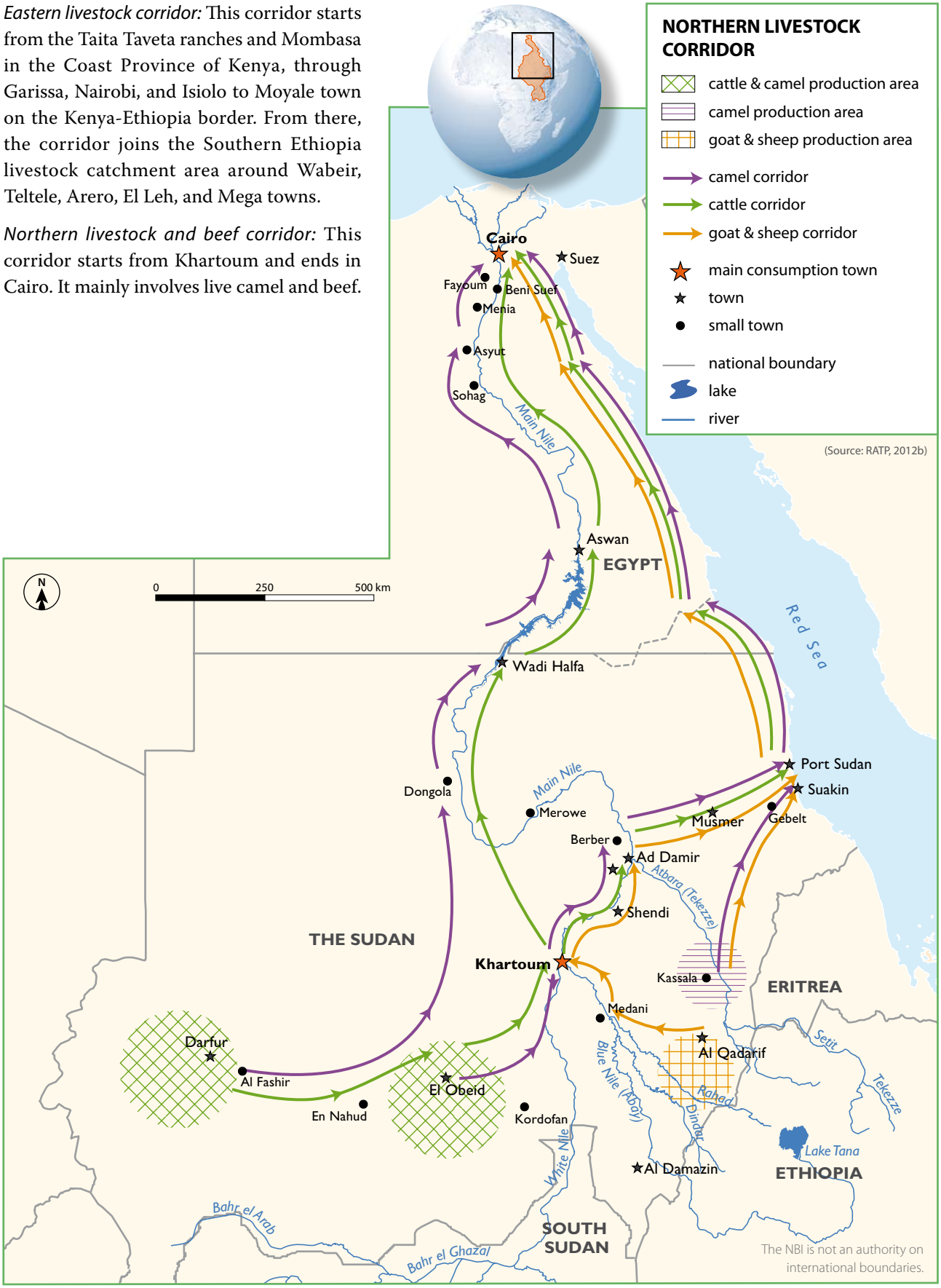
Southern fruits and vegetables corridor: Focuses on passion fruit, pineapple, banana, and Irish potatoes – stretching from Burundi, through Rwanda to Uganda, and finally to Kenya.





