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Demand for products of irrigated agriculture in sub-Saharan Africa

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Demand for products of irrigated agriculture in sub-Saharan Africa

FAO WATER REPORTS

31

by

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Preface

This publication arose from FAO's contribution to a collaborative programme by international organizations (AfDB, FAO, IFAD, IWMI and the World Bank). The programme is entitled "Investment in agricultural water management in Sub-Saharan Africa: Diagnosis of Trends and Opportunities"

The programme comprises a set of component studies that form the basis of a Synthetic report (Volume I) to be compiled by a designated working group representing the five organisations. The component studies are:

Volume II	Regional demand for products of irrigation agriculture.
Volume III	Irrigation development and planning and implementation.
Volume IV	Analysis of irrigation investment performance and costs.
Volume V	Private sector participation.
Volume VI	Environmental and health impacts.
Volume VII	Assessment of food supply and demand using a 'Watersim' model.
Volume VIII	Poverty reduction.
Volume IX	Water-livestock-crop production.

FAO's contribution to the collaborative programme is Volume II which is now presented here as an FAO Water Report.

The publication is primarily targeted at agriculture policy makers and managers, prompting them to review the economic basis for new investment in agricultural water management.

Much has been written about the performance of irrigated agriculture in sub-Saharan Africa, but usually from the standpoint of supply of hydraulic infrastructure and institutions. Very little attention has been paid to an examination of the 'pull factors'. This report attempts to redress the balance.

List of acronyms

ACP	African, Caribbean and Pacific
AGOA	African Growth and Opportunity Act
AoA	Agreement on Agriculture
CP	Collaborative Programme
EBA	Everything but arms
EC	European Community
GATT	General Agreement on Tariffs and Trade
GDP	Gross domestic product
GIS	Geographical information system
GSP	Generalized System of Tariff Preferences
IFAD	International Fund for Agricultural Development
IFI	International financial institution
IFPRI	International Food Policy Research Institute
IMF	International Monetary Fund
IWMI	International Water Management Institute
IWR	Irrigation water requirement
LDC	Least developed country
MFA	Multifibre Arrangement
MFN	Most favoured nation
NGO	Non-governmental organization
O&M	Operation and maintenance
SACU	Southern African Customs Union
SSA	Sub-Saharan Africa
SSR	Self-sufficiency ratio
SUA	Supply and utilization account
WTO	World Trade Organization

Chapter 1
Introduction

BACKGROUND

Investment in agricultural water development in sub-Saharan Africa has declined in the past two decades. The main reason for this decline is thought to be the consequence of concerns over the disappointing performance of past investments in terms of: (i) returns to investment; and (ii) sustainability. However, the production problem remains. Rainfed agricultural production in sub-Saharan Africa is still highly volatile and only the interseasonal and interannual management of water offers a means of buffering regional production shortfalls. Beyond this, the concentration of inputs around irrigated production offers a means to service specific export-market demand. Sustained investment in both rainfed and irrigated production is necessary, but approaches and patterns of investment will have to innovate in order to overcome the disappointments of the past. The analysis attempts to quantify how much of this production shortfall could be met by irrigated production and is based on projections derived from the analysis prepared for *World agriculture towards 2015/2030: an FAO perspective* (FAO, 2003).

Five international organizations – the African Development Bank, FAO, International Fund for Agricultural Development (IFAD), International Water Management Institute (IWMI) and the World Bank – have agreed to collaborate in a joint review of experience in agricultural water development in the region to date in order to identify generic lessons for application in strategies and programmes of future support to the sector. The primary intention is that the initiative will enable the five agencies concerned to improve the quality of their assistance to governments but it is also intended to have a catalytic effect on associated bilateral donors. The review is to be carried out by means of a series of desk and case studies, the results of which will be validated at a regional stakeholder consultation.

The range of the study comprises a set of component studies that will form the basis of a Synthesis report (Volume I) to be compiled by a designated working group representing the five organizations. The component studies cover the following areas:

Volume II	Regional demand for products of irrigation agriculture.
Volume III	Irrigation development and planning and implementation.
Volume IV	Analysis of irrigation investment performance and costs.
Volume V	Private sector participation.
Volume VI	Environmental and health impacts.
Volume VII	Assessment of food supply and demand using a ‘Watersim’ model.
Volume VIII	Poverty reduction.
Volume IX	Water-livestock-crop production.

This document is concerned with the first component study (Volume II), responsibility for which was assigned to FAO.

STRUCTURE OF REPORT

Chapter 2 of this report establishes some regional parameters for irrigated production and is intended to show that confirming demand for irrigation development is a much more complicated affair than merely matching natural and human resources potential with food self-sufficiency targets. Therefore, this study has had to adopt a much broader to irrigated production. Chapter 3 provides information on data sources and methodologies. Chapter 4 presents the baseline obtaining in the period 1997–99. It presents a statistical analysis of the demand, supply and scope for increased irrigated production, expressed *inter alia* in terms of: (i) self-sufficiency ratios (SSRs) for a range of commodity groups; (ii) water and land resources; (iii) current irrigation; and (iv) reported yields under irrigation for a wide range of crops and locations. Chapter 5 continues the discussion from Chapter 4 and sets the scene for the remainder of the document by examining the impacts of irrigation in terms of the potential marketing and processing advantages and social benefits afforded by it. It also sounds a note of caution with respect to rainfed farmers and the victims of ill-conceived institutional arrangements and the "hidden" environmental costs of poorly planned or managed irrigation. Chapter 6 examines the issue of yield growth and the implications for the natural resource base. Chapter 7 reviews relevant international agreements before presenting an analysis of the broad market prospects for the main cropping groups. It then focuses on the scope for regional and intraregional trade in maize, wheat and rice, which are considered to be the crops for which an irrigation-oriented approach to increased production may be justified. However, it does also point to the need for higher value second crops if the investments are to become profitable. Finally, Chapter 7 makes a plea for an appropriate irrigation sector response. Chapter 8 presents the key conclusions and recommendations.

Chapter 2
Irrigation in the context of sub-Saharan Africa

DEFINITONS OF IRRIGATION

Formal irrigation constitutes only a part of the agricultural systems in sub-Saharan Africa and this study adopts a broader definition of “agricultural water management” to reflect the overall contribution of water management to agriculture. To this end, FAO has developed a typology (Annex 1) for all kinds of agricultural water management. This typology is used as the template for data contained in a comprehensive and regularly updated FAO database – AQUASTAT (http://www.fao.org). AQUASTAT compiles data on land areas upon which water is added and/or managed in order to allow or improve agricultural production. The level of management and control of the water may vary greatly according to the agricultural water management types involved. The FAO typology has proved robust when applied across a range of differing countries and, for the sake of consistency, it has been adopted for the purpose of this exercise as presented in Table 1.

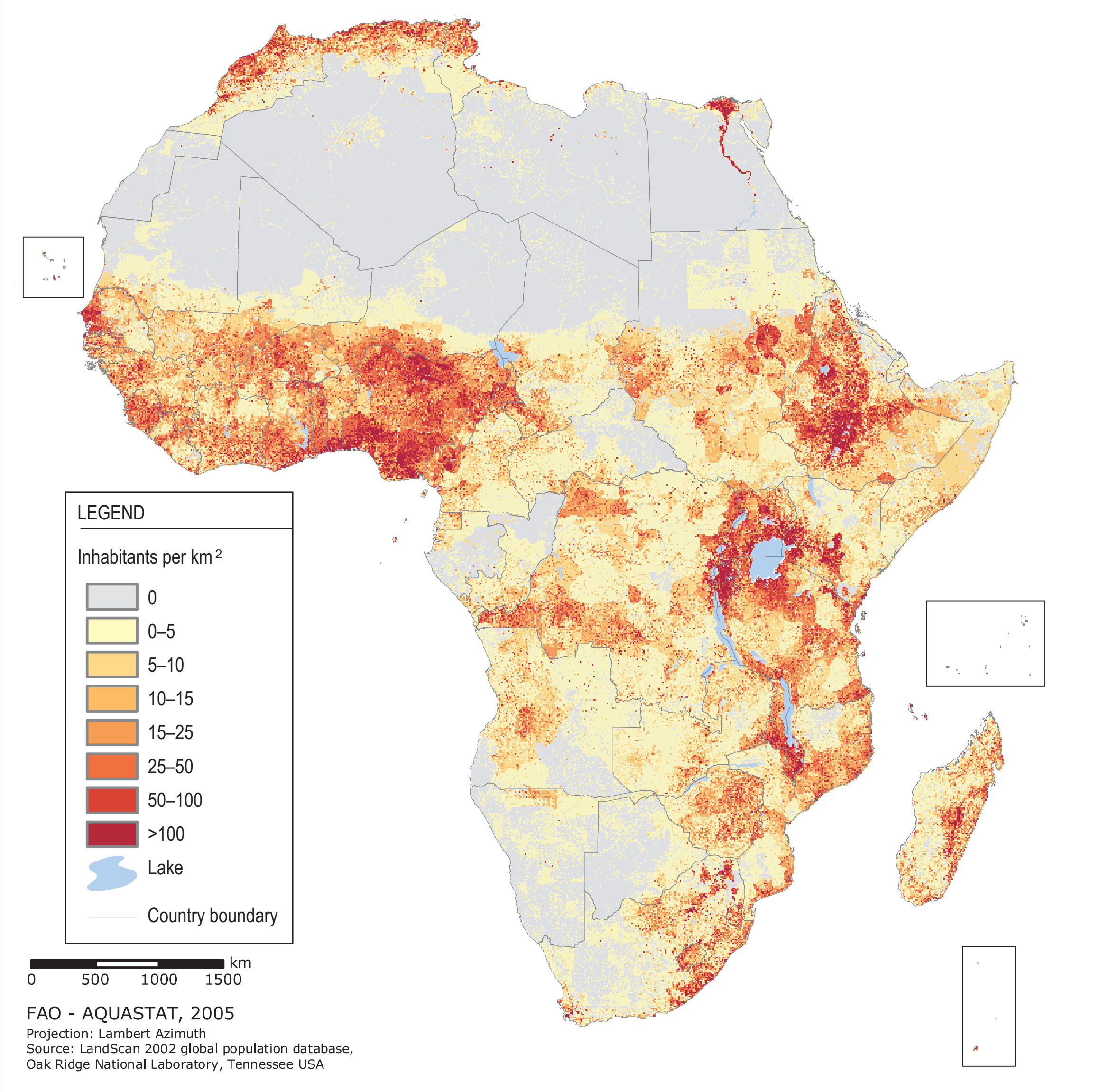
THE REGIONAL CONTEXT

This paper examines the scope for meeting future demand for agricultural products in sub-Saharan Africa through increases in irrigated output. At the outset, in order to establish the relative context, Figures 1 and 2 show, respectively, the population density and the irrigation density in Africa as at 2002. Figures 1 and 2 indicate how rainfed agriculture and transport access underpin human settlement in sub-Saharan Africa. They

TABLE 1
A working template for the FAO area under agricultural water management typology

	COUNTRY OR REGION TOTALS			
AREA UNDER AGRICULTURAL WATER MANAGEMENT>	a+b+c+d+e+f+g+h+i			
AREA EQUIPPED FOR IRRIGATION>	a+b+c+d+e+f+g			
Area equipped for full control irrigation	a+b+c			
Surface	a			
Sprinkler	b			
Localized	c			
Area under spate irrigation		d		
Area of equipped lowlands			e+f+g	
Equipped wetlands and inland valley bottoms			e	
Equipped flood recession			f	
Other			g	
Area with other forms of agricultural water management				h+ i
Non-equipped cultivated wetlands and inland valley bottoms				h
Non-equipped flood recession				i

FIGURE 1
Population density in Africa, 2002



Source: Landscan, 2002 Global Population Database.

also indicate where demand for intensive agricultural production can be anticipated, particularly in order to supply rapidly growing urban populations in countries such as Nigeria. However, with the exceptions of Madagascar and South Africa and central Sudan, there is no strong spatial link between population and irrigated production. What is irrigated in sub-Saharan Africa?

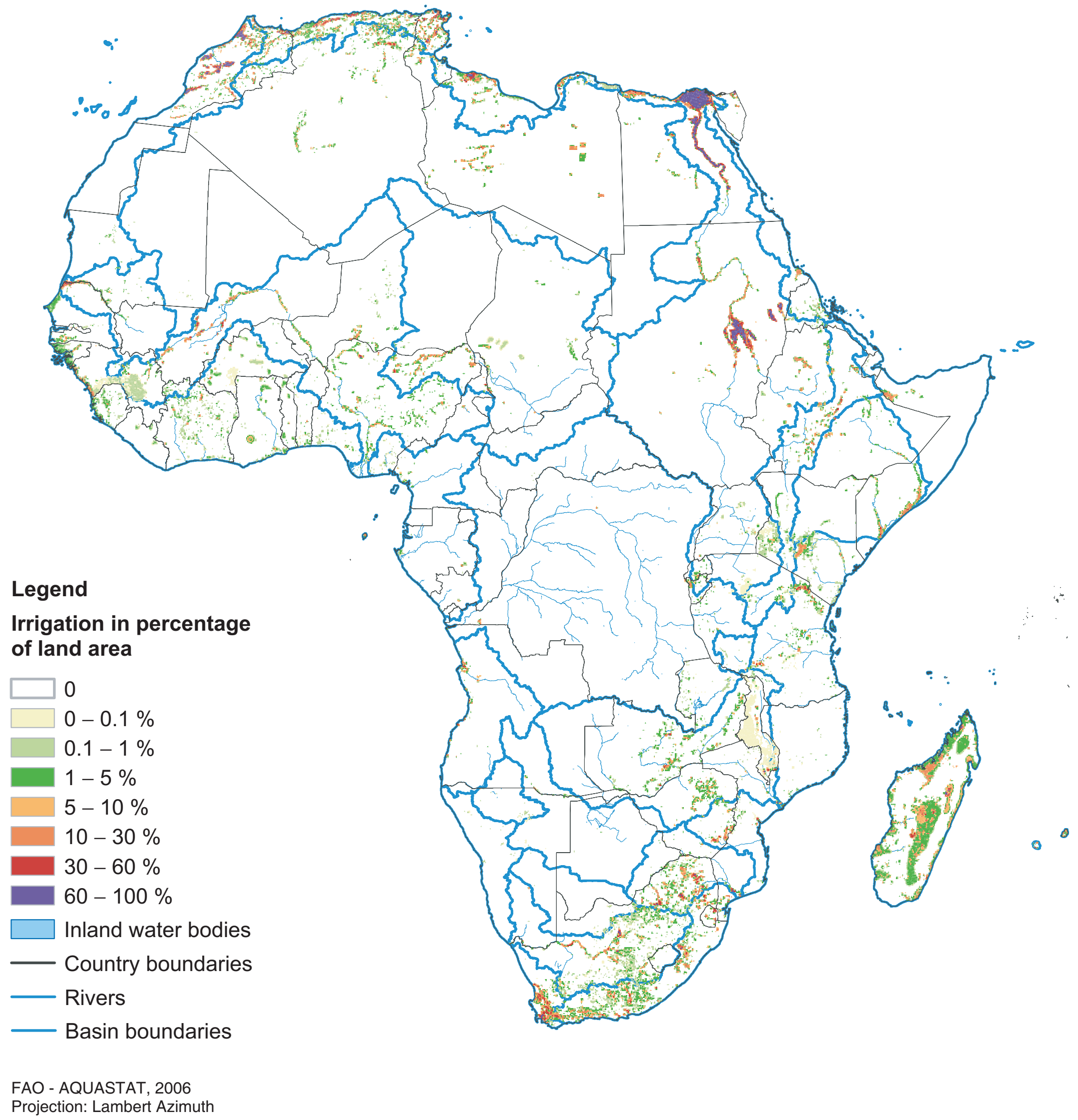
Table 2 summarizes the calculated percentage of irrigated production by crop type.

Table 3 shows the current irrigated statistics for the whole of Africa (sub-Saharan Africa plus Algeria, Egypt, Libya, Morocco and Tunisia).

Table 4 presents a regional breakdown of irrigated areas in accordance with FAO country clusters as detailed in Annex 2.

The relatively low levels and slow growth of irrigation in sub-Saharan Africa (see Box 1) are often attributed, in part, to a lack of demand for irrigated produce. In practice, agricultural commodities can usually be sold. For an existing or potential producer of an agricultural commodity, the key issue is the level of the selling price not whether

FIGURE 2
Irrigation density in Africa, 2002



Source: FAO, 2006 AQUASTAT Global Map of Irrigation Areas v.4 (in collaboration with the University of Frankfurt).

there is demand, but clearly the price depends on the interaction of demand with supply. Thus, demand constraints cannot be addressed in isolation and there can be no meaningful answers to questions such as: "Is irrigated production in sub-Saharan Africa constrained by demand?"

Irrigated produce may differ in quality from rainfed produce, but irrigated and rainfed produce are typically substitutes that compete in final markets. Thus, it is not possible to analyse markets for irrigated

BOX 1
FAO AQUASTAT update: rate of the annual increase in irrigation areas and areas under water management, 1992–2000 (weighted index)

Region	Rate of annual increase (%)	
	Areas under irrigation	Areas under water management
Northern Africa	0.67	0.67
Sub-Saharan Africa	1.17	0.80
Africa	0.88	0.73

Source: http://www.fao.org/ag/agl/aglw/aquastat/regions/africa/index.stm

TABLE 2
Sub-Saharan Africa (incl. South Africa) Rainfed and Irrigation production data (for 1997/99)

Crop	Rainfed land			Irrigated land			Total			
	Area (1000ha)	Yield (t/ha)	Prod (1000 t)	Area (1000 ha)	Yield (t/ha)	Prod (1000 t)	Area (1000ha)	Yield (t/ha)	Prod (1000 t)	% irrigated production
Sugar cane	715	20.1	14372	484	66.96	32411	1199	39.02	46783	69
Wheat	1944	1.44	2802	558	3.04	1697	2501	1.8	4498	38
Rice	5564	1.39	7716	1514	2.51	3800	7077	1.63	11516	33
Fruit	1279	6.88	8797	372	10.69	3975	1649	7.75	12773	31
Vegetables	2504	5.63	14102	637	9.79	6239	3137	6.48	20335	31
Potatoes	539	7	3775	56	28.28	1583	595	9.01	5359	30
Citrus	899	4.9	4409	107	15.71	1681	1007	6.05	6090	28
Cotton	3960	0.81	3213	362	1.14	413	4325	0.84	3626	11
Groundnut	8361	0.83	6909	444	1.1	491	8805	0.84	7400	7
Bananas	925	6.28	5805	21	16.73	351	947	6.52	6170	6
Sorghum	21834	0.81	17755	514	1.46	750	22348	0.83	18506	4
Tobacco	363	1.22	443	19	0.95	18	382	1.21	460	4
Teas	379	1.46	552	8	2.59	21	387	1.48	573	4
Barley	1119	1.07	1202	14	2.96	41	1133	1.1	1244	3
Sunflower	827	1.03	850	17	1.63	28	844	1.04	878	3
Soybean	882	0.91	804	8	2.84	23	890	0.93	827	3
Pulses	15733	0.43	6785	131	1.4	184	15864	0.44	6969	3
Maize	24083	1.4	33732	333	2.49	830	24417	1.42	34561	2
Coconut	612	2.75	1685	3	3	9	615	2.75	1694	1

Source: FAO, 2003.

commodities in isolation. It is necessary to analyse the joint market for irrigated and rainfed output. The extent of demand that is then satisfied by rainfed and by irrigated production depends mainly on their relative unit production, processing and marketing costs.

Thus, it is not possible to analyse markets for irrigated commodities in isolation. It is necessary to analyse the joint market for irrigated and rainfed output.

Final consumers are typically unaware of whether produce derives from irrigated or rainfed sources. However, irrigation normally has an impact on quality and on the structure and efficiency of the processing and marketing systems between the producer and final consumer. This in turn affects the relative farmgate prices of irrigated and rainfed production and is a factor in determining the extent to which there is scope for the expansion of irrigated output.

THE STRUCTURE OF MARKETS AND PRICE FORMATION

Globally, large numbers of farming units – both households and commercial enterprises – are involved in the growing of each major agricultural commodity. The producer prices they obtain are typically the result of the interaction of the supply of large numbers of other producers and of the demand of large numbers of consumers. Frequently, the majority of these producers and consumers are in other countries, often in other continents.

As the output of most producers is small relative to total supply, they are normally price takers, who individually have little or no impact on market prices. However, this is not always the case. Where commodities are perishable and transport infrastructure is poor, the producer price is necessarily determined by supply and demand within a limited distance of the farm. In this case, supply is restricted to a relatively small number of producers, and the sales of an individual producer may affect the market price. At macroscale, dominant producer countries (such as Brasil in the case of its predominantly rainfed sugar) effectively determines global prices, leaving smaller producers as price takers.