Eastern livestock corridor: This corridor starts from the Taita Taveta ranches and Mombasa in the Coast Province of Kenya, through Garissa, Nairobi, and Isiolo to Moyale town on the Kenya-Ethiopia border. From there, the corridor joins the Southern Ethiopia livestock catchment area around Wabeir, Teltele, Arero, El Leh, and Mega towns.

Northern livestock and beef corridor: This corridor starts from Khartoum and ends in Cairo. It mainly involves live camel and beef.



Water footprint of agricultural production

Under NBI's Regional Agricultural Trade and Productivity (RATP) Project, a number of studies were carried out on various aspects of agricultural production and trade in the basin. One of the studies examined the water footprint and comparative advantage of agricultural production in different parts of the basin, while another analyzed trade flows amongst Nile riparian countries and highlighted opportunities and constraints related to enhancing intra-basin trade in agricultural products.

The water footprint, which is an application of the virtual water concept, is a measure of the volume of freshwater used to produce a product, summed over the various steps of the production chain. The water footprint concept was used to assess comparative advantages in agricultural production in the Nile Basin. Characteristic features of the water footprint of food and cash crop production in the region are summarized below.

- Crop production in most upstream Nile countries has a relatively low water footprint due to reliance on rainfall (green water) for production. However, the water footprints are not as low as they could possibly be because of low yields.
- Crop production has a high water footprint in smallholder irrigation schemes in Sudan, and low footprint (comparable to the footprint of the cooler and wetter upstream countries) in large-scale commercial farms in Egypt and Sudan.
- Commonly, the country producing the highest quantity of a particular cash or food crop also has the lowest yields for that crop (high production is achieved by putting large areas of land under the crop).

The water footprint concept enables analysis of comparative advantages in agricultural production from a water-use efficiency and environmental sustainability perspective. For a holistic analysis, other factors that influence production behaviour and investment decisions need to be considered, such as availability of markets, produce prices, dietary preferences, and need by each country to attain some degree of self-sufficiency in staple foods.

Uganda is one of the largest producers of bananas in the region, but its yield for this crop could be improved, thereby decreasing its water footprint.

CHARACTERISTICS OF WATER FOOTPRINT FOR PRODUCTION OF SELECTED CROPS

Crop	Countries with lowest water footprint	Remarks
Maize	Uganda (rainfed) Ethiopia (rainfed) Egypt (irrigated)	Uganda is the only net maize exporter in the basin. Although located in a region of strong maize demand, Uganda is not properly using its comparative advantage in maize production to satisfy regional demand.
Wheat	Tanzania (rainfed) DR Congo (rainfed)	With the exception of Ethiopia, the water footprint for wheat production in the Nile countries is below the world average. The region therefore enjoys a comparative advantage in wheat production from the perspective of water and land use.
Rice	Egypt (irrigated) Rwanda (rainfed and irrigated)	The water footprint of rainfed rice (upland and lowland rainfed systems) is much higher than that of irrigated rice due to low yields in upstream countries. All Nile countries are net rice importers. There is an opportunity for enhancing intra-basin trade through exports of rice from Egypt to the other Nile Basin countries.
Bananas	Kenya (rainfed) Egypt (irrigated) The Sudan (irrigated)	The largest banana producers (Uganda, Tanzania, Burundi, and Rwanda) ironically have the lowest yields for the crop. This represents an opportunity for increasing productivity through increasing yields.
Mangoes	South Sudan (rainfed) DR Congo (rainfed)	Egypt, the largest mango producer in the basin, has the lowest productivity rates and a very high water footprint for the crop. Thousands of tons of mangoes go to waste each year in South Sudan and Uganda due to inadequate processing and preservation infrastructure. For enhancement of regional integration and more efficient use of Nile waters, this is one product that Egypt could import from the upstream countries.
Sugarcane	Tanzania (rainfed and irrigated) Ethiopia (rainfed and irrigated)	The Nile countries except for Kenya, Rwanda, and The Sudan have water footprints below the world average, highlighting the potential to produce for global markets.
Tea	Kenya (rainfed) Uganda (rainfed) Rwanda (rainfed)	The upstream countries have a comparative advantage in tea production due to high rainfall, good soil drainage, high altitude, and a cool climate conducive for tea growing. Export of tea represents high virtual water outflows from the region.