Markets are dynamic. Their spatial coverage varies both within and between years as supply, demand and relative prices change. At any point in time, the extent of coverage of the markets for the majority of agricultural commodities falls somewhere between the extremes of full globalization and high localization. Markets for single commodities

TABLE 3
FAO AQUASTAT update: country irrigation statistics and areas under water management

Country	Year	Area equipped for irrigation	Non-equipped cultivated wetlands & valley bottoms	Non-equipped flood recession cropping area	Total water managed area	% of irrigation potential	% of cultivated area
Unit		ha	ha	ha	ha	%	%
		(1)	(2)	(3)	(4)=(1)+(2)+(3)	(5)	(6)
Algeria	2001	569 418	-	-	569 418	112	6.9
Angola	1975	80 000	320 000	-	400 000	6	11.8
Benin	2002	12 258	6 988	-	19 246	6	0.7
Botswana	2002	1 439	-	6 500	7 939	61	2.1
Burkina Faso	2001	25 000	21 400	-	46 400	28	1.1
Burundi	2000	21 430	83 000	-	104 430	49	7.9
Cameroon	2000	25 654	-	-	25 654	9	0.4
Cape Verde	1997	2 780	-	-	2 780	89	6.2
Central African Republic	1987	135	500	-	635	0	0.0
Chad	2002	30 273	-	125 000	155 273	46	4.3
Comoros	1987	130	-	-	130	43	0.1
Congo	1993	2 000	-	-	2 000	1	1.0
Côte d'Ivoire	1994	72 750	16 250	-	89 000	19	1.4
Democratic Republic of the Congo	1995	10 500	2 000	1 000	13 500	0	0.2
Djibouti	1999	1 012	-	-	1 012	42	100.0
Egypt	2002	3 422 178	-	-	3 422 178	77	100.0
Equatorial Guinea	-	-	-	-	-	0	0.0
Eritrea	1993	21 590	-	-	21 590	12	4.3
Ethiopia	2001	289 530	-	-	289 530	11	2.5
Gabon	1987	4 450	-	-	4 450	1	1.0
Gambia	1999	2 149	13 170	-	15 319	19	6.8
Ghana	2000	30 900	-	-	30 900	2	0.5
Guinea	2002	94 914	-	-	94 914	18	6.2
Guinea-Bissau	1996	22 558	29 368	-	51 926	18	11.7
Kenya	2003	103 203	6 415	-	109 618	31	2.1
Lesotho	1999	2 637	-	-	2 637	21	0.8
Liberia	1987	2 100	18 000	-	20 100	3	3.3
Libyan Arab Jamahiriya	2000	470 000	-	-	470 000	1175	21.9
Madagascar	2000	1 086 291	-	9 750	1 096 041	72	31.3
Malawi	2002	56 390	61 900	-	118 290	73	4.8
Mali	2000	235 791	-	60 000	295 791	52	6.3
Mauritania	1994	45 012	32 786	30 984	108 782	44	22.7
Mauritius	2002	21 222	-	-	21 222	64	20.0
Morocco	2000	1 484 160	-	-	1 484 160	89	16.0
Mozambique	2001	118 120	-	-	118 120	4	2.8
Namibia	2002	7 573	-	2 000	9 573	20	1.2
Niger	2000	73 663	-	12 000	85 663	32	1.9
Nigeria	2004	293 117	-	681 914	975 031	42	3.0
Rwanda	2000	8 500	94 000	-	102 500	62	8.9
Sao Tome and Principe	1991	9 700	-	-	9 700	91	23.7
Senegal	2002	119 680	-	30 000	149 680	37	6.0
Seychelles	2003	260	-	-	260	26	3.7
Sierra Leone	1992	29 360	126 000	-	155 360	19	28.8
Somalia	2003	200 000	-	-	200 000	83	18.7
South Africa	2000	1 498 000	-	-	1 498 000	100	9.5
Sudan	2000	1 863 000	-	-	1 863 000	67	11.2
Swaziland	2000	49 843	-	-	49 843	53	26.2
United Republic of Tanzania	2002	184 330	-	-	184 330	9	3.6
Togo	1996	7 300	-	-	7 300	4	0.3
Tunisia	2000	394 000	-	-	394 000	70	7.9
Uganda	1998	9 150	49 780	-	58 930	65	0.8
Zambia	2002	155 912	100 000	10	255 922	49	4.8
Zimbabwe	1999	173 513	20 000	-	193 513	53	5.8
Africa total	**-**	**13 444 875**	**1 001 557**	**959 158**	**15 405 590**		**7.3**
sub-Saharan Africa total	**-**	**7 105 119**	**1 001 557**	**959 158**	**9 065 834**		

Source: FAO, 2005a.

may cover parts of a single nation or span national boundaries. Only by chance will a market naturally cover the same area as a nation, but the additional costs of trading across national boundaries do on occasion result in the creation of national markets with a complete absence of external trade. In such cases, the prices of the commodity

TABLE 4
AQUASTAT regional distribution of area under water management

Region*	Irrigation		Non-equipped cultivated wetlands and inland valley bottoms		Non-equipped flood recession cropping area		Full water management	
	Area (ha)	% of total	Area (ha)	% of total	Area (ha)	% of total	Area (ha)	% of all Africa
Northern	6 339 756	100	-	-	-	-	6 339 756	41
Sudano-Sahelian	2 619 950	89	67 356	2	257 984	9	2 945 290	19
Gulf of Guinea	565 257	39	196 606	14	681 914	47	1 443 777	9
Central	132 439	29	322 500	71	1 000	0	455 939	3
Eastern	616 143	73	233 195	27	-	-	849 338	6
Southern	2 063 427	91	181 900	8	8 510	1	2 253 837	15
Indian Ocean Islands	1 107 903	99	-	-	9 750	1	1 117 653	7
Total	13 444 875	87	1 001 557	7	959 158	6	15 405 590	100

*See Figure 3 for regional groupings.
Source: FAO, 2005a.

are determined by supply and demand either in a single national market or in a set of self-contained subnational markets.

> The impact of a localized increase in production from, for example, a new irrigation scheme depends critically on the structure of the market into which the commodity sells and the impact that the production has on the structure of the market.

The impact of a localized increase in production from, for example, a new irrigation scheme depends critically on the structure of the market into which the commodity sells and the impact that the production has on the structure of the market. For example, prior to the establishment of the scheme, there may be a small self-contained localized market for the commodity. As the irrigated production comes on stream, its first impact is to increase supply into this market and to reduce local prices. As production expands further, prices may fall to a point where the commodity can be exported profitably from the locality into another domestic market, thereby in effect integrating the two markets into a single new market. At some point, as production continues to expand, domestic prices may eventually fall to a level where greater returns are achievable by exporting across the national boundary. This integrates the domestic market with markets in other countries. Once this happens, prices at each point in domestic marketing chains tend to move towards the selling price in the most remunerative foreign market net of the processing and marketing costs and profit margins incurred in delivering the product to that market. Such market-determined domestic prices for exported commodities are normally termed "export parity prices".

The above example assumes that there is initially no national importation of the commodity. If the commodity were being imported in the initial situation, the new irrigated production would compete with imports, and the producer price would be a function of the import price. In such situations, domestic market-determined prices at each point that the commodity changes hands are normally termed "import parity prices". The import parity producer price at the irrigation scheme would be equal to the price at the point where competition with imports takes place minus the processing and marketing costs incurred from the scheme to this point.

As local production expands, the point of competition tends to move away towards the point of importation. This reduces progressively the unit cost of the imports at the point of competition and increases the marketing costs incurred in delivering the product from the irrigation scheme to this point. This in turn leads to a progressive reduction in the producer price. Once domestic output increases to the point where domestic prices fall below import parity, imports cease and domestic prices are determined solely by domestic supply and demand with no foreign trade. Further domestic production increases could eventually lead to domestic prices falling to export parity. Exports would then commence and domestic prices would again become a function of supply and demand in external markets. However, domestic prices would now be lower than in an import situation.

In sub-Saharan Africa countries, export parity prices tend to be substantially lower than import parity prices, especially as one moves back up marketing chains to the farmgate. A switch from import parity through domestic equilibrium to export parity then has a dramatic impact on producer prices. This is particularly the case for landlocked nations that have no natural nearby markets and must export to distant markets, e.g. Europe. Within sub-Saharan Africa, the generally poor performance of agriculture means that there are few recent examples of sustained switches from import to export parity. However, annual switches are a relatively frequent occurrence for many of the maize-based food economies of eastern, central and southern Africa, from Ethiopia to South Africa, whose grain production varies sharply from year-to-year. Price-inelastic demand means that market prices fluctuate considerably as nations or whole regional national groupings swing between surplus and deficit depending on the timing and abundance of rainfall. In general, the geographic extent of a swing region and the location of the point of trade within this region determine the size of the price swings that occur. For example, in Malawi, which is at the centre of a set of countries that tend to swing together from maize surplus to deficit, producer prices for maize vary dramatically from year to year. In the occasional year when Malawi is in deficit but can, for example, import from neighbouring Zambia, domestic price rises are comparatively moderate compared with when there is an aggregate regional deficit and Malawian traders must import using very high-cost transport links from the world market.

Within sub-Saharan Africa, the generally poor performance of agriculture means that there are few recent examples of sustained switches from import to export parity. However, annual switches are a relatively frequent occurrence for many of the maize-based food economies of eastern, central and southern Africa, from Ethiopia to South Africa, whose grain production varies sharply from year-to-year.

The main impact of irrigation is to increase the value of agricultural output through increasing yields per hectare per year (cropping intensity) and through changing the structure of agricultural output towards crops that have a higher per-hectare value. The main market-related constraint on the expansion of irrigation is the impact that increases in the supply of agricultural commodities have on their prices. The main impact is on the prices of the irrigated commodities themselves, but the prices of competing and complementary irrigated and non-irrigated commodities are also usually affected. These impacts may have little or no effect on commercial incentives to expand irrigation as individual producers are usually too small for their increases in output to have a significant effect on market prices. However, investments in irrigation that affect groups of farmers may well affect prices. For example, a large public investment in the irrigation of maize may reduce the domestic producer and retail prices of both maize and competing staple food crops, harming both rainfed and irrigating surplus producers of staples and benefiting all net consumers. Governments, donors and international financing agencies should take such impacts into account in their decision-making.

In practice, the effects of increased irrigation on prices and incomes are likely to be complex, with changes in prices and the welfare of households differing spatially and by income group. For example, in a net rice-importing country, the expansion of irrigation that is devoted to the growing of rice on land that was formally used for the growing of staple root crops would have a number of effects. It would reduce the consumer price of rice in the irrigated growing area provided that the prices of domestically produced rice were determined by competition between this rice and imported rice at some point away from the growing area, as would normally be the case. However, it would have no impact on rice prices in areas where imported rice remained cheaper. In such areas, prices would remain at their former import parity levels. The production and supply of staple root crops would tend to fall and their prices in the production area and possibly also further afield would increase, although this effect would be moderated by higher-income consumers of root crops switching partially to rice. To the extent that the poorest sectors of the community would remain net buyers of root crops and would still not consume rice, they would tend to be worse off. However, some might obtain employment in the new irrigated paddy fields or be allocated an irrigated plot, and this would offset either partially or fully the adverse impact of the increase in the price of their staple.

> The most important factor that determines the impact of increased irrigation on price is the size of the production increase relative to the size of the potential market.

The most important factor that determines the impact of increased irrigation on price is the size of the production increase relative to the size of the potential market. This varies dramatically between products depending on the extent to which they are traded. Highly perishable, low value-to-weight crops, such as kale and cabbages, tend to have small, localized markets that, depending upon transport systems, may range from a few miles in extent to subnational or national. Crops that are exported from the sub-Saharan region, such as cotton or coffee, or are imported, such as wheat and rice, sell into markets that are global in extent. A localized increase in irrigated supply can be expected to have a major impact on prices that are determined in localized markets, some impact on prices determined in markets that are nationwide, but little or no impact on the domestic prices of internationally traded commodities unless this changes the direction of flow of the commodity.

From the above, it is evident that the prices received by producers for new irrigated production are critically dependent *inter alia* on: the location of this production; the structure of the domestic, regional and international markets; and the magnitude of the increases in output to which this new irrigation leads relative to the size of each of these markets. Chapter 6 discusses this further in the context of sub-Saharan Africa national and regional production.

PROCESSING AND MARKETING SYSTEMS IN SUB-SAHARAN AFRICA

sub-Saharan Africa has witnessed an extensive liberalization of processing and marketing systems in the past two decades. This has led to systems with radically changed organizational and economic characteristics. Staple grains are no longer traded by state enterprises at fixed seasonal and panterritorial prices, and there is greatly reduced state control of the importing and exporting of staples. Single-channel state-run marketing systems for export crops based on state boards and caisse de stabilisation have largely disappeared, as have attempts to stabilize export crop producer prices.

Private trading systems have emerged rapidly as state systems have collapsed or been phased out. Although these are generally competitive, the extent of competition varies markedly between countries and also between high-density and remote farming areas within countries. The new systems have three main characteristics:

- they are inefficient owing to: a lack of grades and standards, the reluctance and inability of farmers and traders to store seasonally, poor physical and electronic communications, and inadequate information;
- the prices facing farmers are unpredictable and unstable;
- the former interlocking at the farm level of crop purchase and the provision of input and credit has largely collapsed following the phasing out of single-channel input supply and marketing systems.

Contract farming has emerged as an important means of replacing the single-channel systems. However, such farming is only appropriate for crops that the supplier of inputs and other services to farmers can be assured of buying. Other crops (particularly food crops grown by small-scale farmers) are vulnerable to "side selling" and are largely unsuited to contract farming (FAO, 2001).

There is now immense diversity in the structure and practices embodied in agricultural marketing systems in sub-Saharan Africa as market forces have led to the development of systems tailored to the production, processing and marketing characteristics of each commodity.

SELF-SUFFICIENCY AS AN OBJECTIVE AND A TOOL IN DEMAND ANALYSIS

Sub-Saharan Africa governments have pursued national self-sufficiency in basic foodstuffs as a means of ensuring an adequate availability of food. This is rational where a nation or region is unable to import or anticipates that it may be prevented from doing so at some time in the future. However, the pursuit of self-sufficiency as a goal in itself necessarily involves sacrifices in terms of economic efficiency as it inhibits the agriculture sector being structured on the basis of comparative advantage and prevents the exploitation of the full gains from specialization and trade. In addition, by not necessarily making the best use of human and natural resource endowment, self-sufficiency can be very expensive in social development and environmental terms.

Once annual national exports of a commodity exceed annual national imports, a country is said to be self-sufficient. However, this conventional definition of self-sufficiency frequently masks substantial outward and inward trade in natural markets that span the country's borders. In addition, if the commodity cannot be readily stored, the country may still be dependent on imports at particular times of the year.

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Increased production within one or more countries of a subcontinental region may similarly lead to statistical annual self-sufficiency of the region. As with a statistically self-sufficient nation, the region is also likely to both export and import after achieving annual self-sufficiency as a result of the seasonality of production and the existence of natural cross-border markets. Regional data on self-sufficiency have the further drawback that a full set of data on trade between countries in sub-Saharan Africa is not readily available and nor is that for the trade of sub-Saharan Africa regions with the rest of the world. As a consequence, it is not possible to estimate regional imports and exports. Thus, the extent of self-sufficiency is usually estimated and projected simply by comparing annual regional production with consumption. As much of the trade of countries within individual sub-Saharan Africa regions is with countries outside the region (and frequently also outside sub-Saharan Africa), it is possible for a region to be statistically self-sufficient in a commodity while some of its countries continue to be dependent on imports from outside the region.

For the above reasons, the available statistics relating to both national and regional self-sufficiency have a very limited and specific meaning. They refer simply to the ratio of annual production to annual consumption in the nation or the region in question. In the case of individual nations, they mask the fact that imports may be necessary at certain times of the year even though annual production is equal to or exceeds annual consumption. They also mask the fact that the location of production and consumption areas near national borders may lead at any point in time to cross-border sales in one part of the country and cross-border purchases in another part. In the case of regions, conventional measurements of self-sufficiency embody both these characteristics and have the further drawback that they underestimate annual extra-regional trade in the commodity.

Notwithstanding these reservations, several reasons make it both worthwhile and necessary to examine the demand for sub-Saharan Africa irrigated production in terms of self-sufficiency. First, estimates and projections of national and regional self-sufficiency are useful in that they indicate the extent to which annual national and regional production falls short of annual demand and give an indication of the additional quantities that can be produced before prices fall from import to export parity. Second, many sub-Saharan Africa governments still consider self-sufficiency in basic foodstuffs an important objective. This is particularly the case in countries where white maize is the staple and where imports of more readily available yellow maize are highly visible and viewed as a sign of national failure. Third, much of the potential for regional trade in sub-Saharan Africa remains unexploited because of infrastructure developed during the colonial period that was tailored to trading with the metropolitan country. There is now a desire for greater self-reliance within sub-Saharan Africa and within its regions and, consequently, an increasing emphasis on regional trade by governments, by regional and Africa-wide bodies, and by national, regional and international aid and financing agencies. Fourth, most regions within sub-Saharan Africa remain far from self-sufficient in most basic foodstuffs. The final reason is one of analytical necessity. The large number of countries in sub-Saharan Africa, coupled with a lack of readily available data on national exports of commodities analysed by destination, means that it is only possible to undertake an analysis of demand that covers all sub-Saharan Africa nations in terms of differences between projected annual consumption and production. However, this analytical focus on self-sufficiency does not imply that self-sufficiency is a rational or desirable objective.

INCREASED IRRIGATION IN SUB-SAHARAN AFRICA AND ITS IMPACT ON COMMODITY PRICES

The extent of the impact on price of a given increase in supply depends on two factors: (i) the percentage increase in total supply to the market; and (ii) the sensitivity of the market price to changes in supply. The former depends on the total size of the existing market, the latter on the price elasticity of demand.

National governments will be interested in the impact of an investment in irrigation both on the economic and financial profitability of that investment and on the welfare of all national producers and consumers of the commodity. Thus, they will be interested not only in the impact on the prices received by farmers participating in the new irrigation but also on other members of the national population. International donors and international financial institution (IFIs) should logically look wider than this and also take account of the impact on prices worldwide.

For grains, projections made using the IMPACT model of the International Food Policy Research Institute (IFPRI) indicate that increased irrigation in Africa will have only a small impact on world grain prices (Rosegrant and Perez, 1997). This is principally because of the small size of African production compared with that of the world. This suggests that donors, IFIs and other external agencies should focus on national and regional price impacts when assessing potential investments. Increases in irrigated output could have significant impacts on both irrigated and rainfed producers in the country in question and the region through their effect on prices in localized markets and on the structure of markets and prices within the country and the region. The impacts are likely to differ markedly between different categories of crops. Chapter 6 discusses the probable magnitude and direction of impacts.

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HOW IRRIGATION RESPONDS TO DEMAND – THE PROCESS

Despite the significant range of tangible benefits that irrigation can provide, it is not a panacea for all problems and not always assured of immediate success, particularly where public agencies prove too rigid (incapable of responding to farmers' needs). In many cases, the installed asset base (equipped area) is underutilized. The poor performance of Nigerian public-sector irrigation is a case in point (Box 2) – only 30 percent of the federally funded equipped area is cropped. This raises questions as to the circumstances under which the private sector will engage in large-scale irrigation, and the circumstances under which new small-scale schemes become viable.

Insofar as the structure of the markets for irrigated produce conditions the pattern and flow of demand, the structure of the irrigated subsector in each country of the region is also critical in determining how producers can respond to changing demand patterns. For example, private commercial scale-irrigation in Nigeria is almost moribund whereas commercial sugar dominates the subsector in Swaziland; yet the opposite is the case with respect to fadama and other smallholder irrigation, which, although constrained in Swaziland, represents a significant livelihood opportunity in Nigeria.

BOX 2

The structure of irrigation in Nigeria

Scheme Grouping	[1]2000 Planned Irrigable Area (ha)	[2]2004 Planned Irrigable Area (ha)	Area Equipped for Irrigation (ha)		Area Actually Under Irrigation (ha)			
			2000	[2]2004	[1]1990–91	[1]1995–96	[1]1999–2000	2003–200
RBDA Schemes								
Anambra-Imo	11 300	11 450	3 936	3941	3 850	0	15	10
Benin-Owena	7 455	10 380	831	317	0	402	5	0
Chad Basin	106 630	101 900	27 500	26 180	15 500	2 250	1 650	1000
Cross River	717	8 477	717	364	0	72	42	40
Hadejia Jama'Are	83 700	40 500	21 045	18 475	14 000	12 925	16 930	21 000
Lower Benue	10 700	12 215	880	1 310	125	137	30	70
Niger Delta	7 250	6 850	722	187	100	0	53	0
Lower Niger	9 510	16 577	1 615	1 344	400	373	230	115
Upper Niger	3 485	53 895	2 928	3 697	{[5]}	310	345	722
Ogun-Osun	33 679	28 574	6 328	512	140	132	152	110
Sokoto Rima	52 812	62 390	15 445	27 580	11 000	0	6 180	5 290
Upper Benue	58 000	63 200	7 550	8 410	6 150	7 230	3 860	783
Sub Total	**397 238**	**416 408**	**89 497**	**92 317**	**51 265**	**23 831**	**29 492**	**29 140**
% Planned		100%	21%	22%	12%	6%	7%	7%
% Developed				100%	53%	24%	30%	30%
State Irrigation Schemes	16 000	16 000	12 200	12 200	6 900	n/a.	6 000 e	6 700 e
Private Sector :								
Bacita Sugar	9 000	9 000	5 600	5 600	5 000	7 000	3 000 e	0
Savannah Sugar[3]	(12 000)	(12 000)	(7 000)	(7000)	(6 000)	(5 500)	(3 200)	(500)
Other :								
Fadama[4]	55 000	55 000	55 000	55 000	18 000	30 000	55 000	55 000
Private Small Scale	128 000	128 000	128 000	128 000	128 000	128 000	128 000	128 000
Totals (ha)	**605 238**	**624 408**	**290 297**	**293 117**	**209 165**	**n/a**	**221 492**	**218 840**

[1] FAO: Irrigation Sub sector Study (Nigeria), September 2000, unless otherwise specified.
[2]FMWR 2004 estimates for planned and developed
[3]Savannah Sugar Company data included in Upper Benue RBDA
[4]Fadama figures from the World Bank Appraisal (Feb 1992) and the later ICR (April 2000) of the National Fadama Development Project – ICR figures not verified in the field and based on number of pumps distributed.
[5]Lower and Upper Niger one RBDA in 1991
"e" refers to estimated figures; n/a., information not available and estimate not possible.
Recession and moisture retention farming excluded.

Source: FAO (2004).

BOX 3

Raising demand for irrigation

Reforms under the Agriculture Sector Development Strategy, United Republic of Tanzania

United Republic of Tanzania's *Agriculture Sector Development Strategy* (ASDS), which was published in October 2001, comprises a set of innovative and practical actions intended to stimulate agricultural growth and reduce rural poverty. These include a focus on commercialization of the agricultural sector and increasing its **productivity** and **profitability**.

Arrangements for implementation of the ASDS are elaborated in the *Agriculture Sector Development Programme* (ASDP) *Draft Framework and Process Document* (September 2002). At the heart of ASDP is a sector-wide approach to changing the function of central government from an executive role to a normative one, to empowering local government and communities to reassume control of their planning and implementation processes, and to encouraging private sector participation in all aspects of agriculture – including investment, processing and marketing. Under this new approach, 70-80% of public (government and/or donor) funding of the sector will now be managed by district councils and utilized through *District Agricultural Development Plans* (DADPs). Greater use will be made of outsourcing through contracts with private sector service providers, and greater awareness of cross cutting issues, including gender and the environment, will also be promoted.

The new approach will require a transformation in the way public investments in the smallholder irrigation subsector are analysed, planned and implemented. In conformity with the ASDS and ASDP, planning and implementation of smallholder irrigation subsector investment projects must now be based on the need for them to be **driven by irrigators** (or potential irrigators), **responsive to market opportunities**, **coordinated at the local level** and **profitable**. This implies a need for more critical analysis of proposed investments and greater farmer participation in this process and that of their subsequent planning and implementation. It also implies a need to recognize that participation means more than mere consultation and that it takes time. It furthermore implies a need to recognize that farmers are the best judges of their own investment priorities and that these may not necessarily include investment in physical irrigation works, which do not always present the best opportunities for increasing output and incomes. Farmers may instead, for example, have identified a marketing opportunity or constraint that, if seized or addressed, would achieve their objectives more effectively.

Source: Ministry of Agriculture and Food Security, United Republic of Tanzania (2003)

Because of differences such as these, any attempt to justify more irrigation would sensibly do so on the basis of the demands of farmers and those to whom they sell instead of the wishes of those that see political or other advantage in the supply of more infrastructure (Box 3). Therefore, the scope of this study is oriented towards examining markets for irrigated produce. Clearly this analysis does not exist in isolation and other component studies need to be referred to appraise the process as through which investment will be mobilized and sustained.

Equally, it should be understood that the term irrigation describes a wide range of physical interventions, each or any of which may be appropriate depending on: local conditions including natural resource endowments; levels of producer/market sophistication; and realistic opportunities for added-value. The range itself begins with traditional recession agriculture, water harvesting or temporary village weirs (usually seasonal) and ends with precision systems that are automatically controlled by tensiometres computers, which as well as controlling water delivery and distribution also factor in the unit costs of water and compare it with probable farmgate prices before delivering specific and optimal amounts of water to the rootzone or subcanopies of the crops involved. Between these extremes are varying degrees of complexity and sophistication encompassing gravity fed, spate irrigation, basin irrigation, surge irrigation, gravity or pumped furrow irrigation, sprinkler, centre-pivot or drip/trickle systems, each or any of which could be managed by state service providers, the users themselves or commercial enterprises.

Therefore, an irrigation subsector is rather more than mere hardware and technology. It has both physical ('hard') and non-physical ('soft institutional') elements that constitute a specific functional 'structure' with a mix of irrigation styles and management approaches.

Consequently, there is little point in deciding whether or not the supply of agricultural commodities in sub-Saharan Africa could be increased by investing in more public-sector irrigation or by removing constraints on private-sector investment by both traditional farmers and commercial farmers. There is no real doubt that it could. Hence, the real questions are, first, should the supply of irrigated agricultural commodities be increased and what are the opportunity costs? Second, at what scale in terms of both physical and non-physical interventions and in relation to demand (markets)? Third, what lessons can be learned from the performance of past investments? Finally, to what extent can production risks be managed by the application of irrigation technology?

Physical interventions

Physical interventions can be placed into four categories. First, there is rehabilitation of existing infrastructure. This would be a waste of time in the absence of an understanding as to why the infrastructure has fallen into disrepair. However, if these reasons can be addressed convincingly during the rehabilitation project cycle, then rehabilitation has the potential to produce the best economic results because of the sunk costs involved. Second, there is the upgrading of existing schemes (which might be carried out at the same time as rehabilitation). Upgrading is usually intended to facilitate more equitable, accurate and efficient water distribution but it can be necessary to facilitate a shift towards higher-value farming systems or the adoption of improved varieties. Third, there are new run-of-river schemes, which will themselves vary from easy to difficult in both technical and social terms as well as costs – small-scale interventions/ fadama. Finally, there are new storage-based schemes. These introduce a new set of environmental, social and economic challenges, not least options for small-scale local storage close to watersheds (thereby taking advantage of reuse potential, enhanced and diversified local livelihoods), the recharge of linked aquifers, or the replenishment of large dams and impounded areas in valley bottoms. The latter may achieve economies of scale while possibly gaining additional municipal water supply and hydropower benefits. Current studies and indeed schemes (e.g. India) confirm that the former, are usually less costly (but not always begnign) in environmental and social terms while storing more of the available water than a large-scale alternative downstream. However, the local-livelihood enhancements that multiple upper-catchment dams provide may have little impact on national or regional self-sufficiency because of lower physical and social connectivity with the economy as a whole.

The viability of each of these levels of physical interventions depends on current levels of development and their effectiveness and on local demand opportunities and cultural preferences in terms of labour and cooperation around shared natural resources. Although this paper is more concerned with local demand opportunities, the importance of local cultures and practices means that non-physical interventions cannot be ignored. Other components of the Collaborative Programme (CP) are addressing these related themes.

Non-physical interventions

As far as non-physical interventions are concerned, these also fall into four categories. The first is public awareness because experience shows that uninformed rural communities tend not to take good advantage of supply-driven irrigation facilities. Therefore, it is far better to raise awareness of the potential benefits of irrigation and relate these to the skills and resource base of the beneficiary community in the hope that they become empowered to demand irrigation and the associated resource utilization rights (Box 2). Equally, with rights come responsibilities. Unless there is awareness of these responsibilities, particularly in relation to operation, maintenance and the prudent use of natural resources, enthusiastic demand can lead to bitter disappointment, resentment, dilapidated infrastructure and degraded environments. Further, under a well-informed and transparent mode of implementation, it is generally easier to introduce potentially unpopular cost recovery and regulatory measures.

The second category is that of politics and policy. sub-Saharan Africa countries (and their development partners) are realizing that irrigation development, if it is taking place at all, cannot take place in the supply-driven ad hoc fashion that it has in the past. Instead, workable sectoral policies are required that recognize the need for the correct balance between hard and soft interventions. Such policies have to be backed up with investment strategies that: (i) provide decision-making and planning frameworks instead of the "shopping lists" of the past; and (ii) that potential investors of any kind consider enabling.

The third category is the legal framework, which provide the basis for economically efficient allocation of water while also protecting customary use and making access to its productive potential more equitable. This is increasingly likely to involve the adoption of: transparent and stable water-use rights; economic pricing of water; and well-regulated markets in which water use rights can be traded between willing buyer and willing seller at a mutually agreeable price. At the same time, where water user groups are involved, the legal provisions for recognizing their status and liabilities are invoked.

Many of these legal provisions have institutional implications, hence the fourth category, which is that of institutions and service delivery. Many state irrigation sectors are or have been managed by centralized bureaucracies with limited local responsiveness. In many cases, gains can be made by decentralizing the sectoral functions, such that decisions are made as close as possible to those affected by them, functions are subsidiarized and beneficiaries involved to a far greater extent in all stages of their project cycles, including operation and maintenance (O&M). This may require in turn that public-service providers become more commercialized in their approach and performance, or that private-sector entities be allowed to provide the necessary services. The art is to effect such transitions without increasing transaction costs in the long term. The example of the Office du Niger in Mali is a case in point where the use of a tripartite performance contract between farmers, the irrigation agency and government has opened up a policy and investment space that might otherwise have closed down (Aw and Diemer, 2005).

Financing modalities

Finally, there is the matter of finance, both capital and recurring. While this study assumes that it is desirable to mobilize increased investment in irrigation through the bilateral and multilateral funding agencies, it is helpful to understand that a wide range of financial sources could be involved and in various combinations. Furthermore, each of the potential players will have their own objectives and sometimes hidden agendas.

First, there is commercial capital. This means financial reserves that a commercial entity could use to invest in new, improved or expanded irrigation, some of which may involve small-scale outgrowers. As this does not involve any public money, it is a desirable way to finance irrigation development. However, it is acknowledged that despite its potential for poverty alleviation by providing direct and indirect livelihoods, commercial irrigation may not be relevant to self-sufficiency and only indirectly relevant to macrolevel food security. Notwithstanding the desirability of commercial investment, many potential commercial investors may not be convinced that such investments are particularly attractive where poor governance is an issue. Consequently, governments that wish to see more commercial investments need to provide acceptable enabling environments. In addition, although much of the enabling environment comprises non-physical elements, such as financial regulation and reliable markets, there may also be physical public goods, such as new or improved rural access and transport facilities, without which an investment in irrigation would be meaningless.

Next are commercial credits. These are funds that can be borrowed from merchant and clearing banks as well as specialist institutions, such as banks for agriculture, insurance companies, central estates and equipment suppliers. Mobilization of such credits often requires collateral in a form that is meaningful to the lender. This can be difficult for many poor small-scale farmers, especially where land tenure is unclear. Various methods have been used to solve this problem including social collateral and loan underwriting by a bilateral donor. Key issues also include affordability, usually in terms of interest rates, but sometimes in terms of commitment fees and modality (i.e. seasonal loans having to be used to finance longer-term farming systems shifts or banks having stop orders on a farmer's production rendering the farmer little more than a labourer for the bank). There is also the issue of financiers' involvement in the farmers' day-to-day business.

The State itself is an obvious source of finance. However, such finance is usually scarce in relation to the wide range of demands upon it. Inordinate state establishment costs can sometimes be trimmed by institutional downsizing. Equally, better enforcement and expansion of tax systems may increase the ability of a government to invest. Even so, most state funding comes in the form of counterpart funding of programmes mainly funded by a country's development partners, or in so-called public/private partnerships.

In this context, the term "development partners" is intended to mean international development banks and bilateral donors. These are one of the main targets of this study and, in addition to counterpart funding, usually expect client countries to have made or be making clear progress towards better governance and increased commitment to social equity, gender opportunity and the adoption of sound environmental principles. Furthermore, such agencies prefer to think of themselves as partners with government. They like to identify investment opportunities with the beneficiary governments rather than simply being given a "wish list". In other words, the mantra of participation and consultation is applicable at all levels. This is beginning to result less in traditional sector master plans than in framework investment strategies. However, there are dangers in that: (i) countries can be forced into uncomfortable or even erroneous positions by donor pressure; (ii) monitoring results in unsustainable disbursement rates owing to donor preference for disbursement-based progress; and (iii) there may be policy conflicts between different development partners.

Non-governmental organizations (NGOs) also have a role to play in the financing of public irrigation. However, budgets are usually limited, hence funds are often targeted not at the infrastructure itself but at building grassroots capacity such that the infrastructure is productively utilized. Nonetheless, some NGOs are involved in the supply of low-tech equipment such as International Development Enterprise, which supplies simple driplines and treadle pumps. There are some examples of NGO-funded infrastructure but these are limited and have met with varying degrees of success.

Finally, there are the beneficiaries themselves. Sustainability and ownership concepts are thought to be closely linked, and participation in the financing of a scheme goes a long way towards establishing the levels of ownership required. Financial capacity at the grassroots is usually limited in the extreme, but there are other ways to mobilize resources. One is labour and another is to use food-for-work or even better labour-based construction modalities. The latter approach is particularly interesting as a proportion of the labour wages can be retained by the implementing agency and used to establish an O&M fund for the scheme. In fact, given the benefits of labour-based construction, some development banks (in order to make them more competitive) discount a portion of the financial bids of labour-based contractors bidding against those preferring to remain with mechanical methods. The importance of O&M funding cannot be overstated. For this, the participation of the beneficiaries becomes paramount. They should be fully responsible for all recurring costs at scheme level as well as those incurred in delivering water to the schemes, except perhaps where shared, large-scale bulk infrastructure is concerned – which it may be appropriate to consider as public goods (Riddell, 1998).

SUMMARY

This discussion of some key physical and non-physical aspects of water development and management in agriculture makes clear that this study is concerned with rather more than a simple alignment of demand (in terms of self-sufficiency) with irrigation development potential. The processes by which irrigation investment is planned and sustained have been indicated. More detailed treatment is available in the companion reports, notably (Morardet, S. *et. al.*, 2005).

Issues relating to demand are complex. In most situations, demand for irrigated production exists. The critical issue for the expansion of irrigation is not whether there is demand for irrigated output, but the impact of increased irrigation on the prices at which irrigated commodities trade. This depends critically on the structure of the market and the extent to which increases in irrigated production can supply the right quantity and quality into that market.

In itself, self-sufficiency is rarely accepted as a viable objective for a country or a group of countries as it prevents the full exploitation of the potential gains from specialization and trade. In addition, self-sufficiency, as normally measured, may mask substantial amounts of seasonal and informal cross-border trade. Notwithstanding these reservations, a set of practical considerations makes it both worthwhile and necessary to examine the demand for sub-Saharan Africa irrigated production in terms of self-sufficiency, at least as a point of departure.

Equally, irrigation development comprises far more than concrete maps that link the available water with the available land. It is not a given that irrigation is the best way to meet demand, nor is increased agricultural production the only route to food security.

However, where irrigation is justified, then it will involve establishing a sustainable mix of physical and non-physical interventions to bring the structure of the irrigated subsector (both public and private operators) into a position where it can adapt to changing market conditions.

Chapter 3
Data sources and methodology

ANALYSIS OF SUPPLY AND DEMAND

Crop sectors

The demand analysis in this paper employs the database assembled by FAO for its study *World agriculture: towards 2015/2030. An FAO perspective* (FAO, 2003). Since the publication of the study in 2003, FAO has continued to refine the data. The analysis in this paper uses the data that were available in February 2004.

The FAO 2015/2030 study has the three-year average 1997 to 1999 as its base year, and shows projections for the years 2015 and 2030 (hereafter called the AT 2015/2030 analysis). This data underlies the AT 2015/2030 main report (FAO, 2003). The study is positive rather than normative. It aims to predict the most likely situations for these two projection years rather than the most desirable. In the case of irrigation, the projected increases in the areas irrigated and in cropping intensity are based on a combination of existing irrigation plans, potentials for expansion, and the need to increase crop production.

The projections to 2015 and 2030 are based on a combination of modelling and the views of FAO experts. The process of making the projections stated for each country and each of 32 commodities/commodity groups (Annex 3) with: (i) projections of demand using Engel demand functions and assumptions of population and growth in gross domestic product (GDP); and (ii) projections of production derived from assumptions about future yields and trade levels. (These commodities cover the vast majority of all agricultural output. To make the analysis manageable, some commodities were grouped. Commodity groups comprise cereals, sweet potatoes and yams, other roots, pulses, vegetables, citrus, other fruit, vegetable oils, tea and coffee, hard fibres, beef and buffalo meat, mutton and goat meat, poultry meat, milk from various animals and eggs from hens and other birds. For convenience, both individual commodities and commodity groups are referred to as "commodities" in the remainder of this paper. The term "commodity group" is reserved for larger groupings of commodities, such as "non-cereal food crops" and "livestock and dairy produce".) There were then several rounds of iteration in consultation with specialists until projections for 2015 and 2030 were arrived at that both were consistent with the expectations of the specialist and met conditions of accounting consistency.

The heart of the FAO projections is a set of national supply and utilization accounts (SUAs) for 1997/99, 2015 and 2030. These show the estimated/projected weight of annual production, demand, imports and exports for a total of 32 agricultural commodities/commodity groups. Demand is analysed into food for human consumption, industrial usage, feed usage, seed, and waste. For the world as a whole, the sum of estimated 1997/99 national exports of each commodity is approximately equal to the sum of estimated imports although not exactly so owing to data anomalies.

The SUAs also contain aggregations of the commodity data a number of categories:

- cereals (including coarse grains);
- other food crops;
- basic staple foods (including grains, staple root crops, plantains and pulses);
- non-food industrial crops;
- tropical beverages;
- livestock products;
- all food commodities.

For the purposes of this paper, the value data were reworked into the following set of non-overlapping commodity categories:

- cereals;
- non-cereal staple food crops (staple root crops, plantains and pulses);
- other food crops;
- dairy and livestock products;
- tropical beverages and industrial crops.

Annex 1 lists the commodities in each of these groups. As with the original AT 2015/2030 categories, these aggregations are in terms of values, which are calculated using estimated average world 1989–1991 producer prices expressed in "international dollars" derived using the Geary-Khamis formula as explained in FAO (1993). These values are notional and, of themselves, have little meaning other than allowing accounting weights to be assigned when comparing different agricultural production. To the extent that the relative producer prices of commodities changed between the period from 1989–1991 and the 1997/99 base-year period, base-year comparisons of the values of groups of commodities will be inaccurate. The same reservation also applies to the value data for the two projection years. By 2030, the prices used to weight commodities will be some 40 years out of date. For this reason, projections to 2015 and 2030 have been based on production figures or kcal/capita/year and to findings that are based on calories rather than value. Nonetheless, this nominal value data still allows comparison of aggregate agricultural output and have been used when appropriate.

Therefore, for each commodity, the national SUA spreadsheets also contain estimates of the mean calories per person per day represented by the data on human demand. Finally, each national account spreadsheet contains separate estimates/projections of: GDP, total population, agricultural population, total labour force, and agricultural labour force.

Sub-Saharan Africa component regions

In this paper, the AT 2015/2030 data for sub-Saharan Africa are grouped into seven regions:

- Central,
- Eastern,
- Gulf of Guinea,
- Islands and Others,
- Republic of South Africa,
- Southern (excluding Republic of South Africa),
- Sudano-Sahelian.

Annex 2 lists the countries that comprise each region and they are shown in the regional grouping in Figure 3.

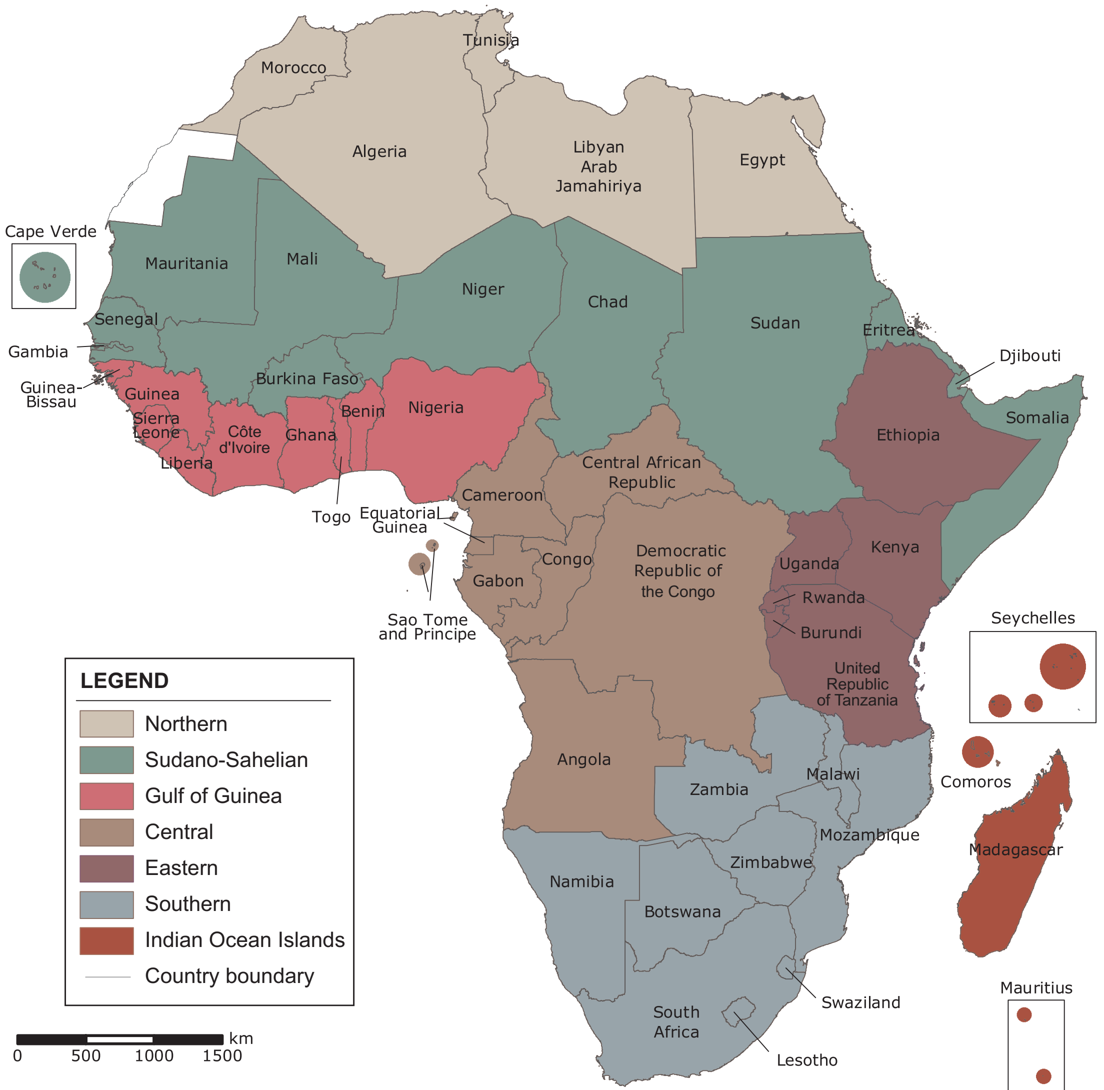
NATURAL RESOURCES

The assessment of natural resources in the form of water and undeveloped irrigation potential for this study is almost entirely based on "Irrigation potential in Africa: a basin approach" (FAO, 1997a). This 1997 *FAO Land and Water Bulletin No. 4* comprises a detailed description of the methodology used in its preparation, which can be summarized as follows.

Planning for water resource development and utilization is best carried out on a basin basis while land-use planning is usually computed according to national boundaries, these two divisions of the continent were combined.

There are 24 river basins and river basin groups (including several endorheic basins) covering 53 countries. Figure 4 shows the main water courses in relation to national borders and internal renewable water resources. By combining basins and national boundaries, some 136 basic units were identified and these became the basis of all

FIGURE 3
Regional Division of Africa



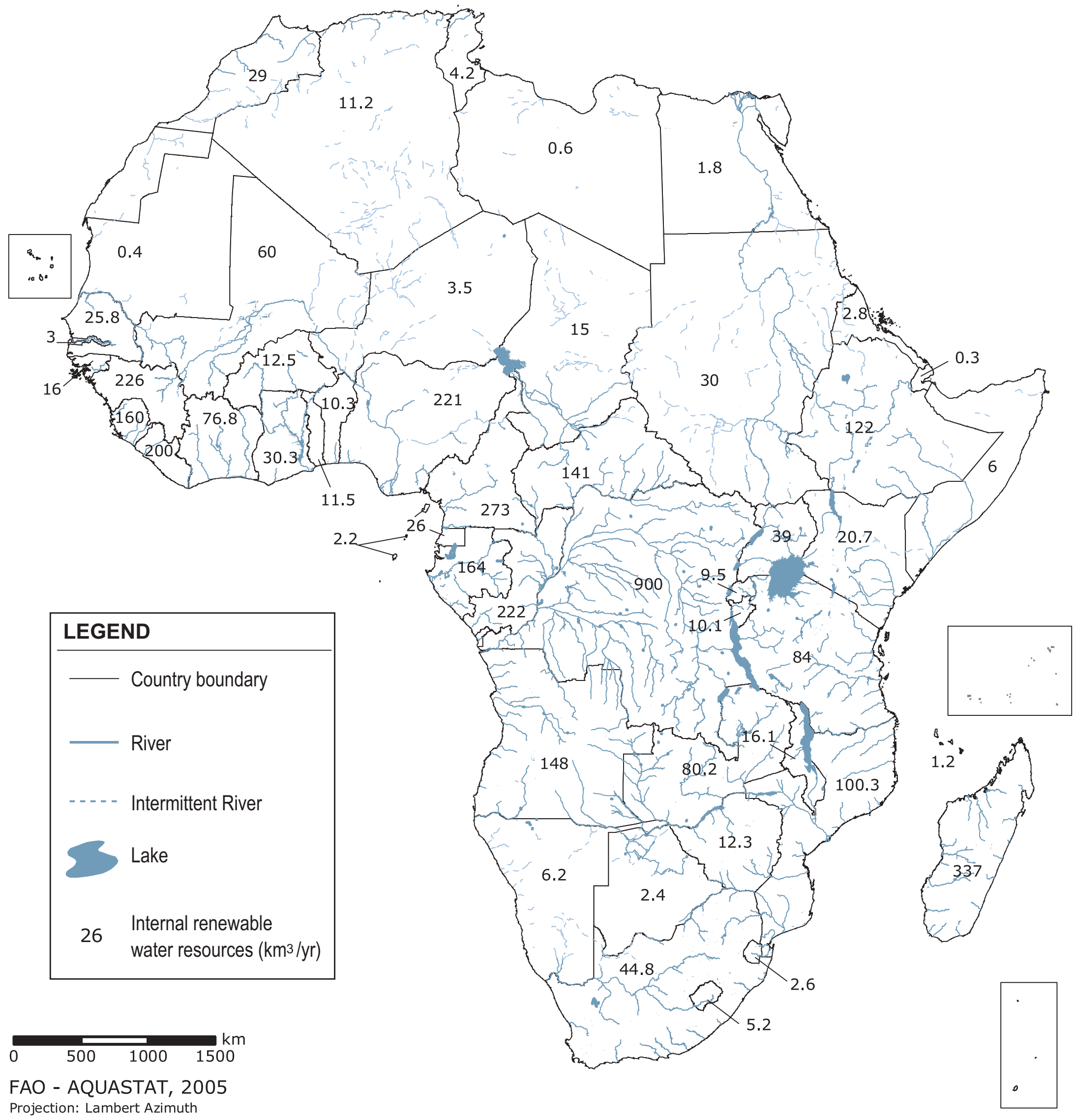
FAO - AQUASTAT, 2005
Projection: Lambert Azimuth

subsequent computations (although not all of these units fall within the scope of this study).