(Source: RATP, 2012a.)

Wheat production, Egypt

Tea production on the cooperatively owned Nshili-Kivu plantation in Rwanda.

Constraints to agricultural trade

A number of policy and regulatory measures have been introduced under the East African Community (EAC) and COMESA to harmonize trade and tax policies, eliminate trade barriers (including non-tariff barriers) and enhance access to information on regional and global trade opportunities. While the impacts of these reforms are begging to be felt, regional trade volumes are still low and trade still suffers from many constraints. Among the constraints, the rudimentary state of the region's rural infrastructure (transport, storage, power, telecommunication, market infrastructure) constitutes the single most limiting factor to cross-border trade. Other barriers include:

An overturned truck in South Sudan highlights the constraints poor infrastructure puts on cross-border trade.

- frequent government bans (on imports/exports)
- multiple and independent regulating institutions
- multiple fees
- lengthy process in obtaining trade permits
- differences in axle-load limit requirements
- many road blocks
- rent seeking, 'go-slow' tactics or harassment by officials
- selective application of regulations to discriminate against certain traders
- lack of market information centres
- lack of standardization in packaging.

Additional constraints in the livestock sector include:

- water and pasture deficits along livestock corridors (which affects body condition and hence market prices)
- multiple certification requirements (movement permits, vaccination certificates, trade licenses, etc)
- frequent disease outbreaks and quarantines
- lack of specialized trucks for livestock transportation
- insecurity in some livestock-producing regions.

The volume of unrecorded trade between Nile countries is considerable, especially with respect to cereals and livestock trade. A significant proportion of the trade in maize along the Tanzania/Kenya and Kenya/Uganda borders is unrecorded. Similarly, the cross-border trade in livestock between Kenya and Ethiopia and between Ethiopia and The Sudan is highly informal. On the other hand, the livestock trade between The Sudan and Egypt is formalized and properly recorded.

UNLOCKING THE POTENTIAL OF AGRICULTURE

Increasing allocations to agriculture

Realizing the full potential of agricultural production and trade will require generating surplus production in one or more Nile Basin countries, and creating conditions conducive to cross-border trade in agricultural products. Both of these conditions are currently absent from the basin. Many of the approximately 172 million people who reside within rural areas in the Nile Basin (the combined rural population for the Nile countries is 317 million) depend on agriculture for their nutrition and livelihoods. Therefore, for most of the Nile countries, strengthening the agricultural sector holds the key to national food security and poverty eradication.

> **" We, the Heads of State and Government of the African Union… resolve to… adopt sound policies for agricultural and rural development, and commit ourselves to allocating at least 10% of national budgetary resources for their implementation within five years."**
>
> ***Declaration on Agriculture and Food Security in Africa, Second Ordinary Session of the AU Assembly, Maputo, 10 to 12 July, 2003.***

To generate surplus production, it will be necessary to increase investments in the agricultural sector. Under the AU's New Partnership for Africa's Development (NEPAD) a Comprehensive African Agricultural Development Program (CAADP) has been developed as a blueprint for increasing investments to the agriculture sector. One of the key goals of CAADP is to increase allocations to agriculture to 10 per cent of national budgets (Maputo Declaration, 2003) so as to raise agricultural production by at least 6 per cent per year, thereby contributing to improvement in food security, enhancement of nutrition, and increase in rural incomes. Countries in the Nile Basin are in the process of aligning their medium-term plans (e.g. Kenya's Vision 2030 MTP, Uganda's Plan for Modernization of Agriculture, and Rwanda's Vision 2020) to the CAADP goals. Change, however, has been slow in coming, and by 2011 only Ethiopia had achieved the 10 per cent allocation to the agricultural sector.

The private sector looks set to play an important role in agricultural development in the basin. Seeing an opportunity to profit from recent world food-price hikes and strong demand for food, biofuels, and essential cash crops, an increasing number of foreign firms are showing interest in acquiring agricultural land in the basin. Most riparian governments have welcomed this initiative, viewing it as an opportunity to make productive use of idle land while at the same time increasing foreign direct investments to the agricultural sector, creating employment in rural areas, enhancing national food security and catalyzing economic growth. Land allocations to foreign investors have been sanctioned in all Nile countries except for Egypt, Burundi, and Eritrea. The total land leased in the Nile countries between 2000 and 2012 totals 11.1 million ha, with 91 per cent of leased land being accounted for by only three countries (Ethiopia, Sudan, and Tanzania). The leased land is being used to grow biofuels (mainly jatropha and croton), 'flex crops' (e.g. sugarcane, oil palm, maize, soya bean, castor oil) and other major commodities (e.g. rice, wheat, sorghum, and maize).

While there are undeniable benefits to be enjoyed from foreign direct investments in agriculture, there has been criticism over the secrecy surrounding land allocations, and the disregard for good environmental and social management practices. Moreover, the beneficial impacts of foreign direct investments have been disputed or downplayed. The impacts on employment creation are considered to be minor, as most ventures are capital-intensive and mechanized, while the impact on food security is subtle, as most of the produce is for export. The high environmental and social costs throw further doubt on the contributions to economic development. It has been argued that foreign land acquisition is a guise for capturing scarce freshwater resources. If this were to be true it would add one more twist to the already complex and sensitive issue of equitable utilization of the Nile waters.

Foreign direct investments play a positive role in the economies of developed western countries, and the Nile riparian countries can also benefit from such investment if they can put in place policies to guarantee that such inflows make a positive contribution. Among other things, policies must seek to regularize agricultural land acquisitions, and to ensure that environmental and social management practices are at the centre of agricultural project planning. Displaced persons must be adequately compensated, and harm to cultural assets, wildlife, or critical ecosystems avoided or mitigated.

A huge automated irrigation machine moves slowly over a potato plantation on reclaimed desert land outside Alexandria, Egypt.

Agricultural land expansion

The traditional response of most of the Nile riparians to the need to increase agricultural production has been to expand the area under agriculture. Over the last decade, while the productivity of rainfed agriculture has remained stagnant at mostly low levels, gross agricultural production has risen across the basin because more land has been taken into production. But the capacity for increasing agricultural production through expanding agricultural land is not elastic. Reserve arable land is quite limited in the Nile Basin, except in countries such as South Sudan, southwestern Ethiopia, and northern Uganda, where population densities are low. Therefore, in the long run, expansion of agricultural production through this approach will be constrained.

Irrigation development

Another common response to the widening gap between production and demand, also used to reduce the ever-increasing disruptive impact of climate change on production, has been to increase the area under irrigation. Some governments in the basin have already prepared irrigation master plans that put emphasis on irrigation development in particular and water infrastructure development in general. Despite this, the expansion in irrigated area within the Nile Basin in the near future is likely to be limited, considering the huge financial requirements for development of irrigation infrastructure and the finite and shared nature of Nile water resources. Thus, the present situation of dominance of rainfed agriculture in the upstream areas is likely to persist to 2030 and beyond, pointing to the importance of improving the performance of the rainfed sector, alongside investment in irrigation development and water infrastructure augmentation.

Rainwater harvesting

Yet another approach that is gaining in popularity is the promotion of rainwater harvesting for small-scale rainfed crop and livestock production. Water harvesting, which has not been part of the traditional drive for agricultural development in the region, is beginning to be mainstreamed in national agricultural and water development policies, and supported through the training of farmer associations, the preparation and dissemination of best-practice guides and design manuals, and the setting up of demonstrations on appropriate technologies.