Criteria for land potential (based only on suitability for surface irrigation) were developed using the FAO–UNESCO soils map of the world while renewable water resources were based on an earlier study (FAO, 1995). The information gleaned from the 1995 study was compared with surface runoff estimated for each of the 136 basic land units using GIS methods based on a surface runoff map of Africa (UNESCO, 1997). As non-renewable resources were not taken into account, this may have resulted in relatively low or even negative irrigation potential in the more arid units. This may explain some of the negative figures in the baseline tables presented in Chapter 4 (data anomalies account for the others).

Irrigation water requirements were estimated using FAO CROPWAT software and climate data from the FAOCLIM database (1995). This provided estimates of net reference crop irrigation water requirements (IWRs) for each of the 136 units; and wherever possible these estimates were compared with historic site-specific studies. To be of any use, reference crop IWRs have to be applied to actual farming systems.

FIGURE 4
Water courses in Africa in relation to national boundaries and internal renewable resources



For the purpose of the water resources assessment, these were delineated as notionally homogeneous zones in terms of types of crops grown, cropping calendar, cropping intensity and irrigation efficiencies, before being combined with such climate data as were available. The coverage of the climate was defined using Thyssen polygons.

After collating all the farming system and IWR information, it was analysed and compared with the figures resulting from the basin studies in order to prepare: (i) regional commentaries describing conditions within each basin; (ii) tables collating statistical data such as irrigation potential by country and basin, irrigation potential by basin, and areas currently under irrigation by country and basin, etc.; and (iii) maps of where and to what extent water is a limiting factor, irrigation potential, existing and potential irrigation as a percentage of basin areas, and populations densities and possibilities for irrigation expansion. These commentaries and tables form the basis of much of what follows in this document. However, in order to be of use in this context, considerable re-organization of the data was required. The results of this were provided in the first report of the irrigation specialist and are used synoptically in this report.

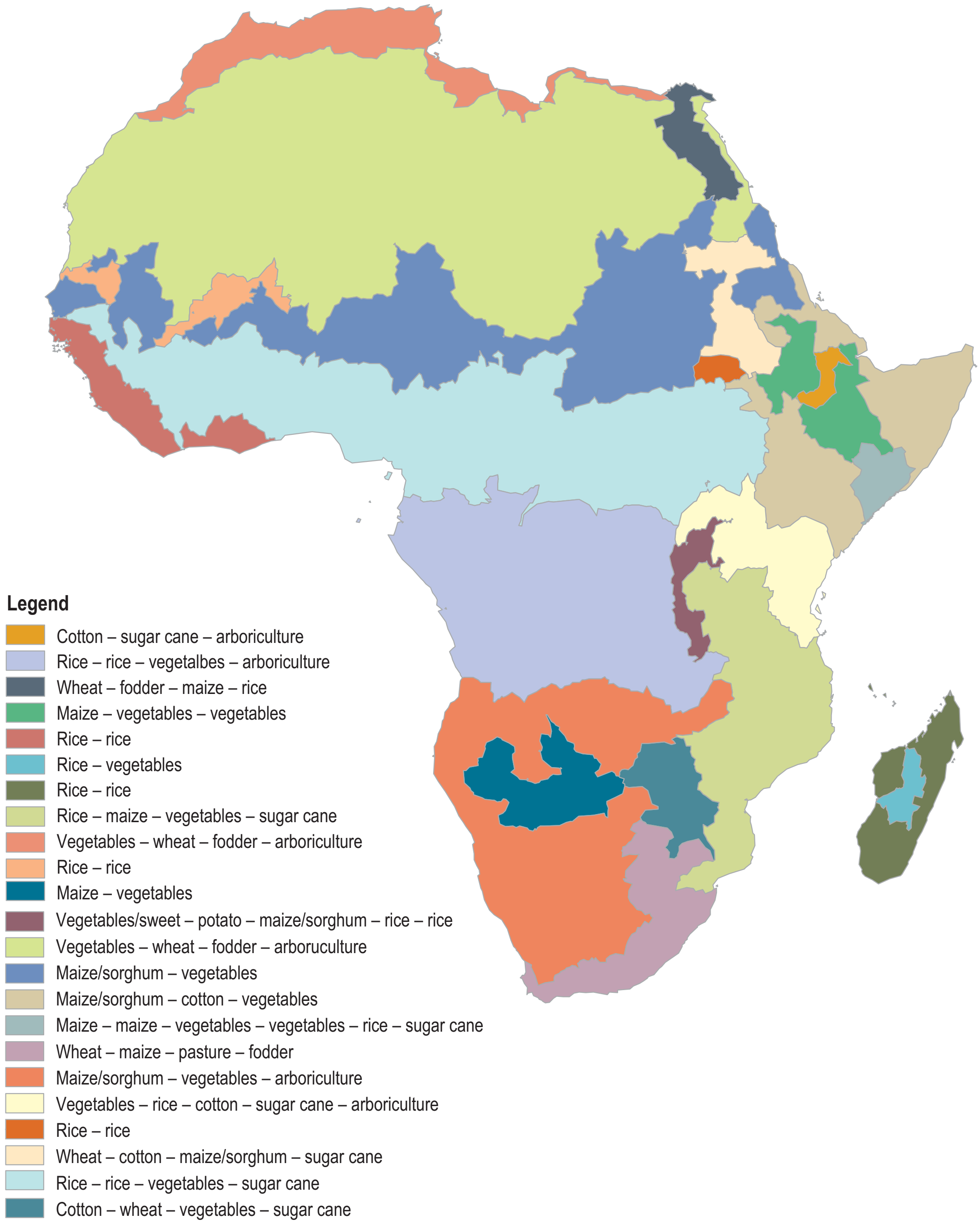
However, the analysis used for the preparation of FAO Water Bulletin No. 4 (1997a) was mainly concerned with an assessment of physical potential and its scope did not take into account complex institutional issues such as those described in Chapter 2.

AGRICULTURE

Cropping patterns / farming systems

Two systems of farming were used during the preparation of this study, one as described in FAO (1997) as indicated in Figure 5, the other from a joint FAO/World Bank (2001)

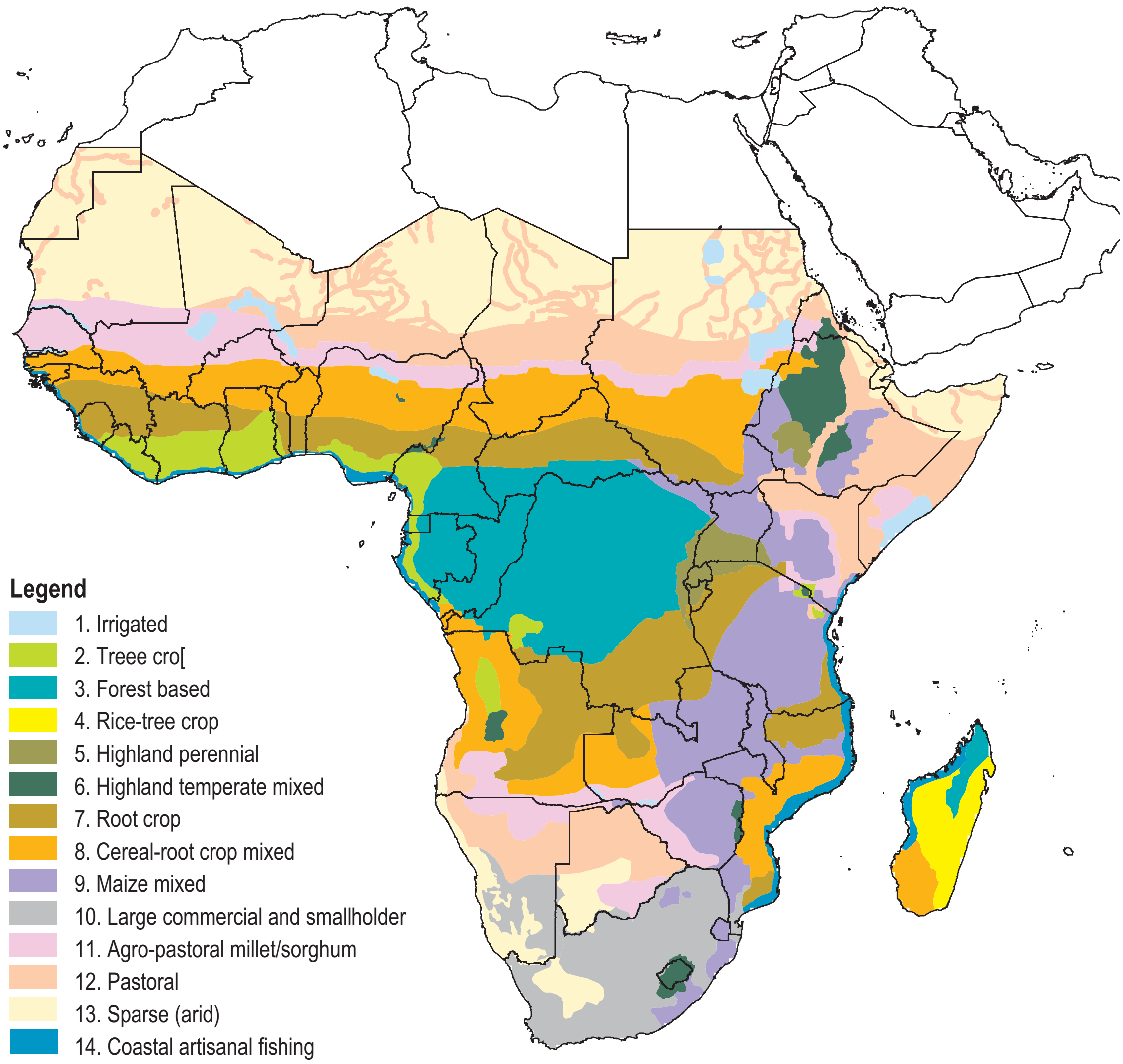
FIGURE 5
Cropping patterns map



Note: Multiple codes reflect different cropping calendars.
Source: FAO (1997).

publication, Figure 6. Despite FAO involvement in the preparation of both, they are essentially incompatible, not least because the former is based on specific cropping calendars with specific crops, whereas the latter considers clusters of crop types. In fact, both systems are highly generic and in some cases do not represent a complete picture of irrigated agriculture for any particular country, basin or region. Equally, the “Irrigated Farming System” for sub-Saharan Africa as described in FAO/World Bank (2001) concerns only permanently equipped areas (whether managed by commercial operators, government service providers, parastatals or farmer groups). It specifically does not include small-scale schemes or water harvesting, which are subsumed into other farming systems which are not classified as irrigated. As a consequence, a degree of judgement, caution and adaptation was necessary in order to prepare this analysis.

FIGURE 6
Farming systems map from “Farming Systems and Poverty”



Source: FAO/World Bank (2001).

Areas under agricultural water management

Baseline data for the area under agricultural water management have been taken from the AQUASTAT database and are summarized in Annex 4.

Irrigated yields

The data underlying the AT 2015/2030 analysis also provide information regarding yields and areas under both rainfed and irrigated production for a wide variety of crops and countries. Actual baseline information is provided (1997/99), while yields and irrigated areas have been estimated for 2015 and 2030 on the basis of expert judgement.

When using yields in a diagnostic exercise such as this, it is very important to compare actual yields with yields attainable on well-managed and well-resourced farms, thereby establishing realistic indications of any yield gaps.

With the important caveat that low yields are also a function of price expectation and social connectivity in terms of market access, yield gaps are a very important parameter in the context of this study. This is because a yield gap analysis provides an appropriate framework within which to consider the baseline situation, and also for financial and environmental reasons, it makes better sense to improve the yields upon existing assets before investing in new infrastructure, especially if expensive storage works are required. To calculate expected yield gaps, it has been necessary to make reasonable estimates of obtainable yield targets. This was done on the basis of literature review and expert judgement. The results are presented in Table 5.

Hence, an analysis of yield gaps provides an indication of the extent to which the 2015 and 2030 estimates can be achieved. Closing the gaps obviates the need to develop new irrigated areas. Type I yield gaps (generally reflecting agro-ecological constraints such as poor soils, topography, or climate) that cannot be narrowed are not applicable in this case. Type II yield gaps (generally taken to mean the difference between actual yields and those that could be obtained at the same location with better crop management) are much more relevant to irrigated production and they are generally of much larger magnitude. Intuition and the literature suggest that Type II gaps can be closed without recourse to major leaps forward in agronomic technology but rather by means of rehabilitated or upgraded infrastructure and strengthened institutions (including extension services).

Accordingly, it is necessary to examine:

- areas currently irrigated;
- typical yields of key crops;
- potential yields of these key crops.

Hence, for the purposes of this study, target yield estimates have been taken from several sources (ILACO, 1981; FAO, 1979). In some cases, these have been adjusted according to the judgement and experience of the consultants (Table 5).

It is also important to note that SSRs in excess of unity, but nonetheless low, do not necessarily represent a satisfactory state of affairs. Population growth means that

TABLE 5
Target yields assumed for the yield gap analysis

Crop	Potential yield (tonnes/ha)	Crop	Potential yield (tonnes/ha)	Crop	Potential yield (tonnes/ha)
Bananas	50.00	Millet	3.75	Sugar	150.00
Barley	4.25	Other cereals	2.50	Sunflower	3.00
Beets	75.00	Potatoes	20.00	Sweet potatoes	20.00
Citrus	32.50	Rice	4.00	Wheat	5.00
Groundnuts	2.50	Sorghum	1.20		
Maize	7.50	Soybean	3.00		

Note: Potential yields for groundnuts are for unshelled nut.

demand for agricultural production will continue to rise. This may mean improving productivity, but equally it may require that production be increased through new investments. This in turn requires an understanding of the regional irrigation sectors as they now stand and how they might look in the two horizons of 2015 and 2030.

Chapter 4
Baseline

Using the FAO 2015/30 analysis described above, this chapter examines the challenges faced by sub-Saharan Africa agriculture in fulfilling the regional demand for food and analyses the scope for meeting this challenge through expanded irrigated crop production. The chapter is in two parts. The first highlights the challenge by examining the structure of agricultural output in sub-Saharan Africa and projecting shortfalls in key crops. The second describes the current status of irrigation in sub-Saharan Africa in terms of water resources, levels of development, typical yields and yield gaps. In this report agricultural output is taken to comprise food crops, cash crops and livestock commodity groups, as defined in Annex 3.

ANALYSIS OF PROJECTED PRODUCTION AND CONSUMPTION OF AGRICULTURAL COMMODITIES IN SUB-SAHARAN AFRICA

Population growth

In 1997/99, some 10.5 percent of the world's population and 13.5 percent of the population of developing countries lived in sub-Saharan Africa (incl. South Africa). Between 1997/99 and 2030, the population of sub-Saharan Africa is projected to more than double. This compares with a 40-percent increase in the population of the world as a whole and a 41-percent increase in non-sub-Saharan Africa developing countries. By 2030, a projected 15.5 percent of the world's population will be living in sub-Saharan Africa (Table 7).

Production

Table 6 compares the base-period and projected aggregate agricultural output as defined in Chapter 3 in all developing countries and in sub-Saharan Africa with world agricultural output. The variables are indexed in percentage terms against a nominal value of 100 for the base year 1997/99 (required growth) and in terms of global achievement (regional share).

TABLE 6
Population and aggregate agricultural output for sub-Saharan Africa, developing countries and the world

	Growth (1997/99 = 100)			Regional share (World = 100)		
	1997/99	2015	2030	1997–99	2015	2030
	Developing countries 1997/99 = 100			World = 100		
Population						
World	100	122	140	100	100	100
Developing	100	127	150	77.8	81.2	83.5
Developing excluding SSA	100	124	141	67.3	68.3	68
Sub-Saharan Africa	100	150	207	10.5	12.9	15.5
Output						
World	100	131	160	100	100	100
Developing	100	141	182	60.5	65.4	68.9
Developing excluding SSA	100	142	180	54.6	59.2	61.5
Sub-Saharan Africa	100	138	203	5.9	6.2	7.4
Output per head						
World	100	107	114	100	100	100
Developing	100	111	121	78	81	83
Developing excluding SSA	100	114	127	81	87	90
Sub-Saharan Africa	100	92	98	56	48	48

Source: Annex 4.

The FAO 2015/30 analysis projects that the share of sub-Saharan Africa (excluding Republic of South Africa) in global output will increase for each of the commodity groups (food crops, cash crops and livestock) and that its share in global agricultural output will rise from 5.9 percent of the world total to 6.2 percent in 2015 and to 7.4 percent in 2030. However, the more rapid growth of population in sub-Saharan Africa will result in projected agricultural output per capita in the region falling even further behind that of the rest of the world. The FAO 2015/30 projection is that sub-Saharan Africa agricultural output per head will have fallen to as little as 48 percent of the average for the world as a whole by 2015 and will remain at 48 percent through to 2030. This contrasts with the rest of the developing world, where agricultural output per capita is projected to rise by 2030 to 90 percent of that of the world as a whole (Table 6).

Table 7 shows sub-Saharan Africa developing and developed (i.e. including Republic of South Africa), country shares in 1997/99 in world production of each commodity. sub-Saharan Africa accounted for more than half of the world's production of cassava, other roots, plantains and cocoa, and for more than 25 percent of millet, sorghum and sweet potatoes. Of these, only cocoa and sorghum are widely traded internationally (with some trade in millet between countries in the Sahel). However, sub-Saharan

TABLE 7
World production of agricultural commodities, 1997/99 baseline

	SSA (excluding Republic of South Africa)	Developing countries	Developed countries*	World	SSA	Developing countries*	Developed countries
	(1 000 tonnes)				(% share of world production)		
Wheat	4 502	280 235	316 738	596 973	0.8	46.9	53.1
Rice	11 670	561 877	25 531	587 408	2.0	95.7	4.4
Maize	34 614	268 110	333 558	601 667	5.8	44.6	55.4
Barley	1 245	24 014	115 906	139 920	0.9	17.2	82.8
Millet	13 132	26 427	1 491	27 917	47.0	94.7	5.3
Sorghum	18 537	43 831	17 304	61 135	30.3	71.7	28.3
Other cereals	2 159	8 580	60 678	69 258	3.1	12.4	87.6
Potato	5 361	123 656	175 740	299 397	1.8	41.3	58.7
Sweet potato	43 155	168 209	2 000	170 208	25.4	98.8	1.2
Cassava	90 115	164 708	0	164 708	54.7	100.0	0
Other roots	10 560	14 962	338	15 300	69.0	97.8	2.2
Plantains	22 468	30 380	0	30 380	74.0	100.0	0
Sugar	7 623	128 814	44 601	173 415	4.4	74.3	25.7
Pulses	6 992	39 320	16 783	56 102	12.5	70.1	29.9
Vegetables	20 423	405 138	145 258	550 397	3.7	73.61	26.4
Bananas	6 258	57 933	996	58 929	10.6	98.3	1.7
Citrus	6 102	72 110	29 324	101 434	6.0	71.1	28.91
Fruit	12 819	229 723	103 595	333 318	3.9	68.9	31.9
Vegetable oil & oilseeds	6 363	67 668	35 999	103 667	6.1	65.3	34.7
Cocoa	1 979	2 999	0	2 999	66.0	100.0	0
Coffee	1 242	6 452	3	6 455	19.2	99.9	0.1
Teas	574	3 691	149	3 840	14.94	96.1	3.9
Tobacco	461	5 507	1 358	6 865	6.7	80.2	19.8
Cotton	1 435	12 133	6 270	18 403	7.8	65.9	34.1
Fibres	134	4 491	147	4 637	2.9	96.8	3.2
Rubber	389	6 601	0	6 601	5.9	100.0	0
Beef	3 100	27 981	30 701	58 682	5.3	47.7	52.3
Mutton	1 427	7 360	3 466	10 825	13.2	68.0	32.0
Pigmeat	584	49 348	37 193	86 541	0.7	57.0	43.0
Poultry	1 393	31 250	30 599	61 849	2.3	50.5	49.5
Milk	18 580	219 317	342 412	561 729	3.3	39.0	61.0
Eggs	1 256	33 719	18 007	51 726	2.4	65.2	34.8

* Defined as world less developing countries.

Africa produced less than 1 percent of the world's wheat and barley, less than 2 percent of the world's rice and, despite its importance as the basic staple in most of eastern and southern Africa, only 5.75 percent of the world's maize. The generally very small percentage shares of sub-Saharan Africa in total world output mean that increases in sub-Saharan agricultural production stemming from increased irrigation are likely to have little impact on world prices, other than for crops where sub-Saharan Africa has a disproportionate share of particular markets (e.g. table grapes in South Africa). However, as mentioned in the introduction to this report, increased national output could have a significant impact on national prices and in the profitability of investment in irrigation.

Among the commodity groups, the greatest increase in the share of sub-Saharan Africa in world output is projected to be in livestock and dairy products, the share of which may rise from 3.4 percent in the base period to a projected 8.8 percent in 2030. This compares with a projected increase of 3.9–6.0 percent for different cereals and 11.5–13.3 percent in beverages and industrial crops. This suggests that demand for feed crops may be an important factor in driving the expansion of irrigation in sub-Saharan Africa.

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...This suggests that demand for feed crops may be an important factor in driving the expansion of irrigation in sub-Saharan Africa

Analysis of the FAO 2015/30 value data (the nominal value being used as a proxy for actual agricultural output as explained in Chapter 3) shows the very low nominal value of non-food crops compared with the total nominal value of all agricultural commodities (Table 8). In the base year (1997/1999), non-food crops (including tropical beverages) accounted for only an estimated 4 percent of the total nominal value of all agricultural commodities, and this is projected to remain roughly constant to 2030. In the case of sub-Saharan Africa, the share of non-food crops is substantially higher at 8.6 percent, but this is projected to fall to 6.9 percent by 2030. These very low percentages partly reflect the fact that the 2015/30 data are gross figures, which means that they include both the value of feed and of the livestock that consume it. However, even if the farmgate value of feed were to be excluded completely from the value of food commodities, it would only increase the shares of non-food commodities marginally. A more important fact masking the relative value of non-food crops is that more value tends to be added during the off-farm processing of such crops than of most food commodities.

Notwithstanding the greater relative importance of non-food crops in sub-Saharan Africa compared with the rest of the world, they are of only minor importance for sub-Saharan Africa as a whole. Food crops are vastly more important, and their importance will increase. Thus, while the impact of declines in non-food export crop prices tends to be heavily publicized internationally, it is food crop production and prices that will remain of critical importance for most sub-Saharan Africa countries and for the majority of their farmers. While non-food crops are more important in some sub-Saharan Africa countries than others, the detailed FAO 2015/30 data show that, in each sub-Saharan Africa country, the nominal value of food crop production comprises well over 50 percent of the nominal value of all agricultural production.

... while the impact of declines in non-food export crop prices tends to be heavily publicized internationally, it is food crop production and prices that will remain of critical importance for most sub-Saharan Africa countries and for the majority of their farmers.

Table 8 shows the importance of non-cereal staple food crops for sub-Saharan Africa. This contrasts with the rest of the world and, indeed, with developing countries as a whole, where non-cereal staples account for only some 7 percent of the value of agricultural output. The reliance on non-cereal staple crops is particularly heavy in the sub-Saharan Africa countries bordering the Gulf of Guinea and the Atlantic Ocean to the north of Namibia. These countries, together with

TABLE 8
Production values of commodity groups as a percentage of the value of agricultural production**

		Cereals	Non-cereal staple food crops*	Other food crops	Livestock & dairy	Beverages & industrial crops	All food commodities	All commodities
					(%)			
World	Base year	22.7	6.5	26.5	40.4	3.9	96.1	100.0
	2015	21.7	6.1	26.9	41.3	3.9	96.1	100.0
	2030	20.9	5.9	27.4	42.0	3.8	96.2	100.0
Developing countries	Base year	23.5	7.5	30.3	33.6	5.1	94.9	100.0
	2015	21.4	7.0	30.0	36.7	4.8	95.2	100.0
	2030	19.9	6.7	29.8	39.0	4.6	95.4	100.0
SSA	Base year	16.9	24.1	23.9	26.5	8.6	91.4	100.0
	2015	17.1	22.2	25.1	28.0	7.6	92.4	100.0
	2030	16.8	21.1	25.3	29.9	6.9	93.1	100.0
Central	Base year	8.3	41.0	25.3	17.8	7.6	92.4	100.0
	2015	8.6	39.7	26.4	18.1	7.1	92.9	100.0
	2030	8.6	38.7	26.3	20.3	6.2	93.8	100.0
Eastern	Base year	15.9	29.0	15.2	31.2	8.7	91.3	100.0
	2015	15.8	29.3	16.4	30.9	7.6	92.4	100.0
	2030	15.8	28.3	17.0	31.9	7.0	93.0	100.0
Gulf of Guinea	Base year	17.4	34.8	27.4	10.1	10.3	89.7	100.0
	2015	18.0	28.6	31.0	13.2	9.3	90.7	100.0
	2030	17.6	25.3	32.5	16.4	8.2	91.8	100.0
Indian Ocean Islands	Base year	23.7	14.6	22.4	35.0	4.3	95.7	100.0
	2015	22.6	14.8	22.4	36.3	3.9	96.1	100.0
	2030	23.1	14.3	21.4	37.6	3.6	96.4	100.0
Republic of South Africa	Base year	19.7	3.0	31.9	44.0	1.4	98.6	100.0
	2015	21.0	2.8	31.5	43.4	1.3	98.7	100.0
	2030	20.5	2.5	30.8	44.9	1.3	98.7	100.0
Southern	Base year	18.6	19.4	20.2	25.6	16.2	83.8	100.0
	2015	20.7	18.9	21.6	26.1	12.7	87.3	100.0
	2030	20.5	17.3	22.7	27.8	11.8	88.2	100.0
Sudano-Sahelian	Base year	17.4	5.1	23.5	46.5	7.6	92.4	100.0
	2015	17.7	4.9	22.7	48.1	6.7	93.3	100.0
	2030	17.6	5.0	22.1	49.5	5.8	94.2	100.0

* Staple root crops, plantains and pulses.
** Nominal values based on 1989–91 produce prices which do not reflect actual farmgate or commodity prices

the Central African Republic, account for 27 percent of the total sub-Saharan Africa population. In 1997/99, in sub-Saharan Africa as a whole, the estimated farmgate value of staple root crops, plantains and pulses exceeded that of cereals, with the total value of these non-cereal staples accounting for 24 percent of the total value of agricultural output against 17 percent for cereals.

Annex 3 presents more detailed information on commodity shares. In terms of kcal/capita/day cassava, in the base year, was the most important staple food crop, with production accounting for 8.6 percent of the total of sub-Saharan Africa agricultural output, 9.5 percent of the value of all food output (including livestock products) and 13.3 percent of the value of all food crop output.

The FAO 2015/30 analysis suggests that this dominance of non-cereal staples in sub-Saharan Africa will continue, but for their contribution to the total value of sub-Saharan Africa agricultural output to have nonetheless declined to 21 percent by 2030. The contribution of cereals is projected to remain at 17 percent. There are exceptions to the dominance of non-cereal staple food crops, as in Ethiopia and South Africa, where cereals account for all but a small proportion of staple food crop output. Vegetable oils produced from seeds and nuts were also of major importance in sub-Saharan Africa in 1997/99, accounting for 9.1 percent of the value of food output and 8.3 percent of the total value of agricultural output.

A further key fact highlighted by FAO 2015/30 data is the importance of livestock in each sub-Saharan Africa region other than the Gulf of Guinea. Although the sub-Saharan Africa output of livestock products is relatively less important than in both non-sub-Saharan Africa developing countries and the world as a whole, it contributes more to the value of agricultural output than cereals in every sub-Saharan Africa region except for than the Gulf of Guinea. The importance of livestock is projected to increase further in the periods to 2015 and 2030, except in Eastern Africa and the Republic of South Africa. Within livestock products, beef and milk were the main commodities, together accounting for some 64 percent of the total value of livestock output.

TABLE 9

Analysis of crop use for feed in Sub-Saharan Africa, developing countries and the world

	SSA	Developing	World
Base year (1997/99)		**(world = 100)**	
Feedgrain	1.2	35.0	100.0
Other feed	3.1	54.6	100.0
Total crop-based feed	1.8	38.8	100.0
Feedgrain as % of all crops	1.9	5.4	10.4
Other feed crops as % of all crops	1.6	2.7	3.3
All feed crops as % of all crops	3.5	8.1	13.7
2015		**(world = 100)**	
Feedgrain	1.5	45.0	100.00
Other feed	3.9	62.8	100.00
Total crop-based feed	2.2	48.2	100.00
Feedgrain as % of all crops	2.3	7.2	11.3
Other feed crops as % of all crops	1.7	3.0	3.4
All feed crops as % of all crops	4.0	10.2	14.7
2030		**(world = 100)**	
Feedgrain	2.0	51.5	100.00
Other feed	5.4	67.8	100.00
Total crop-based feed	3.0	54.4	100.00
Feedgrain as % of all crops	2.7	8.4	11.9
Other feed crops as % of all crops	2.1	3.2	3.4
All feed crops as % of all crops	4.7	11.7	15.3

Notes:
1. The data in the table exclude animal products recycled as feed.
2. Some feed is a by-product of processing and this component of feed tends to be greater for non-cereal based feed.

Table 9 presents an analysis for 1997/99, 2015 and 2030 of the importance of feed production in sub-Saharan Africa relative to all developing countries and the world. For each of these three groups, Table 10 also contains estimates and projections of the importance in total crop production of feedgrain, other feed crops and all feed crops. As Table 9 shows, in 1997/99, about 1 percent of all crops (by value) was used worldwide as animal feed. The majority of this was grain. Some 40 percent of the total consumption of feed crops took place in developing countries, where 8 percent of all crops was used as feed. Feed use in sub-Saharan Africa was much lower, accounting for only 3.5 percent of the value of all crop output. This reflects a greater reliance on grazing and also the lower ratio of livestock to crop output. Compared with other developing countries and the world as a whole, relatively more non-grain feed is used in sub-Saharan Africa, but grain is still the main source of feed.

It is projected that the use of crop-based feed in sub-Saharan Africa will expand almost threefold between 1997/99 and 2030, raising the proportion of all crops used in feed from 3.5 to 4.7 percent. This is a much higher rate of increase in feed use than projected for developing countries and the world as a whole. However, the projected sub-Saharan Africa increase is from a small base. Worldwide, projected feed use will increase in tonnage by twenty times the increase in sub-Saharan Africa. Thus, as with increases in crop production, the increased use of feed in sub-Saharan Africa will have only a minor impact on world markets, but a greater impact on markets within individual sub-Saharan Africa countries.

Projected self-sufficiency ratios and trade

Annex 5 presents the 1997/99, 2015 and 2030 nominal value data for commodity groups as contained in the FAO 2015/30 SUAs, reworked into a set of tables that refer to each of the six sub-Saharan Africa regions plus South Africa. A final column in each table shows the extent to which the region is self-sufficient in each commodity group in the base period. These SSRs, reworked into ratios for the modified set of commodity groups, are shown in Table 11 on the basis of the traded nominal values of the respective commodity groups.

Table 10 shows that sub-Saharan Africa cereal production is projected to be about 20 percent less than demand in 1997/99, 2015 and 2030. The lowest SSR in 1997/99 was for wheat (Annex 5), for which only about one-third of that utilized was produced within sub-Saharan Africa. About one-third of all rice consumed was imported, together with small amounts of maize, sorghum and other cereals. The FAO 2015/30 projections indicate that the percentage of consumption met by imports will increase marginally for wheat and rice.

At the regional level, the greatest cereal shortfalls will remain in Central Africa, where the cereal SSR may fall from 0.63 in the base period to a projected 0.59 in 2015 and 0.52 in 2030. For all foodstuffs, including sugar and horticultural and livestock products, the SSR for sub-Saharan Africa will fall slightly from 0.93 in the base year

TABLE 10
Self-sufficiency ratios* analysed by commodity group and region: baseline, 2015, 2030

	Cereals	Non-cereal staple food crops*	Other food crops	Beverages and industrial crops	Livestock and dairy	All food commodities	All agricultural commodities
World							
1997-1999	1.01	0.99	1.04	0.92	1.01	1.02	1.02
2015	1.00	1.00	1.01	0.99	1.00	1.01	1.01
2030	1.00	1.00	1.00	0.99	1.00	1.00	1.00
Developing							
1997–1999	0.92	1.02	1.07	3.06	0.97	0.96	0.97
2015	0.89	1.02	1.03	2.99	0.96	0.94	0.94
2030	0.87	1.01	0.97	2.70	0.96	0.93	0.93
Sub-Saharan Africa							
1997–1999	0.83	1.00	0.93	6.55	0.93	0.90	0.91
2015	0.83	1.00	0.91	7.90	0.93	0.89	0.90
2030	0.82	1.00	0.89	8.01	0.93	0.88	0.89
Central							
1997–1999	0.67	1.00	0.87	5.72	0.78	0.87	0.88
2015	0.64	1.00	0.86	5.93	0.78	0.86	0.86
2030	0.58	1.00	0.80	5.07	0.76	0.81	0.81
Eastern							
1997–1999	0.86	1.00	0.79	1.15	0.99	0.89	0.89
2015	0.87	1.00	0.79	0.72	0.99	0.89	0.89
2030	0.86	1.00	0.80	0.73	0.99	0.89	0.89
Gulf of Guinea							
1997-1999	0.86	1.00	0.93	7.15	0.71	0.92	0.95
2015	0.83	1.00	0.92	9.12	0.76	0.90	0.93
2030	0.82	1.00	0.91	9.48	0.79	0.89	0.91
Indian Ocean Islands							
1997–1999	0.76	0.99	1.09	1.73	0.87	0.89	0.89
2015	0.75	1.00	0.92	1.76	0.89	0.84	0.85
2030	0.76	1.00	0.81	1.82	0.90	0.83	0.83
RSA							
1997–1999	0.88	0.95	1.09		0.95	0.94	0.94
2015	0.96	0.94	1.25		0.94	1.02	1.02
2030	0.97	0.92	1.40		0.95	1.06	1.06
Southern							
1997–1999	0.75	1.00	1.08		1.01	0.87	0.87
2015	0.81	1.00	1.02		1.00	0.89	0.89
2030	0.82	1.00	1.00		0.99	0.89	0.89
Sudano-Sahelian							
1997–1999	0.79	0.91	0.90		0.99	0.84	0.84
2015	0.80	0.97	0.85		0.99	0.84	0.84
2030	0.80	0.97	0.81		0.99	0.83	0.83

* On the basis of nominal values for 1989–91 producer prices.
** Staple root crops, plantains and pulses.

to a projected 0.92 in 2015 and 0.91 in 2030. For non-food crops, SSRs in sub-Saharan Africa and projected to fall sharply from 3.12 in the base year to 2.20 in 2030.

Table 11 shows there will also be growing shortfalls of other food commodities in all the sub-Saharan Africa regions, but the size and rate of increase in the magnitude of these calorie shortfalls will be much less than for cereals. The main contributor to net sub-Saharan Africa deficits will be rice and wheat. In 2030, it is projected that sub-Saharan Africa will import 11.3 million tonnes of rice and 20.4 million tonnes of wheat. As rice trades at higher prices than wheat, the cost to sub-Saharan Africa of importing its net rice needs will exceed that of wheat. For staple food crops other than cereals, their low value-to-weight ratios and greater perishability are likely to result in

TABLE 11
Value of net agricultural trade Baseline, 2015 and 2030

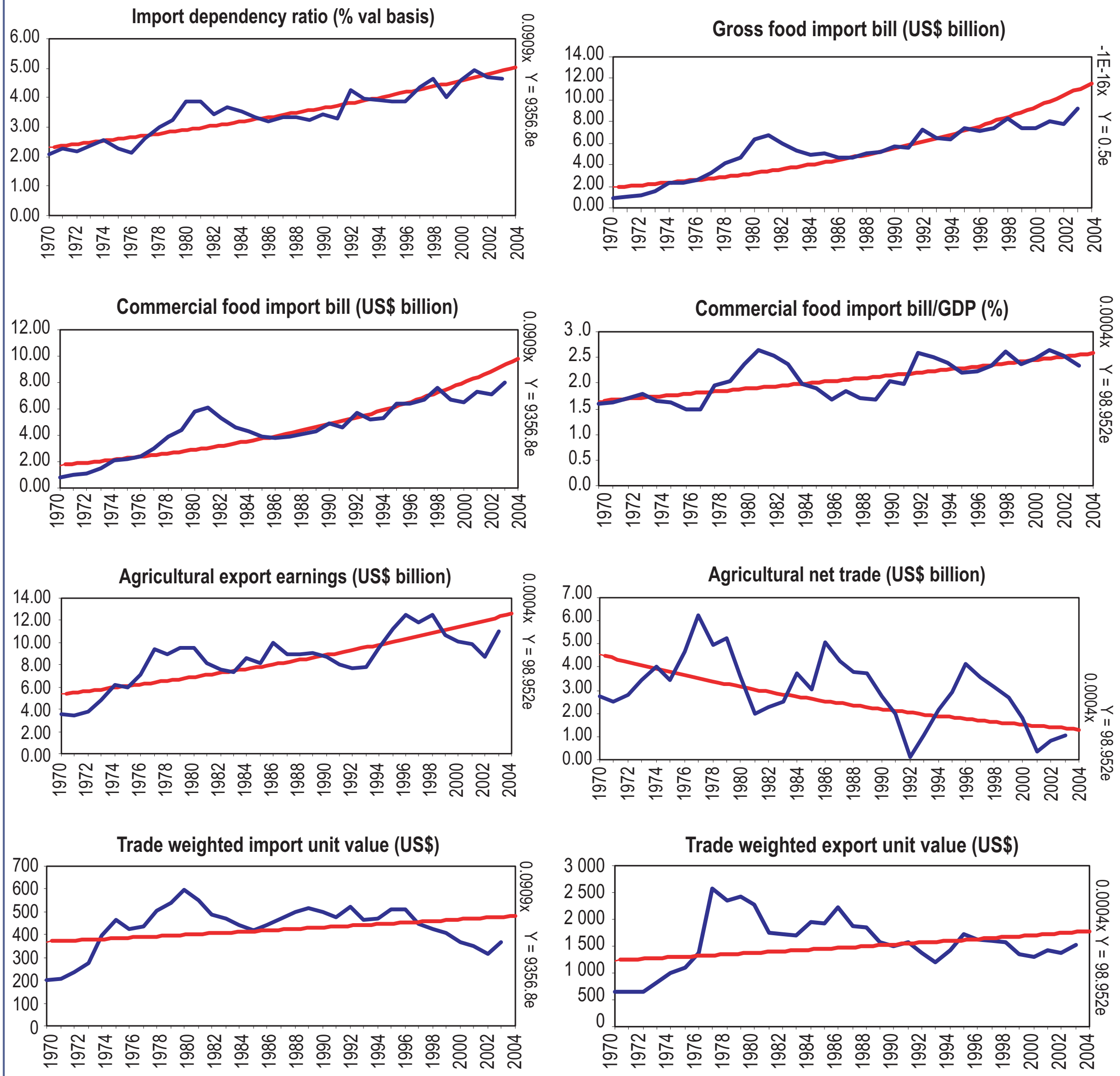
	Tonnes ('000)			kcal/cap/day		
	1997-1999	2015	2030	1997-1999	2015	2030
Wheat	-8 241	-13 394	-21 135	-106.38	-114.92	-132.10
Rice	-6 575	-11 443	-18 015	-70.39	-81.41	-93.37
Maize	-2 772	-3 262	-5 589	-38.79	-30.34	-37.87
Barley	-609	-988	-1 455	-6.94	-7.48	-8.03
Millet	-35	-57	-65	-0.43	-0.48	-0.40
Sorghum	-644	-191	-329	-8.24	-1.63	-2.04
Other	-184	-295	-386	-2.66	-2.84	-2.70
Subtotal	**-19 059**	**-29 630**	**-46 973**	**-233.84**	**-239.10**	**-276.50**
Potato	-114	-158	-258	-0.36	-0.33	-0.40
Sw. Potato	-21	1	1	-0.09	0.00	0.00
Cassava	-112	-12	-30	-0.48	-0.03	-0.06
Other Root	-141	-95	-128	-0.72	-0.33	-0.32
Plantain	0	-8	-81	0.00	-0.02	-0.14
Subtotal	**-388**	**-272**	**-495**	**-1.66**	**-0.71**	**-0.91**
Sugar	49	-1 347	-3 235	0.79	-14.45	-25.29
Pulses	-157	-219	-327	-2.35	-2.18	-2.38
Vegetables	-308	-203	-249	-0.38	-0.17	-0.15
Bananas	364	494	592	0.85	0.77	0.67
Citrus	778	952	1 148	0.85	0.69	0.61
Fruit	1 033	1 351	1 393	1.97	1.72	1.29
Vegetable Oils	-1 104	-1 654	-2 967	-47.03	-46.84	-61.22
Subtotal	**655**	**-626**	**-3 645**	**-45.30**	**-60.47**	-86.47
Cocoa	1 677	2 249	2 695	28.47	25.37	22.15
Coffee	962	1 082	1 234			
Teas	320	421	568			
Tobacco	331	207	182			
Cotton	792	1 009	1 204			
Fibres	6	-8	-22			
Rubber	269	576	974			
Subtotal	**4 356**	**5 535**	6 836	28.47	25.37	22.15
Beef	-14	-105	-209	-0.12	-0.60	-0.88
Mutton	10	23	30	0.08	0.12	0.11
Pigmeat	-52	-81	-118	-0.82	-0.85	-0.90
Poultry	-212	-360	-687	-1.19	-1.34	-1.87
Milk	-2 288	-3 505	-5 126	-6.99	-7.11	-7.58
Eggs	-7	-6	-19	-0.04	-0.02	-0.05
Subtotal	**-2 563**	**-4 033**	**-6 129**	**-9.08**	**-9.81**	**-11.17**
Total Trade Deficit	-16 999	-29 026	-50 407	-261.41	-284.71	-352.90
Total Net Exports	6 590	8 365	10 021	33.01	28.67	24.83
Total Net Imports	-23 589	-37 390	-60 428	-294.42	-313.39	-377.73
Total Production				2 567.39	2 615.92	2 729.46
Total Demand				2 828.80	2 900.64	3 082.36
Total Deficit (%)				**9.2**	**9.8**	**11.4**

a continuation of the present situation where markets clear nationally and there is only limited intercountry trade.

Vegetable oils will also be a major contributor to the increasing agricultural trade deficit for sub-Saharan Africa, with the oil equivalent of net imports (all oils and oilseeds combined) projected to increase by 170 percent between the 1997/99 base year and 2030. Sub-Saharan Africa will also be a major importer of livestock products, especially milk and poultry.

The main agricultural export commodities of sub-Saharan Africa will continue to be cocoa, cotton, coffee and tea, in that order. Of these, cocoa exports are projected to increase the most rapidly, expanding by over 60 percent between 1997/99 and 2030. In terms of nominal value, total food exports of sub-Saharan Africa countries are projected to increase by almost 50 percent over this full projection period, compared with a near tripling of food imports.

FIGURE 7
Trade data profile for sub-Saharan Africa



* additional production of the commodity to meet the calorific shortfall for that commodity.
** Additional production of the commodity required to make good the total calorie shortfall.

Although the expansion of the agricultural trade deficit of sub-Saharan Africa will be large in nominal value terms, the total agricultural imports of sub-Saharan Africa in 2030 will be only a projected 27 percent of the total agricultural imports of developing countries as a whole. Given that the population of sub-Saharan Africa in 2030 is projected to be 1 300 million compared with a figure of 6 900 million for all developing countries, the projected deficit per head will be marginally smaller in sub-Saharan Africa than elsewhere in the developing world. However, agricultural trade deficits are likely to be a much greater problem for most sub-Saharan Africa countries, given that their manufacturing and service sectors tend to be less well developed than in developing nations in other continents.

These findings are echoed in actual trade data. The Trade and Food Security Database compiled by FAO presents a profile for sub-Saharan Africa, which is presented in Figure 7. These data confirm an acceleration of commercial food imports for sub-Saharan Africa as a whole region and a decline of agricultural net trade.

Calories

Table 12 contains estimates and projections of calorie surpluses and nutritional/ commodity deficits in sub-Saharan Africa. For each commodity, the baseline and

TABLE 12

Sub-Saharan Africa calorie shortfalls and the additional production needed to eliminate the apparent shortfall, baseline 2015 and 2030

		1997/99			2015			2030		
		Shortfall			Shortfall			Shortfall		
	Calories per kg	Nutritional Deficit (cal's*10^9)	Commodity Deficit* (m. tonnes)	Group Deficit** (m. tonnes)	Nutritional Deficit (cal's*10^9)	Commodity Deficit* (m. tonnes)	Group Deficit** (m. tonnes)	Nutritional Deficit (cal's*10^9)	Commodity Deficit* (m. tonnes)	Group Deficit** (m. tonnes)
Wheat	2 904	23 931	8.24	20.25	38 896	13.39	33.18	61 375	21.13	56.46
Rice	2 408	15 834	6.58	24.42	27 555	11.44	40.02	43 379	18.01	68.09
Maize	3 148	8 725	2.77	18.68	10 268	3.26	30.61	17 595	5.59	52.08
Barley	2 563	1 562	0.61	22.94	2 532	0.99	37.60	3 729	1.45	63.97
Millet	2 831	98	0.03	20.77	161	0.06	34.04	185	0.07	57.92
Sorghum	2 880	1 854	0.64	20.42	551	0.19	33.46	947	0.33	56.93
Other cereals	3 253	598	0.18	18.08	961	0.30	29.62	1 255	0.39	50.40
Potato	716	82	0.11	82.13	113	0.16	134.59	185	0.26	229.00
Sw. Potato	991	21	0.02	59.34	-1	0.00	97.24	-1	0.00	165.45
Cassava	968	108	0.11	60.75	12	0.01	99.55	29	0.03	169.38
Other Root	1 156	162	0.14	50.87	110	0.10	83.36	147	0.13	141.83
Plantain	800	0	0.00	73.51	7	0.01	120.45	64	0.08	204.95
Sugar	3 632	-177	-0.05	16.19	4 892	1.35	26.53	11 748	3.23	45.14
Pulses	3 375	528	0.16	17.42	739	0.22	28.55	1 105	0.33	48.58
Vegetables	279	86	0.31	210.77	57	0.20	345.39	69	0.25	587.67
Bananas	525	-191	-0.36	112.01	-259	-0.49	183.55	-311	-0.59	312.31
Citrus	246	-191	-0.78	239.04	-234	-0.95	391.72	-282	-1.15	666.51
Fruit	430	-444	-1.03	136.75	-581	-1.35	224.10	-599	-1.39	381.30
Veg/Oils	9 586	10 580	1.10	6.13	15 854	1.65	10.05	28 445	2.97	17.10
Cocoa	3 819	-6 403	-1.68	15.40	-8 588	-2.25	25.23	-10 291	-2.69	42.93
Beef	1 954	27	0.01	30.09	205	0.10	49.32	408	0.21	83.91
Mutton	1 747	-18	-0.01	33.66	-41	-0.02	55.16	-53	-0.03	93.85
Pig meat	3 544	185	0.05	16.59	287	0.08	27.19	420	0.12	46.26
Poultry	1 262	267	0.21	46.60	454	0.36	76.36	867	0.69	129.92
Milk	687	1 572	2.29	85.60	2408	3.50	140.27	3521	5.13	238.66
Eggs	1 289	10	0.01	45.62	7	0.01	74.76	24	0.02	127.20
Total		58 804			96 363			163 961		

* additional production of the commodity to meet the calorific shortfall for that commodity.