Rainwater harvesting system in Nyanza District, Rwanda, part of the Strategic Plan for the Transformation of Agriculture, 2010, supported by IFAD.

Given that the overall expansion of the irrigation sector is constrained by water availability, it is clear that the use of water in irrigated agriculture will need to be made significantly more efficient. This is quite possible, considering the large gap in yield between large smallholder systems in Egypt and those in Sudan, and the still substantial share of crops with low water productivity in Egypt. In upstream countries, some irrigation will also have to shift to areas with a lower rainfall deficit during the growing season.

The situation in the rainfed sector is different, as the impact of rainfed cultivation on the overall water balance of the Nile is negligible. Evapotranspiration from cultivated land under rainfed conditions is close to that under natural conditions. Thus, there is no saving in water when arable land is not put under productive use because natural vegetation will still transfer to the atmosphere the same volume of water that the crops themselves would transfer. The constraints to expansion of rainfed agriculture are therefore more likely to be land limitation and need to sustain natural ecosystem functions.

Increasing production through a multidimensional approach

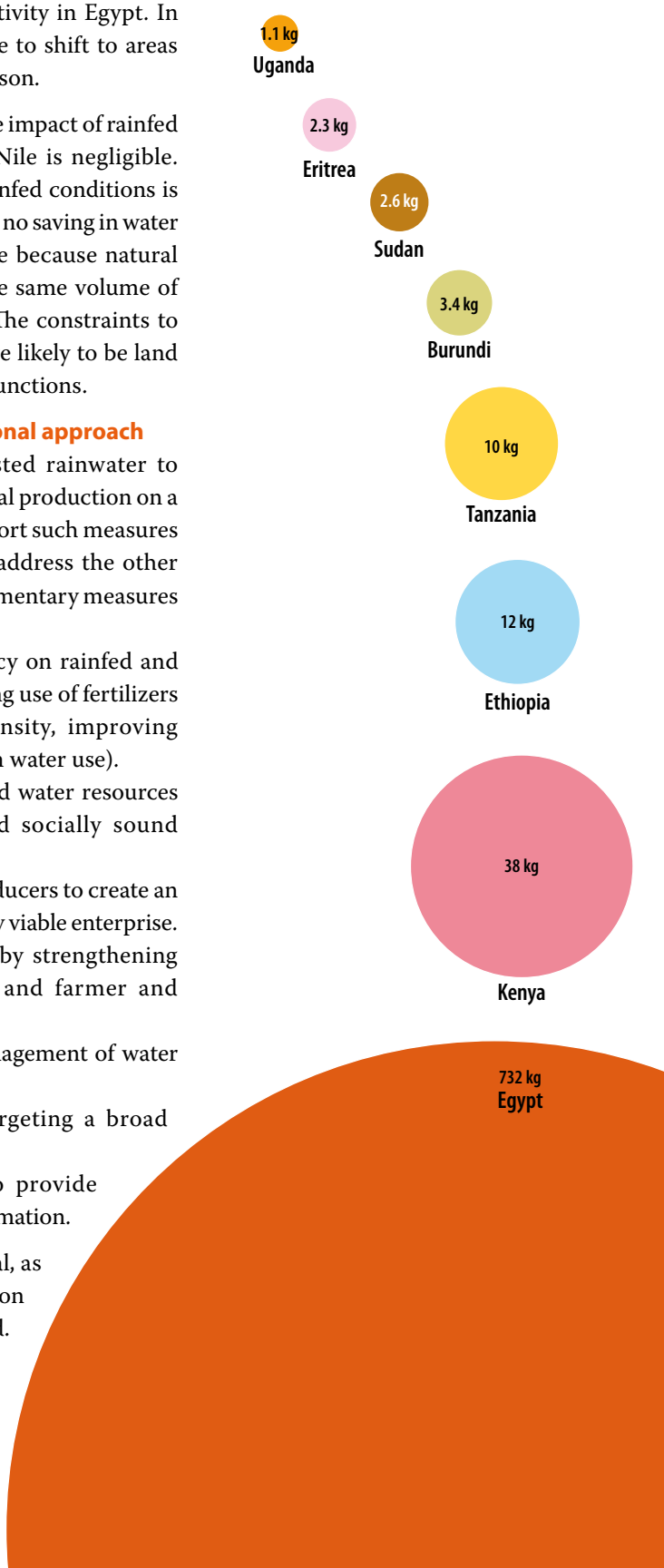
The response of providing irrigation or harvested rainwater to farmers is not sufficient by itself to boost agricultural production on a sustained basis. There is need to concurrently support such measures with parallel and complementary activities that address the other constraints to agricultural production. The complementary measures (not an exhaustive list) include:

- Increasing productivity and water use efficiency on rainfed and irrigated production systems (through promoting use of fertilizers and quality seeds, increasing cropping intensity, improving irrigation water conveyance, improving on-farm water use).
- Strengthening the implementation of integrated water resources management to ensure environmentally and socially sound agricultural irrigation development.
- Bolstering the pricing power of smallholder producers to create an environment in which farming is an economically viable enterprise.
- Promoting research and technology transfer by strengthening partnerships between research institutions and farmer and manufacturers.
- Increasing participation of stakeholders in management of water and irrigation facilities.
- Carrying out extensive capacity building targeting a broad spectrum of stakeholders.
- Establishing market information systems to provide producers and traders with updated market information.

Increasing the security of land tenure is also critical, as farmers will be reluctant to invest in soil conservation and water harvesting without controlling their land.

FERTILIZER CONSUMPTION
Kilogramme per hectare of arable land
2005

(Source of data: World Bank African Development Indicators)



GETTING MORE FROM THE SOIL

> **"I have worked with small-scale farmers in Kawanda whose farm banana yields have increased from five to 50 tonnes from a hectare of land … I do not tell them what to do. They come and we work together on my small farm. They then carry the same message home. There is probably nothing else that is taken for granted like the soil."**
>
> ***Professor Julius Zaake, Faculty of Agriculture, Makerere University***

The productivity of smallholder rainfed agriculture is very low in many parts of the Nile Basin. The reasons for this are complex and site-specific, and related both to the natural resource base and to factors such as insecure land tenure, low farm-gate prices, or insufficient support from extension services.

Prof Julius Zaake, from the Faculty of Agriculture, Makerere University, has demonstrated that yields in the Lake Victoria zone in Uganda can increase tenfold by simple soil management practices. On his farm close to Kawanda he uses a combination of organic and inorganic methods to restore soil fertility. Small trenches trap water in the soil, which helps to irrigate the crops and curtail soil erosion. Mulching protects the soil and aids the process by which nutrients are recycled in the soil. Compost and a limited amount of chemical fertilizer are added to improve soil nutrients.

Soil exhaustion is serious and widespread in Uganda. According to Prof Zaake, farmers deplete 1.2% soil nutrients every year and use fertilizers at a rate of 0.31% per year. Years of cultivation has depleted the soil, leading to poor harvests.

Many farmers around Kawanda have now realized the importance of soil management to increase agricultural productivity and improve their livelihood.

The private sector will be expected to play a critical role in filling the vacuum created by the withdrawal of the public sector from the provision of agricultural services relating to extension, veterinary medicines, and artificial insemination, input distribution, credit and marketing. In order to provide these services effectively, the private-sector institutions need both the enabling environment and private–public partnerships. The latter are already in fledgling stages in countries such as Kenya. The Nile region already hosts private-sector initiatives such as the regional commodity groups that lobby for trade-policy reforms for selected agricultural commodities. The main commodity groups are the East African Grain Council (EAGC) and Horticultural Council of Africa (HCA).

Enhancing adaptation of rainfed agriculture to climate change

Climate variability and change impacts agriculture through changes in the amount and frequency of rainfall, changes in temperature levels, and alteration in seasonal patterns. Both rainfed and irrigated systems are affected, with impacts on the former being significantly greater. Intense rainfall during planting seasons has the potential to damage seedlings, reduce growth, and provide conditions that promote plant pests and diseases. Prolonged dry seasons, warmer temperatures, and greater evaporation, on the other hand, have the potential to induce plant stress, increase pest proliferation, and reduce yields.

Farmers in the Nile Basin using rainfed farming systems have for thousands of years had to contend with the problem of variable climate and have devised numerous way of coping with it. Usually, small-scale farmers maintain crop diversity as a way of maximizing output and ensuring protection against climatic risks. Traditional practice favours mixed farming, with livestock and poultry kept by most households alongside crops as a way of minimizing risks. Farmers traditionally try to ensure household food security by drying foodstuffs and storing them in granaries, baskets, and other containers. Also, farmers grow food crops that can stay in their gardens for long periods, especially tubers such as cassava, sweet potatoes, and yams. In times of acute food shortage, communities collect wild berries, leaves, and tubers to supplement dwindling food reserves.

Pastoral livestock production systems in the Nile Basin are probably the most vulnerable to climate-change impacts, particularly in the large swathes of Kenya, Ethiopia, Sudan, and Tanzania. Traditional pastoralists cope with climate vagaries through annual migration with livestock (a source of cross-border tension in some areas) and keeping livestock such as camel that can go for many days without water.

Modern practices and technologies that could increase the resilience of rainfed farmers to climate variability and change include:

- Improving soil cover and establishing water harvesting structures to reduce soil erosion, maintain soil moisture and improve soil.
- Careful choice of plant and animal breeds, with emphasis on early maturing, and on drought-tolerant and disease-tolerant varieties.
- Adoption of appropriate small-scale irrigation.

Impacts of agriculture on the environment

Agriculture is among the sectors responsible for environmental degradation in the Nile Basin through alteration, fragmentation, and destruction of natural habitats, spread of pests and diseases, pollution of surface and groundwater sources, and exposure of land to soil erosion (see Chapter 3). Efforts to expand agriculture production need to mainstream good environmental management practices to minimize damage to the already fragile Nile ecosystems.

A farmer in Nyamarobyo, Uganda, putting potatoes in a storage shed.

KENYA – INCREASING RESILIENCE TO CLIMATE CHANGE

The Nile countries are at various stages of formulating and introducing measures to improve the resilience of the agricultural sector to the impacts of climate change. Adaptation measures for the agriculture and livestock sector in Kenya, which serves as an example of the changes being introduced in Sub-Saharan Africa, include:

Expanding water harvesting: Kenya has launched a Water Harvesting Program in the arid and semi-arid parts of the country to stabilize livestock-based economies while promoting diversification of livelihoods though increased crop production. Under the Program, about 500 water-harvesting structures (mainly water pans and dams) with an average capacity of 20,000 m^3 will be constructed using modalities such as constituency-based Water Harvesting Projects.

The promotion of climate-smart agriculture: The development of a policy on Conservation Agriculture With Trees (CAWT) is being fast-tracked as a strategy for soil-fertility improvement and climate-change mitigation and adaptation. Implementation of an earlier policy on Agriculture (Farm Forestry) Rules 2009 helped to increase national tree cover from 2% to 5.9%. The target for the new policy is 10% cover.

Focusing on food security: a number of projects have been initiated. The notable one are:

- *High value Traditional Crops (HVTCP)* – improving food security through provision of drought-tolerant and early-maturing seed varieties to farmers in semi-arid areas of the country.
- *National Accelerated Agricultural Inputs Access Project (NAAIAP)* – supplying farm inputs to vulnerable farmers at subsidized prices to improve productivity and reduce reliance on relief food supply.
- *Njaa Marufuku Kenya (NMK)* – supporting farmers' groups improve livelihoods under MDGs.
- *National Small Scale Horticultural Project (NSSHP)* – helping farmers in traditional horticultural districts improve production through irrigation.

Source: Ministry of Agriculture, Kenya.