** Additional production of the commodity required to meet the total calorie shortfall for the whole of the commodity group (thereby indicating prospects for trade).

projected production is subtracted from overall demand including human consumption, use for animal feed and seed, industrial usage, and losses. The largely positive data shown in Table 12 are in effect the calorie content of the imports of that commodity that would be necessary to allow demand to be met fully. Of all the commodities produced in sub-Saharan Africa, the only one that generates a large calorie surplus is cocoa.

The calorie deficit in sub-Saharan Africa comprised 9.2 percent of the estimated total demand for calories in 1997/99 and is projected to comprise 11.4 percent of such demand in 2030. In terms of kcal/cap/day, the sub-Saharan Africa net annual deficit will increase by more than 40 percent between 1997/99 and 2030. The projected deficit that would need to be made good through imports would need to be even larger than this in order to offset the 25 kcal/cap/day that sub-Saharan Africa is projected to export in 2030, principally in the form of cocoa and cocoa products.

Table 13 gives an indication for each commodity of the magnitude of the sub-Saharan Africa calorie deficits that are projected for 2015 and 2030. This is achieved by converting calorie deficits into the amount of the commodity that would need to be produced in order to make good the deficit. The magnitude of aggregate calorie deficits for sub-Saharan Africa is proportionally larger than the deficits specified in value terms because none of its major exports other than cocoa, contains usable calories.

TABLE 13
Absolute and relative size of projected calorie deficits in Sub-Saharan Africa, by commodity, 2015 and 2030

Baseline		2015				2030			
	Estimated production	Projected production	Projected deficit	(C) as a	(C) as a	Projected production	Projected deficit	(G) as a	(G) as a
	(m. tonnes)	(m. tonnes)	(m. tonnes)	% of (A)	% of (B)	(m. tonnes)	(m. tonnes)	% of (A)	% of (F)
	A	B	C	D	E	F	G	H	I
Wheat	4.50	6.92	13.39	-297.64	-193.55	9.69	21.13	-469.66	-218.11
Rice	11.67	18.99	11.44	-98.05	-60.26	28.29	18.01	-154.37	-63.68
Maize	34.61	55.93	3.26	-9.42	-5.83	80.95	5.59	-16.15	-6.90
Barley	1.24	1.89	0.99	-79.66	-52.26	2.64	1.45	-117.33	-55.11
Millet	13.13	20.35	0.06	-0.43	-0.28	29.31	0.07	-0.50	-0.22
Sorghum	18.54	28.39	0.19	-1.03	-0.67	39.27	0.33	-1.77	-0.84
Other cereals	2.16	3.27	0.30	-13.68	-9.03	4.95	0.39	-17.86	-7.79
Potato	5.36	8.75	0.16	-2.94	-1.80	12.67	0.26	-4.82	-2.04
Sw. Potato	43.15	48.75	0.00	0.00	0.00	64.98	0.00	0.00	0.00
Cassava	90.11	133.24	0.01	-0.01	-0.01	183.64	0.03	-0.03	-0.02
Other Root	10.56	13.61	0.10	-0.90	-0.70	17.12	0.13	-1.21	-0.74
Plantains	22.47	34.05	0.01	-0.04	-0.02	47.31	0.08	-0.36	-0.17
Sugar	7.62	10.83	1.35	-17.68	-12.44	15.03	3.23	-42.45	-21.52
Pulses	6.99	11.61	0.22	-3.13	-1.89	17.34	0.33	-4.68	-1.89
Vegetables	20.42	32.52	0.20	-0.99	-0.62	47.31	0.25	-1.22	-0.53
Bananas	6.26	10.48	-0.49	7.89	4.71	14.75	-0.59	9.46	4.01
Citrus	6.10	9.91	-0.95	15.60	9.61	14.09	-1.15	18.82	8.15
Fruits	12.82	19.29	-1.35	10.54	7.00	26.7	-1.39	10.86	5.22
Veg. Oils	6.36	10.93	1.65	-26.00	-15.13	16.79	2.97	-46.66	-17.67
Cocoa	1.98	2.57	-2.25	113.58	87.50	3.08	-2.69	136.09	87.49
Beef	3.10	4.89	0.10	-3.38	-2.14	7.35	0.21	-6.74	-2.84
Mutton	1.43	2.33	-0.02	1.62	1.00	3.55	-0.03	2.13	0.86
Pigmeat	0.58	0.98	0.08	-13.95	-8.26	1.64	0.12	-20.41	-7.22
Poultry	1.39	2.65	0.36	-25.91	-13.59	5.17	0.69	-49.42	-13.29
Milk	18.58	29.36	3.50	-18.86	-11.94	42.94	5.13	-27.59	-11.94
Eggs	1.26	2.33	0.01	-0.44	-0.24	3.95	0.02	-1.49	-0.48

Table 13 shows that the projected 2030 deficit in wheat production would be some 4.7 times the size of mean annual sub-Saharan Africa production in 1997/99 and more than three times the amount produced in 2015. The 2030 rice deficit is projected to be just over 1.5 times the size of 1997/99 production. On the other hand, the 2030 maize deficit, although substantial in absolute terms, is only some 16 percent of 1997/99 production and only 6.9 percent of projected 2030 production. The shortfall in vegetable oil, the other commodity that is projected to be a major component of the overall sub-Saharan Africa calorie deficit, would be equivalent to an estimated 47 percent of 1997/99 production.

THE CONTRIBUTION OF IRRIGATED AGRICULTURE

SSRs will remain low for most commodity groups in most of sub-Saharan Africa for the foreseeable future. However, despite: (i) the potential production increases that could be secured by means of well-planned and properly managed irrigation; and (ii) the vast undeveloped resources of sub-Saharan Africa, irrigated production comprises only a small percentage of overall production. This is shown in Figures 8, 9 and 10.

Nonetheless, the comparisons presented in these figures are somewhat artificial as they compare irrigated production with an overall production scenario that necessarily includes crops that would not normally be irrigated, and sometimes, as in the case of non-cereal staple foods these are of major importance. However, they do provide an indication of the relative insignificance of the sub-Saharan Africa irrigation sector.

No data are given with respect for the livestock and dairy group. This is because the AT 2015/2030 analysis provide no data with respect to pasture or silage crops, even though it is known: (i) that there is irrigated pasture at various locations in sub-Saharan Africa; (ii) that where farming systems involve agroforestry, fodder is often one of the outputs. Furthermore, residues or by-products from other crops, such as oil-seed cake and maize stover, are also used for animal feed, thereby introducing the risk of double counting in the absence of clarification.

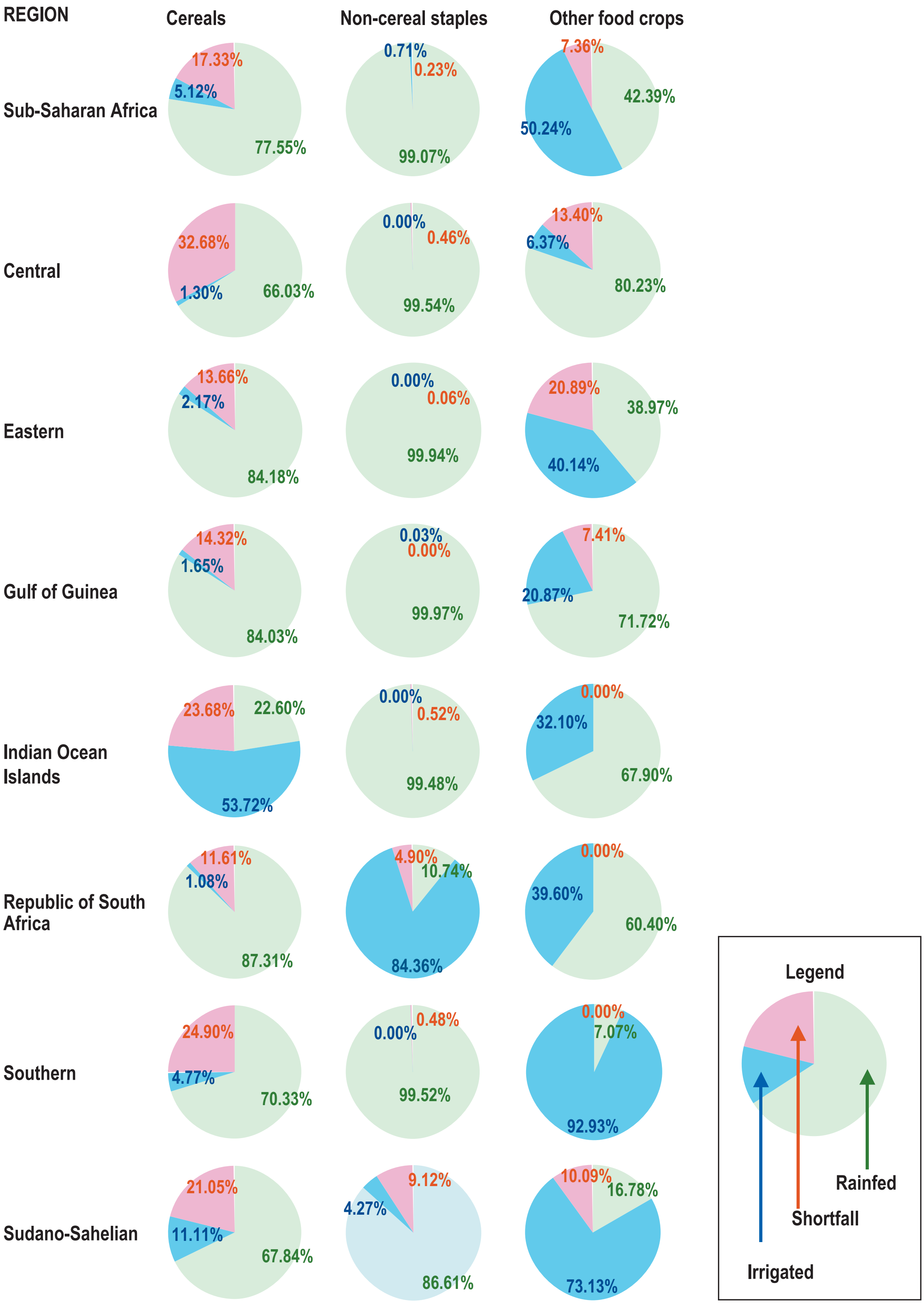
Similarly, the beverages and industrial commodity group is not featured in Figure 8 because: (i) any comparison based on calorific equivalents would be meaningless as only cocoa has any calorific value; and (ii) while tea and coffee are irrigated as estate crops in Kenya and United Republic of Tanzania these are relatively small areas upon which supplementary irrigation is applied. Also, it should be noted that the graphic for South Africa is indicative. These assumptions are that the total irrigated area will increase from 1 498 000 ha (Base Year) to the full potential of 1 500 000 ha by 2015; and that irrigated cropping intensities will increase 1.11 (Base Year) to 1.15 in 2015 and 1.2 by 2030.

The AT 2015/2030 analysis carries projections based on two assumptions: (i) increases in irrigated areas; and (ii) improved yields under irrigation (Figure 9 and 10). Despite the substantial increases in productivity assumed in the projection, unremitting population growth means that, percentage shortfalls in terms of per capita calorie requirements, remain at much the same levels across the board. The figures also indicate that irrigation continues to make only a small contribution to overall production. The only important exceptions are the country, Madagascar, and the commodity, rice. While this small relative contribution of irrigated production is most immediately obvious with respect to cereals, it should be noted that the other food crops group is dominated by sugar. If sugar were removed from the analysis, then irrigation would again represent only a very small proportion of overall productivity.

1997/99

FIGURE 8

Baseline comparison of rainfed production, irrigated production and apparent shortfalls* according to 1997/99 calorific equivalents**



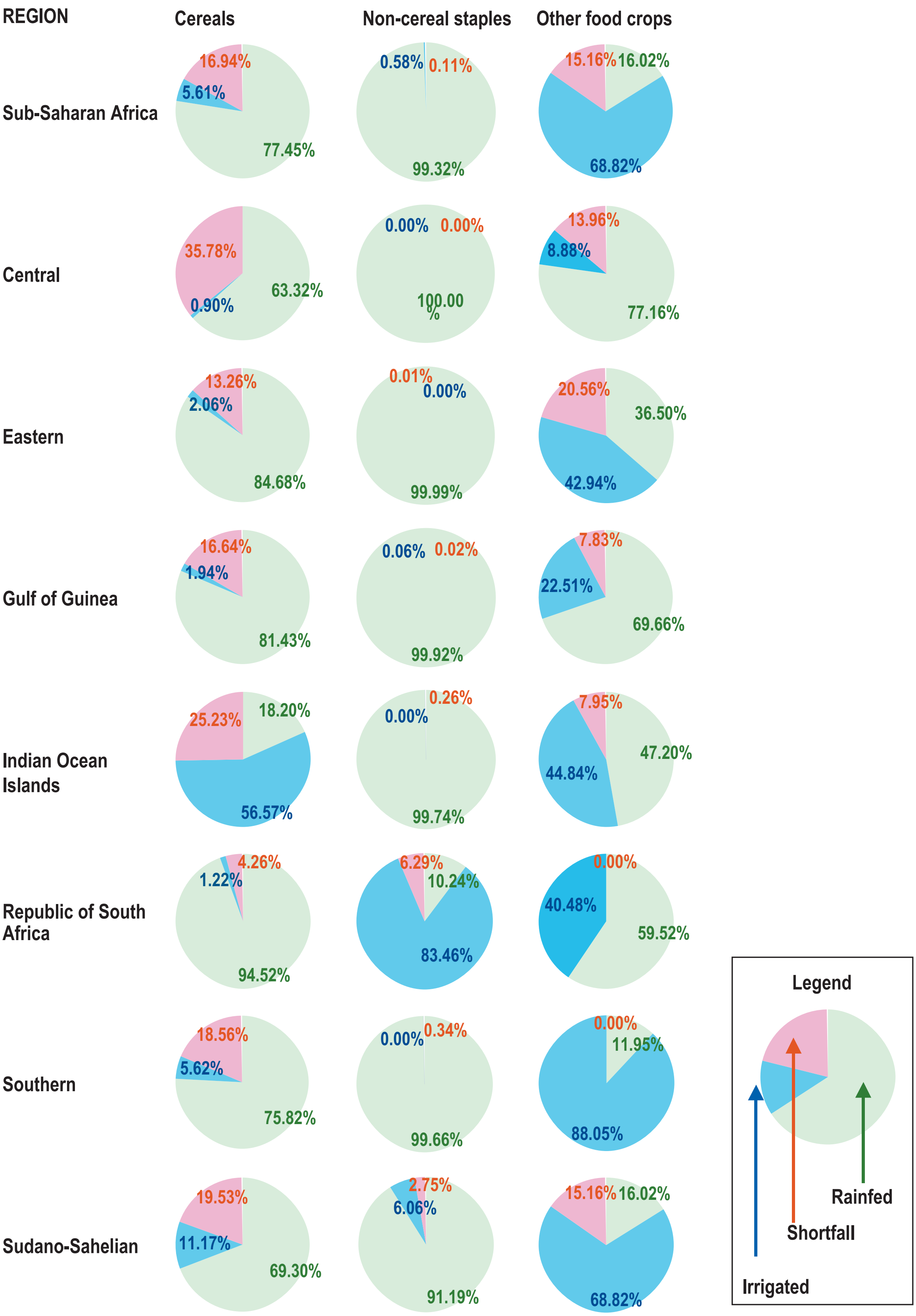
* On the basis of an assumed SSR 57 1, which may not be an appropriate goal (see Chapter 2).

** Calorific equivalents have been used for accounting purposes only to aggregate the contribution from different food crops.

2015

FIGURE 9

Comparison of rainfed production, irrigated production and apparent shortfalls* according to calorific equivalents, 2015**



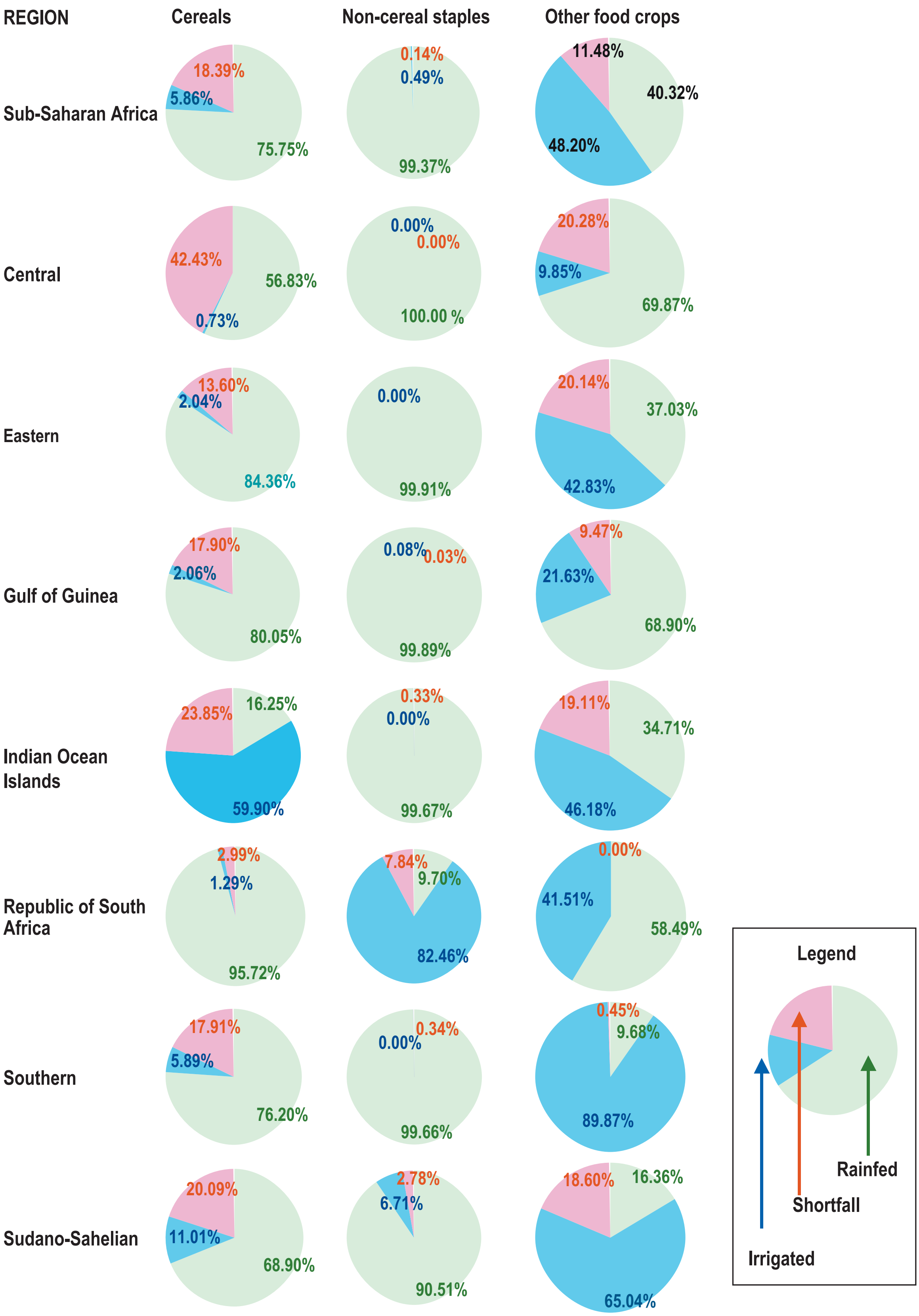
* On the basis of an assumed SSR 57 1, which may not be an appropriate goal (see page 11).

** Calorific equivalents have been used for accounting purposes only to aggregate the contribution from different food crops.

2030

FIGURE 10

Comparison of rainfed production, irrigated production and apparent shortfalls* according to calorific equivalents, 2030**



* On the basis of an assumed SCR 57 1, which may not be an appropriate goal (see page 11).

** Calorific equivalents have been used for accounting purposes only to aggregate the contribution from different food crops.

LAND AND WATER RESOURCE UTILIZATION IN IRRIGATION

The 2005 AQUASTAT update for Africa estimates that of 182 645 012 ha of cultivated land in sub-Saharan Africa, only 7 105 119 ha (or 4 percent) are equipped for some form of irrigation and only another 2 million ha are cultivated as non-equipped wetlands/valley bottoms/flood recession. While there was overall growth in irrigated areas between the 1992 and 2002 baselines established in AQUASTAT in absolute terms, much of this increase in large- and medium-scale irrigation schemes is attributed to just three countries: Morocco, Egypt and South Africa.

Table 14 presents historical growth rates in irrigated areas for all Africa countries. Some of these figures need to be qualified. For the whole continent, the increase in the equipped area is 10 percent, an annual rate of 0.88 percent in the 1992–2000 weighted year index (Table 14). The weighted year index is calculated by allocating to the year for each country a weighting coefficient proportional to its area (equipped for irrigation or under water management), therefore giving more importance to countries with the largest areas under irrigation and water management. On a national scale, the expansion in equipped areas has been concentrated in a few countries, with four countries (South Africa, Morocco, Egypt) accounting for nearly 60 percent of the total increase. Although the increases in equipped areas may not be as important, other countries have also shown considerable rates of increase.

However on a country to country basis the results need some explanation. The rate of annual increase in Ghana, the highest in Africa (30 percent), is distorted by informal irrigation that, although probably already existing, was not included in the data in the previous survey. Moreover, the area under traditional irrigation was underestimated for Ethiopia. The increase in irrigated areas in Mali (20.1 percent) is explained by the reclassification of areas previously indicated as non-equipped, which were this time accounted for as equipped areas because of better knowledge of the field situation. The increase in equipped areas in Zambia (12.9 percent) is accounted for by the equipping of areas that were non-equipped in 1992 during the first survey; indeed, the total area under water management has increased only slightly (5.7 percent). The same holds for Rwanda (11.4 percent), even though its total area under water management fell between 1993 and 2000, and again for Senegal (6.7 percent and 0.7 percent, respectively). The annual rate of increase in areas under water management is 0.73 percent, slightly lower than that of the areas equipped for irrigation (0.88 percent) since much of the previously unequipped area under water management has now been equipped. For Guinea-Bissau, a more detailed inventory (1994–96) enabled a more accurate assessment of the irrigated areas, but it is not possible to speak of a real increase. Finally, the Sudan shows a drop in its areas equipped for irrigation. This is the consequence of some of its equipment being so severely degraded that it has become unusable and even beyond rehabilitation.

Similarly, in terms of water resources, only 2 percent of the renewable water resource is used for irrigation, and even if all the potentially irrigable land were irrigated, it would still consume less than 12 percent of the renewable water resources. However, these overall figures, which were developed from basin-wide analyses, mask local variations. These become more marked as the analysis moves closer to the regional, national and subnational levels, where in a significant number of cases, expensive storage would be required to make use of the renewable resources. An indication of the local variations can be seen in Figure 11, which uses logarithmic scales to compare the percentage of renewable water actually used with the percentage of total agricultural production that is produced under irrigation. Each data point represents a specific country within a region. Figure 11 confirms that water resources so far mobilized for agricultural use are insignificant in respect of the total annually renewable resource, and that irrigated production comprises only a small proportion of overall production in many places.

TABLE 14
Historical growth rates in irrigated areas for all African countries

Country	Year	Full/partial control irrigation	Spate irrigation	Equipped lowlands	Total irrigation	% of cultivated area	Part of equipped area actually irrigated	Annual increase rate
Unit		ha	ha	ha	ha	%	%	%
		(1)	(2)	(3)	(4)=(1)+(2)+(3)	(5)	(6)	(7)
Algeria	2001	513 368	56 050	-	569 418	6.9	80	0.3
Angola	1975	80 000	-	-	80 000	2.4	44	-
Benin	2002	10 973	-	1 285	12 258	0.4	23	2.3
Botswana	2002	1 439	-	-	1 439	0.4	-	0.4
Burkina Faso	2001	18 600	-	6 400	25 000	0.6	100	0.3
Burundi	2000	6 960	-	14 470	21 430	1.6	-	2.7
Cameroon	2000	22 450	2 800	404	25 654	0.4	-	1.6
Cape Verde	1997	2 780	-	-	2 780	6.2	66	0.0
Central African Republic	1987	135	-	-	135	0.0	51	-
Chad	2002	30 273	-	-	30 273	0.8	87	5.7
Comoros	1987	130	-	-	130	0.1	65	-
Congo	1993	217	-	1 783	2 000	1	11	-
Côte d'Ivoire	1994	47 750	-	25 000	72 750	1.1	92	-
Democratic Reppublic of the Congo	1995	10 000	-	500	10 500	0.1	70	-
Djibouti	1999	1 012	-	-	1 012	100	38	4.1
Egypt	2002	3 422 178	-	-	3 422 178	100	100	0.6
Equatorial Guinea	-	-	-	-	-	0.0	-	-
Eritrea	1993	4 100	17 490	-	21 590	4.3	62	-
Ethiopia	2001	289 530	-	-	289 530	2.5	-	6.2
Gabon	1987	3 150	-	1 300	4 450	1	-	-
Gambia	1999	2 149	-	-	2 149	1	65	3.2
Ghana	2000	30 900	-	-	30 900	0.5	90	30.1
Guinea	2002	20 386	-	74 528	94 914	6.2	100	0.3
Guinea-Bissau	1996	8 562	-	13 996	22 558	5.1	100	14.8
Kenya	2003	103 203	-	-	103 203	2.0	94	4.1
Lesotho	1999	2 637	-	-	2 637	0.8	3	-
Liberia	1987	100	-	2 000	2 100	0.3	-	-
Libyan Arab Jamahiriya	2000	470 000	-	-	470 000	21.9	67	0.0
Madagascar	2000	1 086 291	-	-	1 086 291	31	100	0.0
Malawi	2002	56 390	-	-	56 390	2.3	96	7.3
Mali	2000	97 499	-	138 292	235 791	5.0	75	20.1
Mauritania	1994	45 012	-	-	45 012	9.4	51	-
Mauritius	2002	21 222	-	-	21 222	20.0	98	2.8
Morocco	2000	1 458 160	26 000	-	1 484 160	16	98	1.1
Mozambique	2001	118 120	-	-	118 120	2.8	34	1.3
Namibia	2002	7 573	-	-	7 573	0.9	100	2.1
Niger	2005	13 663	-	60 000	73 663	1.6	89	0.9
Nigeria	2004	238 117	-	55 000	293 117	0.9	75	1.8
Rwanda	2000	3 500	-	5 000	8 500	0.7	-	11.4
Sao Tome and Principe	1991	9 700	-	-	9 700	23.7	-	-
Senegal	2002	102 180	-	17 500	119 680	4.8	58	6.7
Seychelles	2003	260	-	-	260	3.7	77	-
Sierra Leone	1992	1 000	-	28 360	29 360	5.4	-	-
Somalia	2003	50 000	150 000	-	200 000	18.7	33	0.0
South Africa	2000	1 498 000	-	-	1 498 000	9.5	100	2.8
Sudan	2000	1 730 970	132 030	-	1 863 000	11.2	43	-0.9
Swaziland	2000	49 843	-	-	49 843	26.2	90	-
Togo	1996	2 300	-	5 000	7 300	0.3	86	0.7
Tunisia	2000	367 000	27 000	-	394 000	7.9	100	0.3
Uganda	1998	5 580	-	3 570	9 150	0.1	64	0.0
United Republic of Tanzania	2002	184 330	-	-	184 330	3.6	-	2.3
Zambia	2002	55 387	-	100 525	155 912	2.9	100	12.9
Zimbabwe	1999	173 513	-	-	173 513	5.2	71	6.9
Africa	**-**	**12 478 592**	**411 370**	**554 913**	**13 444 875**	**6.4**	**81**	**0.88**

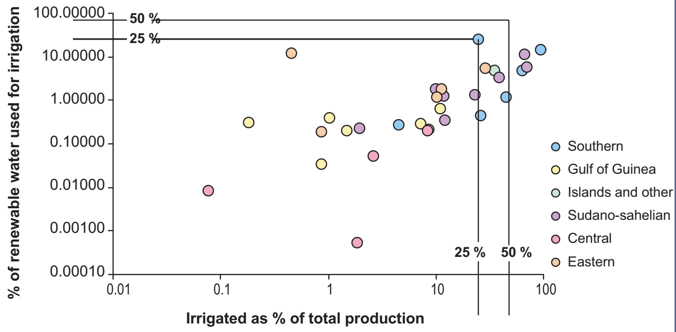
Source: FAO (2005).

Although potential data anomalies require that Figure 11 be treated with a degree of caution, at the synoptic level its message is that there is a lot of undeveloped irrigation potential in sub-Saharan Africa. This conclusion, when considered alongside the low

SSRs and the limited contribution of irrigation, does seem to suggest, at least as regards the cereals group and to a lesser extent the other food crops group, significant potential for increased irrigation in sub-Saharan Africa provided it is demand driven and justifiable in financial and economic terms.

On the other hand, given the high SSRs that characterize the non-cereal staple food crops group and which are being achieved with minimal irrigation, a soley irrigation-based strategy to increase production within this group would not seem justified. Similarly, high SSRs, which will continue to be achieved for the beverage and industrial group, are noted for every region except South Africa, and to an extent, the Indian Ocean Islands region. As it is unlikely that either of these regions will to want to achieve self-sufficiency in beverage and industrial crops, opportunities for expanded irrigation would seem limited, particularly as many of the crops involved are never or seldom irrigated. Further, any irrigation that does take place is limited to private-sector or parastatal producers such as tea estates.

FIGURE 11
Irrigated production as a percentage of total production compared with water used for irrigation as a percentage of totally annual renewable water resources



This analysis confirms that, from a macroperspective, an increased and invigorated irrigation subsector could play a major role in reducing poverty and increasing food security in sub-Saharan Africa with respect to high-value staples, principally rice . However, any serious planning to this end must be based on a thorough assessment of the performance and achievements of the regional irrigation sector to date. In addition, where problems exist, convincing measures to fix them now and mitigate them in future willneed to be included and should reflect lessons learned while replicating as whatever successes have been achieved.

A useful way to begin assessing performance is to consider the yields currently obtained from irrigation in sub-Saharan Africa.

TYPICAL IRRIGATED YIELDS

Yield gap data for irrigated crops provide a helpful indication of how existing irrigation is performing. Figures 12–18 compare typical yields for regional commodity-groups,

FIGURE 12
Central region yield/production comparisons

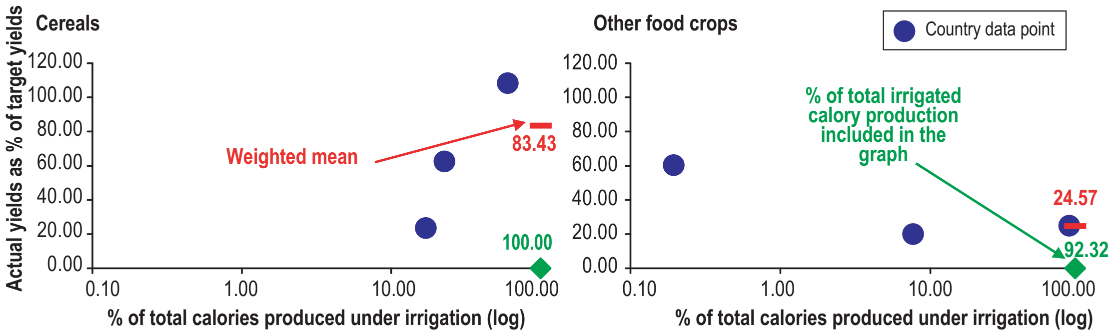


FIGURE 13
Eastern region yield/production comparisons

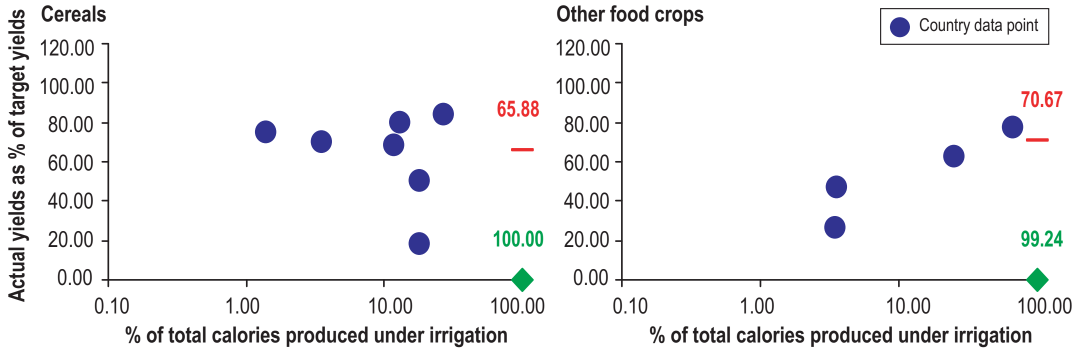


FIGURE 14
Gulf of Guinea region yield/production comparisons

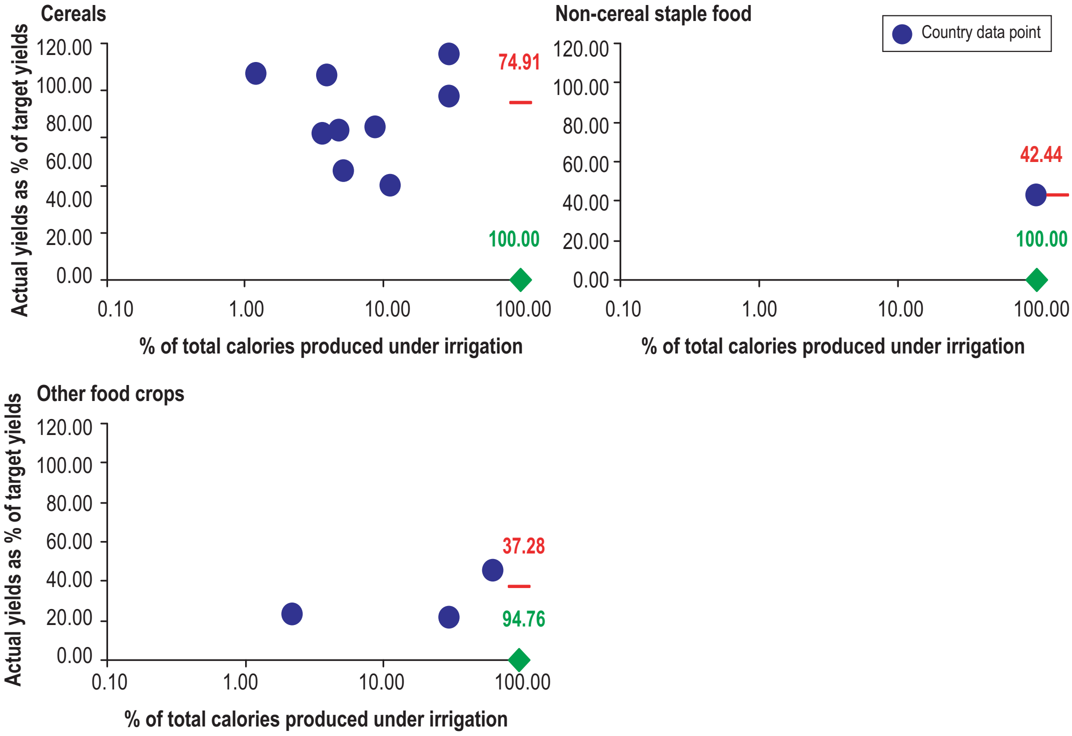


FIGURE 15
Indian Ocean Islands region yield/production comparisons

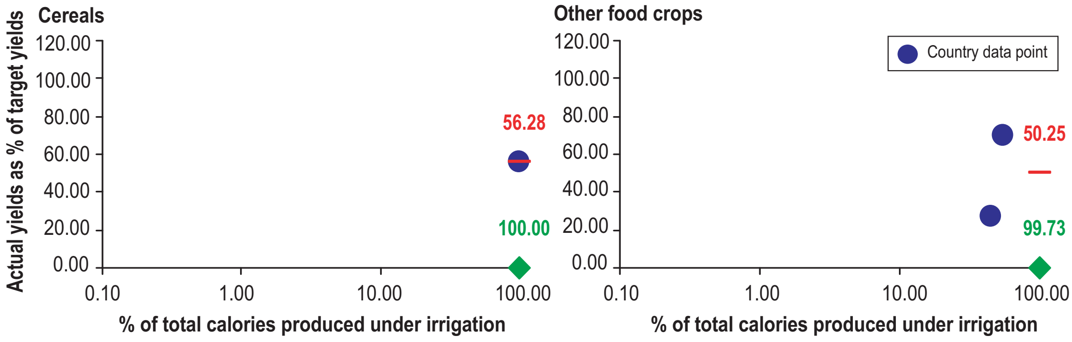


FIGURE 16
Republic of South Africa yield/production comparisons

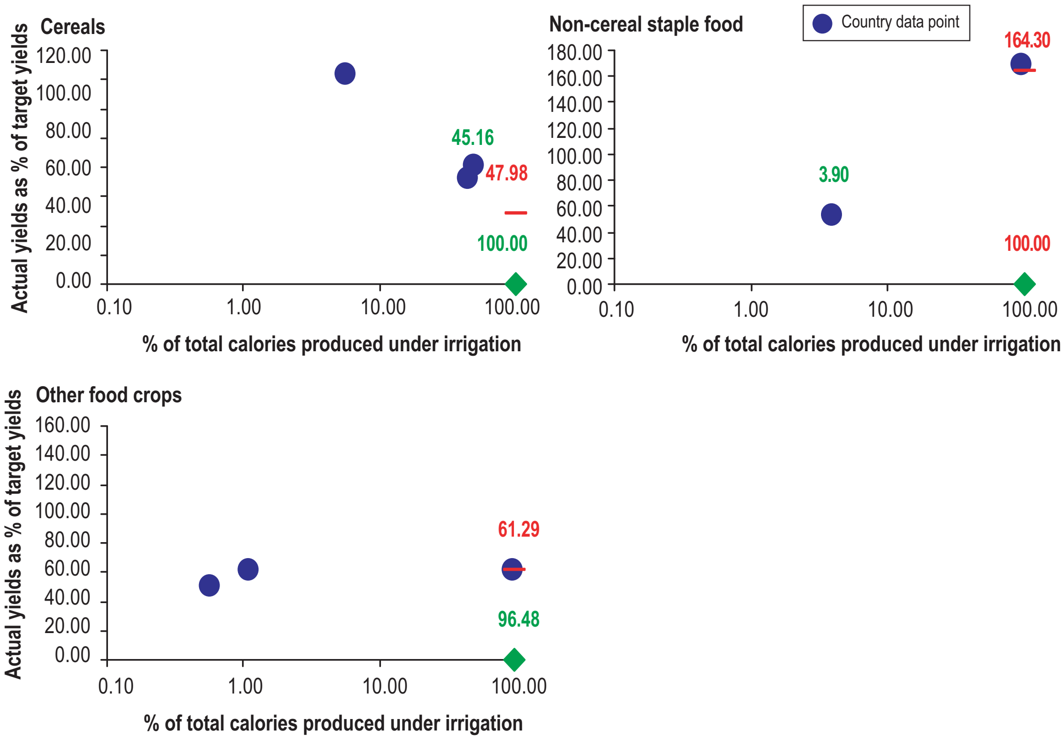
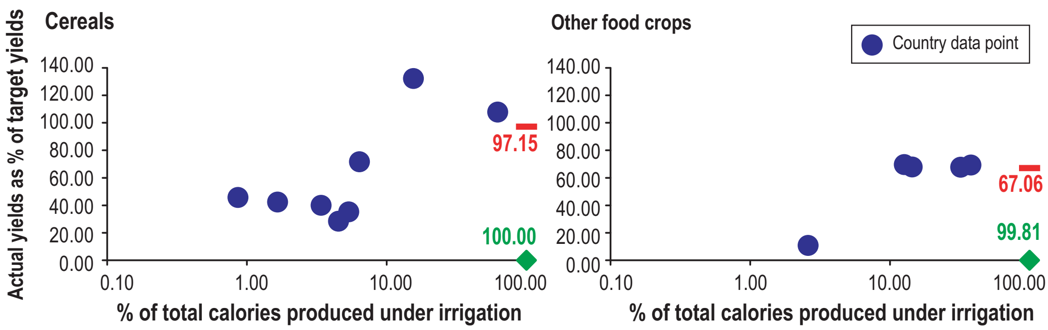


FIGURE 17
Southern region yield/production comparisons



expressed as percentages of target yields. These are plotted against the percentage of irrigated commodity production in terms of calories and plotted on a logarithmic scale. Presenting the data in this way avoids the need to consider each crop individually. In addition, Figure 19 aggregates the same information for sub-Saharan Africa as a whole, for cereals, other food crops and all food crops (no curve is provided for “other food crops” group as so little of it is irrigated). It shows that 50 percent of total calorie production is achieved at or below yields 70 percent of attainable target yields. It also indicates a remarkable degree of consistency between cereals and other food crops up to that level. The industrial and beverage commodity group is not included because of its insignificance in terms of calories. Equally, for all regions except Gulf of Guinea,

Figure 18
Sudano-Sahelian region yield/production comparisons

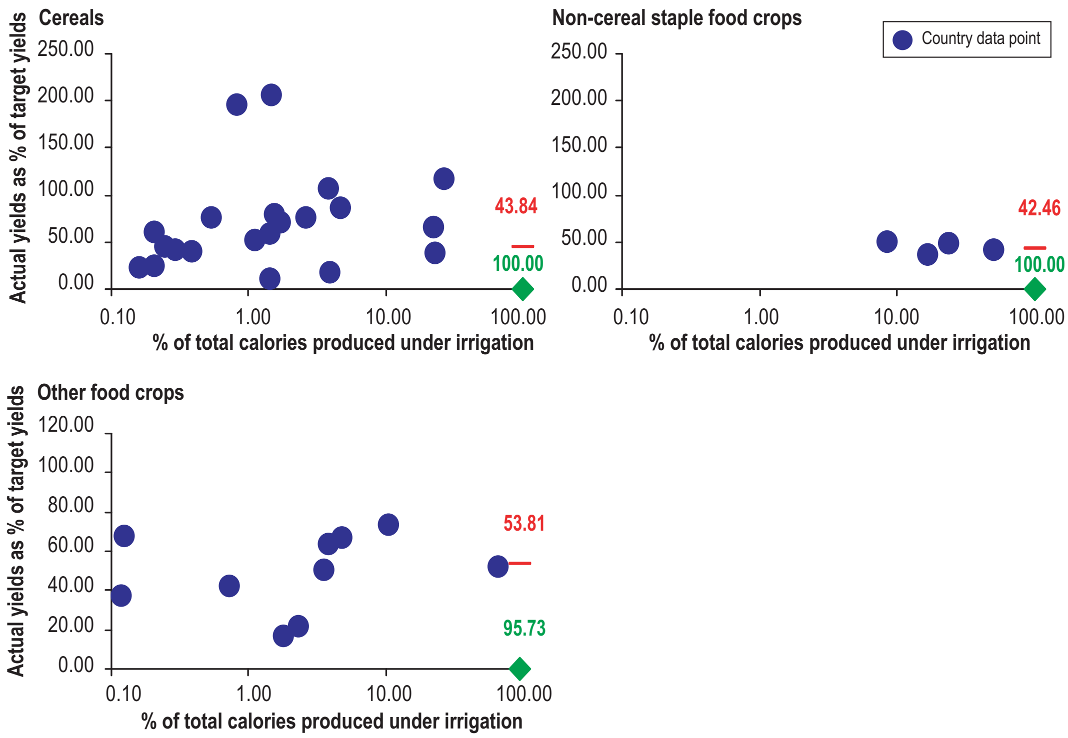
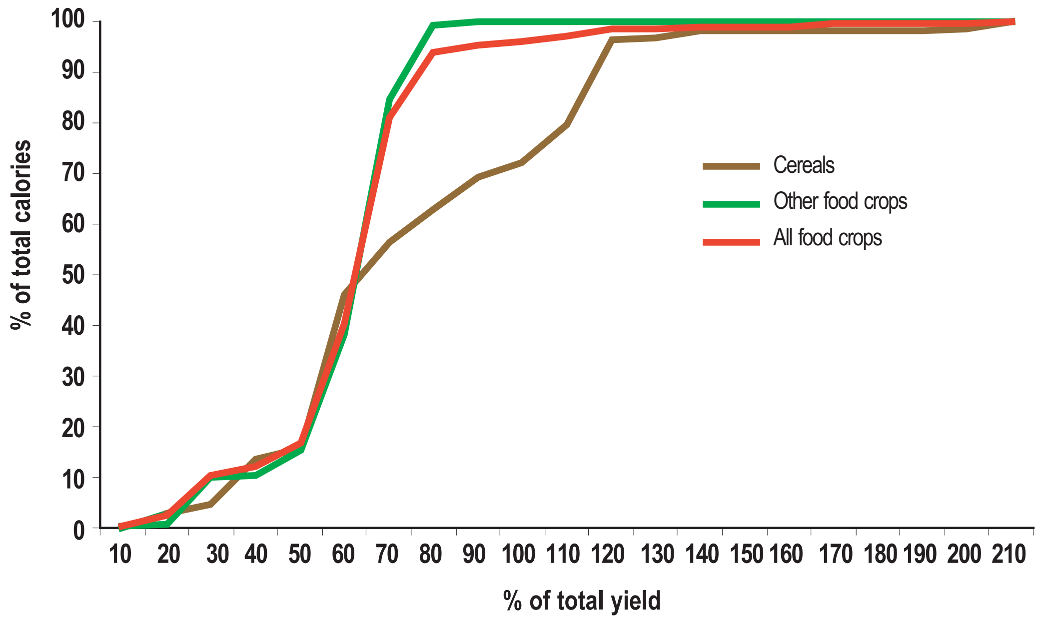


FIGURE 19
Yield levels compared with calorific production for sub-Saharan Africa as a whole



South Africa and Sudano-Sahelian, there is no significant irrigation of non-cereal staples. Table 6 in Chapter 3 presented target yields for selected crops. Target yields are not suggested for the full range of irrigated crops because reliable estimates have not yet been identified for the full range.