NBI'S SUPPORT TO AGRICULTURAL SECTOR

The NBI has implemented the Efficient Water Use for Agricultural Production (EWUAP) Project under the Shared Vision Program (SVP) – a first step in bringing together a broad range of stakeholders from the basin to develop a common vision on water availability and efficient water use for agricultural production. The project carried out capacity building focusing on enhancing basin-wide agricultural water-management capacities, and provided a sound concept and practical basis (through best-practice manuals and guidelines) for the riparian countries to increase use of water in agriculture.

The EWUAP was followed by the Regional Agricultural Trade and Productivity (RATP) project under NELSAP, which further enhanced the knowledge base for policy making on efficient water use focusing on comparative advantage in production in different parts of the basin, and enhancement of trade flows between Nile riparian countries.

Under NELSAP's river basin management projects, a number of feasibility studies are being conducted on proposed small-scale irrigation projects located around Lake Victoria and the Aswa sub-basin. These projects, if deemed feasible, will incorporate best practices for efficient water use identified under EWUAP, as well as sound environmental and social management practices that have become an integral part of project preparation under NBI's Subsidiary Action Programs (SAPs).

CONCLUSIONS AND RECOMMENDATIONS

About 317 million people in the Nile Basin countries and 172 million within the basin itself reside in rural areas and depend mainly on agriculture for their nutrition and livelihoods. Growth of agricultural production is, therefore, key to food security and poverty reduction yet it remains a largely subsistence activity, with production lagging behind population growth. As local production of food falls short of local demand, the basin countries are net importers of food. A considerable proportion of the basin population, do not, however, receive sufficient nourishment.

There are two broad types of production systems in the Nile Basin: rainfed crop and livestock production systems, and irrigated agriculture. The former is vulnerable to impacts of climate variability and change, and is characterized by subsistence production, and low inputs and yields. The latter, especially on a commercial scale, has high productivity and improved water-use efficiency, but there are a number of schemes in the basin where yields are still low.

Intra-basin trade in agricultural products has the potential to promote rural development, enhance regional food security and foster regional integration. However, trade volumes in primary agricultural commodities between Nile Basin countries are low because none of the riparian countries produces sufficient surplus to sustain high-volume intra-basin trade. The opportunity for enhancement of regional

Farmers irrigate rice paddies with water from the Buswahili Dam, in Buswahili town, northeast of Musoma, Tanzania.

integration through trade therefore remains largely unutilized, despite the improving climate for regional trade brought about by the creation of regional trade bodies such as EAC and COMESA.

To produce sufficient food to feed the basin population and generate surplus for regional trade and enhancement of rural household incomes, it is recommended that the Nile countries implement a coordinated set of measures targeting the multiple constraints affecting the agricultural production sector, which include:

- floods and failing rains
- vigorous weeds
- high disease and pest prevalence
- high cost of farm inputs such as fertilizer and pesticides
- high post-harvest losses
- weak extension services
- lack of credit
- inadequate information on market opportunities.

The present dominance of smallholder rainfed subsistence farming in the upper riparian countries is likely to persist to 2030 and beyond. It is therefore important to improve the productivity of this farming system to be able to improve rural livelihoods and enhance national and regional food security.

From a water-management perspective, the important interventions should include:

- Increasing investment in irrigation development in the Nile countries. In the downstream countries, this should focus on improving water-use efficiency, while in the upstream countries it should focus on improving efficiency of existing irrigation systems and expanding the land under irrigation.
- Improving scheme management and agricultural productivity in the large smallholder irrigation schemes in the downstream countries so as to triple agricultural production without additional water demands.
- Increasing investment in rainwater harvesting and small-scale irrigation in upstream countries to increase the resilience of rainfed agriculture to climate-related shocks.
- Increasing investment in watershed management in upstream countries to reduce soil erosion and to increase water availability, especially in mixed highland smallholder subsistence farming systems.

As production rises and agricultural commodity trade within the region continues to benefit from progressive reduction in tariffs, the struggle to increase trade should shift to deal with the many non-tariff barriers between countries.