Any analysis of this sort is indicative and as such should be treated cautiously in overall terms, more as an heuristic than as presentation of hard data. Even so, at the synoptic level required of this study, the message is both valid and clear. Much of irrigated calorie production in sub-Saharan Africa is achieved inefficiently, the data confirm that irrigation is generally not performing as intended.

SUMMARY

Sub-Saharan Africa continues to face significant supply problems with respect to all commodity groups except beverages and industrial crops. However, the supply challenge is not homogeneous when considered at the regional and national levels. The differences at these levels may be explained by differences not only in natural resource endowments but also in terms of skills, aspirations, the status of any existing national irrigation sectors and agriculture, land-use and trade policies.

All other things being equal, irrigation has an obvious role to play in meeting existing demands. The vast irrigation potential of sub-Saharan Africa remains largely untapped, and where irrigation is already taking place, significant gains can be made in terms of improving the yields and the sophistication of the farming systems, thereby: (i) improving the returns on historic investments; and (ii) demonstrating the viability of the sector to potential IFI and bilateral investors. However, in order to establish the demand for water and any comparative advantage in specific irrigated crops, it is necessary to appreciate the impacts of irrigation on the supply chain in the context of the environmental and cultural diversity of sub-Saharan Africa. Chapter 5 explores these impacts.

Chapter 5
The impacts of irrigated agriculture

In addition to altering the level and composition of factors of production and raising or lowering unit production costs, the introduction of irrigation has an impact on the level, stability, composition and seasonality of agricultural output and on the physical characteristics of the commodity harvested. Using sub-Saharan Africa examples, this chapter analyses these impacts and how they in turn affect the structure and efficiency of product processing and marketing systems, the level of market prices, and the ability of producers to exploit market opportunities.

Before relating this to the specifics of sub-Saharan Africa irrigation opportunities, the chapter closes with a similar consideration of the likely social and environmental impacts of introducing irrigation.

VALUE CHAINS AND THE INFLUENCE OF IRRIGATION ON MARKETING AND PROCESSING

Most sub-Saharan Africa agricultural production is marketed and physically transformed prior to final consumption or industrial use. This includes a significant proportion of the foodstuffs produced on small-scale subsistence farms. Such farms frequently sell much of their output to meet urgent cash needs and then seek to buy staple foodstuffs later in the crop year. Given that a large proportion of total sub-Saharan Africa agricultural output is marketed, the efficiency of markets is vital both for the livelihoods of farm households and for other rural households that rely on the agriculture sector for employment.

Until the recent period of structural adjustment, grains, tropical beverages and most industrial crops grown in sub-Saharan Africa were processed and marketed either under systems operated by state-owned enterprises or under systems that involved some form of state price control. These have now largely been replaced by systems in which individuals, private firms and cooperatives undertake the processing and marketing. These systems rely on competitive forces to determine prices. The prices offered to producers of agricultural commodities depend on the costs incurred at each stage of the system and on the extent of competition at each point at which the commodity is traded.

The former state-run systems were designed to be compatible with the production and market characteristics of the commodity in question. Under a free market, the structure of marketing systems evolves over time to suit the characteristics of the commodity, often through a painful process that involves the collapse of unsuitable systems and the failure of enterprises involved in them.

As irrigation affects the production and market characteristics of agricultural commodities, it influences the evolution of marketing systems, their structure, and the efficiency at which they operate.

SPATIAL AND TEMPORAL IMPACTS

Spatial impacts

Irrigation affects the spatial distribution of agricultural production by allowing: (i) the growing of crops on land that was unable to sustain agriculture under rainfed conditions; (ii) the more intensive growing of existing crops; and (iii) the growing of alternative crops. For example, irrigation has allowed desert, semi-desert and low-productivity rangeland in Namibia, Kenya and Sudan to be converted to the production of fruits and cotton. In South Africa and other sub-Saharan Africa countries, irrigation has been utilized to raise the productivity of existing crop production, most notably the production of maize and vegetables. In central Kenya, irrigation has allowed some 5 000 ha that had been devoted to grazing and the growing of maize and other rainfed crops to be converted to rice production. In Swaziland, former low-veldt rangeland has been irrigated and utilized for the production of sugar cane.

> As irrigation normally leads to substantially higher yields, it has the effect of concentrating production spatially.
> The tendency for irrigation to lead to concentrated production applies to all irrigation regardless of the prior use of the land.

As irrigation normally leads to substantially higher yields, it has the effect of concentrating production spatially. This tendency is reinforced by engineering considerations relating to the supply of water, which frequently requires that irrigated land comprises a single contiguous area. The tendency for irrigation to lead to concentrated production applies to all irrigation regardless of the prior use of the land.

The concentration of production raises the efficiency of marketing by allowing the exploitation of economies of scale, especially in transport. This applies both to road construction and maintenance and to vehicle use. Concentrated production also allows larger and more efficient processing units and reduces the distances over which the raw commodity is transported to a processing unit. The benefits that stem from this differ between commodities depending on the value-to-weight ratio of the raw commodity, its perishability, the extent to which it is damaged during transport, and weight loss during processing. Of the main commodities grown under irrigation in sub-Saharan Africa, seed cotton is exceptionally bulky and sugar cane is both bulky and perishable. For both these commodities, but especially for sugar cane, the majority of the weight of the harvested commodity comprises low-value by-products that are removed during primary processing. For such commodities, the relative processing and marketing advantages afforded by irrigation are greater than for crops that are storable, are not easily damaged during transportation, are not exceptionally bulky, and which lose little weight during processing. The main sub-Saharan Africa crops that fall into this category are the staple grains, of which maize is the most important for food security. However, as yet, maize is largely insignificant as an irrigated crop, as shown in Table 15.

> On balance, the concentration of production afforded by irrigation probably gives fruits and vegetables less of a marketing and processing edge than it does for bulky crops such as cotton and sugar.

Vegetables and fruits vary significantly in terms of all the important variables that relate the spatial production characteristics of irrigation to processing and marketing efficiency. However, the generally labour-intensive nature of post-harvest activities for fruits and vegetables means that economies of scale in these activities are generally low. Most fruits and vegetables also lose little weight during “processing”, which typically comprises only cleaning, grading and packing (fruits that are dried being the exception). Against this, most fruits and vegetables are highly perishable and easily damaged during handling and transport. On balance, the concentration of production afforded by irrigation probably gives fruits and vegetables less of a marketing and processing edge than it does for bulky crops such as cotton and sugar.

The concentrated production afforded by irrigation tends to lead to more-competitive assembly markets as it increases the number of traders able to operate viably in a particular area. It also reduces the cost of tracing the origin of products and thereby increases the potential for small-scale farmers to sell to supermarkets and to other buying enterprises that seek to trace products to their source. Concentrated production also increases the feasibility of marketing by a single agency by reducing the costs of dealing with a set of small-scale farmers. The marketing agency could be either a farmers cooperative or association or an enterprise such as a ginnery company. Contract farming organized by ginnery companies and other processors has been particularly successful in sub-Saharan Africa as a replacement for former state-run single-channel marketing systems (FAO, 2001). The concentration afforded by irrigation helps increase the feasibility of contract farming by making it more difficult for farmers to engage in undetected side-selling.

TABLE 15
Irrigated maize in sub-Saharan Africa for the baseline year

Region	Irrigated maize area as % of total maize area	Irrigated maize production as % of total maize production
Central	0.00	0.00
Eastern	1.45	2.09
Gulf of Guinea	0.29	0.70
Indian Ocean Islands	0.00	0.00
Republic of South Africa	3.47	8.99
Southern	0.29	0.61
Sudano-Sahelian	9.11	8.86
Sub-Saharan Africa	1.36	3.40

Against the generally positive impacts that spatially concentrated irrigated production has on marketing is the fact that the areas that can be irrigated most effectively may be distant from markets. For example, in Namibia, the only significant permanent rivers are in the extreme north and south of the country. Population density is low in the north and exceptionally low in the south. In the case of irrigation from the Orange River in the south, produce has to travel long distances to markets. Such new irrigation may only be commercially viable if new transport links are constructed, which may make the full investment package unattractive in terms of net benefits. While this can be a major problem that inhibits the development of irrigation, integrated irrigation development may have the desirable long-term side-effect of opening up new areas of the country to more widespread economic development. Indeed, governments may construct irrigation schemes in remote areas as part of a national strategy to decentralize development or stablilize rural communities. However, the general experience with the development of small-scale irrigation schemes in areas not effectively linked to markets has been disappointing.

Temporal impacts

Irrigation has the major advantage that it reduces dependence on seasonal weather patterns. This, coupled with control of the input of water, allows growing cycles to be reduced in length and crops to be established and raised during seasons with little rainfall. The impact of this on output depends principally on whether the crop is a perennial or an annual. In the former case, irrigation may allow harvesting throughout most or all of the year, as is typically the case for sugar cane, or there may still be distinct seasons, as is usually the case for tree or vine-grown fruits. For annual crops, control of the timing of irrigation may allow some variation in the timing of the harvest, permitting intra-annual market-price patterns to be exploited. For example, irrigation coupled with the application of chemical ripeners allows grapes to be harvested in central and southern Namibia in advance of the main South African crop and sold in European markets at substantial price premiums.

In areas with only a single annual rainy season, the irrigation of annual crops may allow the number of crops produced per year to be raised from one to two, and exceptionally to three. However, this depends on the time that the main crop takes to mature and the existence of viable crops for the potentially less productive new second season. In central Kenya, it has proved possible to grow two crops per year of the local Sindano variety of rice but only one crop of the higher-valued Basmati variety, which has a longer growing season. In general, there is a greater possibility of growing multiple crops at low latitudes where there is no distinct winter season and where there is adequate sunshine and warmth for rapid vegetative growth throughout the year.

The impact on processing and marketing of the introduction of irrigated double cropping depends on the storage properties of the unprocessed crop and on whether or not the same crop is planted during the second season. If the same crop is planted in both seasons, and particularly if the crop is rapidly perishable, double cropping is likely to increase the efficiency of processing as it increases the number of months in which processing capacity can be utilized. The likelihood of the second irrigated crop being the same diminishes as one moves away from the equator.

IMPACTS ON QUALITY

A switch from rainfed to irrigated production affects the quality characteristics of the commodity produced, including size, taste, smell, visual appearance, milling characteristics, and cooking properties. It also affects the extent to which these characteristics vary within a single harvested crop and between years. In so far as irrigation leads to healthier plants, the general size and quality of the produce is likely to be higher. However, it is possible that rapid growth may diminish the intensity of flavour and smell, reducing market value.

BOX 4

The Fresh Produce Exporters Association of Kenya initiative

Since 1990, Kenyan exports of fresh fruits, vegetables and cut flowers have grown explosively. In 2002, these products accounted for some 35 per cent of national agricultural export earnings. Kenya is now the second largest horticultural exporter in sub-Saharan Africa, after South Africa, and the second largest exporter of vegetables to the EU, after Morocco. Nationally, the value of horticultural exports have overtaken that of coffee and is now second only to tea.

Some 40 per cent of Kenya's fresh horticultural exports are sold to United Kingdom (UK) supermarkets and the majority of the remainder to UK wholesalers and to other European countries. Fresh fruit and vegetable exports comprise principally French beans and so-called Asian vegetables, with smaller amounts of other vegetables and fresh fruits.

Exports, especially to UK supermarkets, are characterized by high and constantly changing standards and by demand for new varieties and new forms of processing and presentation. Supermarkets in particular also now specify conditions relating to the conditions under which the products are grown and processed, including minimum agronomic and labour standards. This requires that each unit of output be traceable back to its origin.

To respond to these stringent and demanding conditions, a marketing system has developed that is driven by buyers in developed importing countries and is markedly different from the systems that have developed for the marketing of grains in Ethiopia and in other sub-Saharan Africa countries, including Kenya. The major supermarket groups work with a small number of specialized importing firms that acquire consignments from a relatively small number of specialized exporters. Some of these exporters have ownership linkages with importing firms, some have their own packhouses and some own their own farms. Small-scale farmers have been progressively squeezed from the industry and about 25 large farms now account for some 75 per cent of total exports. The small-scale producers that remain operate on a contract-farming basis with exporters who supply them with both inputs and credit and advice. In the case of fruits and vegetables retailed by European supermarkets, most are grown to order with prices at each point in the marketing chain being pre-agreed rather than determined by market forces at the time of delivery. To meet and exploit the concerns of developed country buyers with 'process' as well as 'product', exporters have formed a Fresh Produce Exporters Association of Kenya (FPEAK) which, *iner alia* has developed its own minimum process standards.

The vertical coordination within the supply chain and the horizontal concentration of production, processing and marketing have developed to allow timely delivery to supermarket groups of high-quality produce of a precise and frequently changing specification produced under conditions that the groups deem acceptable. By contrast, Ethiopian grain faces much less stringent requirements. Grain is storable, poor quality grain is readily saleable, there is little change over time in the required quality of the final product, and buyers are concerned only with what they buy not how it was produced and processed.

Irrigation typically has a major beneficial impact on the uniformity of the crop both between growers and over time. The main increase in uniformity is usually between years as under irrigation similar amounts of water can be applied on a timely basis each year. This contrasts with rainfed agriculture, where the timing and intensity of rainfall often varies markedly between years. Between farms, the introduction of irrigation into an area has the potential to lead to increased uniformity of the crop within that area to the extent that farmers under the former rainfed regime planted at different times or received different amounts of rainfall. However, this increased uniformity is dependent on equitable distribution of irrigation water between farmers, which is not always achieved.

Another advantage stemming from increased planting-date uniformity under irrigation results from decreased accumulation of stage-dependent pests and pathogens. This is because populations of such pests and pathogens are not given the opportunity to expand by moving from plot to plot where excessively staggered planting provides ideal conditions for longer.

Within an individual field, the contribution of irrigation to uniformity is likely to be minimal as all parts are likely to receive similar amounts of water under a rainfed regime. Indeed, it is possible for irrigation to lead to a less-uniform application of water within fields, as is often the case under furrow irrigation.

In summary, the introduction of irrigation most commonly improves the overall level of quality and leads to less variation in quality between producers and between years. Reduced quality variation between producers serves to increase the efficiency of processing, especially where machinery is set for a specific standard of raw material, as is the case for most agricultural processing, particularly that involving milling. Reduced quality variation between years leads to two marketing benefits. First, it allows a set of irrigated farmers or an irrigated estate to develop a reputation for a particular quality of produce that attracts regular customers prepared to pay a premium price for dependable quality. Second, it assists producers to predict the quality of their crop. This helps them to sell forward with confidence and to lock into an assured producer price prior to harvest. Box 4 presents an illustration of this impact.

IMPACTS ON THE STABILITY AND PREDICTABILITY OF PRODUCTION

Income stability is particularly important for small-scale producing households. This is because they typically lack the capacity to save and normally cannot borrow other than informally at very high rates of interest. This means that they are unable to moderate the impact of income instability on household expenditure. Consequently, they face severe hardship when income falls.

The introduction of irrigation not only increases the level of crop output but also increases the stability of output from year to year. This tends to have a stabilizing impact on producer incomes, especially for internationally tradable commodities whose domestic prices are a function of international prices. For low-value perishable commodities, for which markets clear domestically, quantity and price movements tend to be offsetting. This moderates income instability in situations where common weather patterns affect the output of growers. Once irrigation is introduced for such commodities, output comprises stable irrigated production and unstable rainfed production. In this situation, the irrigated production reduces aggregate domestic instability in supply and prices. This in turn partially stabilizes the incomes of rainfed producers, provided demand for the commodity is price inelastic. The necessary degree of price inelasticity to lead to more stable gross incomes for rainfed producers increases as the share of irrigated output increases. Conversely, in such market circumstances, instability in rainfed production will always destabilize the gross incomes of irrigated producers unless irrigated output is for some reason unstable and correlated with rainfed output.

The generally stabilizing impact of the introduction of irrigation on farm household incomes stems from its effect on the stability of yield of a specific crop that was being grown previously under rainfed conditions. Should irrigation result in a switch of crops, it is conceivable that yields of the new irrigated crop may be less stable than the former rainfed crop. It is also possible that a switch to irrigated production may result in the growing of a crop for which prices tend to be less stable than those of the former crop.

The stabilization of production has the important additional advantage of improving the accuracy with which producers can predict their output in advance of the production season. As with improvements to the consistency of quality, this increases their ability to sell forward and to enter into long-term contractual arrangements with input suppliers/processors. This in turn allows them to lock into a price in advance of the harvest and to eliminate price risk.

In summary, the introduction of irrigation tends to reduce the risks facing producers by reducing the instability and improving the predictability of both yields and producer prices. As noted above, it also tends to improve and increase the predictability of quality. Together, these effects have the potential to improve the welfare of producers and to increase the net benefits from investing in irrigation.

OTHER SOCIAL IMPACTS

The predictability of quality and output as discussed above could arguably be described as social impacts, but there are more as Box 5 illustrates..

First, there is the income stability that better predictability brings as does the ability to diversify and thereby hedge against both market and climate shocks. This helps with household or group financial planning, and it also makes credit more manageable. It could also make credit more accessible, thereby facilitating further increases in production. Diversification also means that higher-value crops and crops with significant seasonal niche markets and/or added-value opportunities can often replace former subsistence systems, thereby allowing poor households better access to the local and national economies. Added-value opportunities often include grading, processing and packaging, many of which can be carried out within the farm or scheme boundary, thereby raising incomes significantly. As well as creating more on-farm jobs, the same measures increase the need for direct and indirect services concerned with the basic agricultural activity. Direct services might include cold-storage construction and operation, transportation, freight consolidation and the manufacturing and supply of packaging material and farm inputs. Indirect services are those associated with an economic growth point and are supplied by a broadening range of local artisanal skills, retail trade and equipment maintenance capacity.

Finally, irrigation is beneficial also because it makes it easier to keep urban costs of basic commodities at affordable levels.

However, when the supply of commodities increases, prices are likely to fall especially when shortfalls requiring imports are replaced by surpluses looking for a place in regional or global markets. Although it has been argued that adequately informed dynamic pricing capability is in place and sufficient to contain the more extreme results of price reductions, there will nonetheless be a detrimental effect on rainfed producers of the same commodities and the rural landless, further marginalizing them. This is especially the case the further such producers are from the employment opportunities represented by successful irrigation. Equally, ill-conceived or inflexible institutional measures have the potential to bankrupt farmer groups and their members, even where productivity is both efficient and high. This is especially risky where production becomes more specialized and dependent on inputs, monopolistic markets and rent-seeking creditors and intermediaries. This situation is not helped by the fact that irrigated production is often subsidized (e.g. by low recurring-cost recovery) whereas rainfed farming seldom is.

BOX 5

The impact of irrigation on poverty: a case-study from the Gambia

Von Braun *et al.* (1989) studied a new rice irrigation project involving 7 500 farmers in The Gambia. The technology was in the form of mechanical pump irrigation and improved drainage for rainfed and tidal irrigation. Its expansion pulled labour away from other crops, reducing output of the latter, but increasing net calorie production overall. The project was likely to benefit excess farm-household or landless labour since 24 percent of the work is carried out by hired labour which played a marginal role in rice production before the project. Average labour productivity was greatest in the fully water-controlled rice fields (ones with pump irrigation). In partly water-controlled fields (tidal irrigation or improved rain-fed cultivation and drainage) labour productivity was only half of that in the fully water-controlled, though 30 percent higher than that in swamp rice.

At the sample average, the irrigation project increased real incomes by 13 percent per household. Moreover, since rice production contributed 43 percent of per adult equivalent income to the bottom income quartile and 26 percent to the top quartile, poor households gained disproportionately, and thus the new rice technology contributed to a more equal distribution of income in the area (at least in the short run). However, the study predicts that the poorest are also likely to be most adversely affected in case there is deterioration in project yields. The gains to household income raised calorie consumption, in turn improving the nutritional status of children. Mothers' weight loss in the wet season, not only a health and nutrition problem for them but also indirectly for the children as it relates to low birth weight, was found to be reduced with increased access to the new rice land. Unfortunately without supplementary programs for child-support, the greater the access to the rice project, the more frequently mothers took their smallest children with them to the swamps, which increased their susceptibility to disease.

The introduction of the new technology led to a transformation of the status of rice, traditionally a women's crop grown to a large extent on private farms, to communal crop under the authority of the male compound head. Thus female farmers, despite being previously allocated formal land titles, now controlled only 10 percent of their pump-irrigated plots. This change increased the burden of communal agricultural work disproportionately for women (though men's burden increased also), reducing women's opportunity to grow private cash crops and receive independent incomes, as well as limiting the beneficial calorie consumption effect of higher household income. However, women were not necessarily dispossessed of all individual farming rights or of an independent income. They organized private production of upland crops (such as groundnuts and cotton) and many were paid for work on the new rice fields by the compound head

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ENVIRONMENTAL IMPACT

The literature on the environmental impacts of irrigation in sub-Saharan Africa is extensive from Cameroon (Loth, 2004), Zambia (Jeffery *et al.*, 1992).

Although there are environmental benefits that accrue to irrigation (e.g. paddy fields can provide havens for migrating wetland birds), the costs trend to out-weigh the benefits particularly if schemes are poorly operated. If irrigation is to be justified, these costs need to be internalized by the irrigation scheme or mitigated through alternative agricultural practice and hydraulic design (Box 6).

As explained above, at the macrolevel, undeveloped land and water resources are large in relation to irrigation development potential. However, this comment needs qualification. For example, in Zambia, national-level water resources are large in relation to the country's irrigated area, yet in many areas where water is used for irrigation, there is considerable and increasing competition for it. Although this is

BOX 6
Environmental Solutions from the World Wide Fund for Nature

With ZESCO and MEWD, WWF is working to improve the management of water resources in the Flats by improving the operating procedures of the Kafue Gorge and Itezhi-tezhi Dams. The aim is to mimic natural water flows as closely as possible in order to restore wetland functions and values. The first phase of this partnership produced an Integrated Water Resources Management Strategy, which has since been accepted by all stakeholders. Computer models were also developed to simulate potential water management scenarios and to study their likely impacts. The second phase began in July 2003 and, over nine months, will focus on implementation of the new water management system for Kafue Flats. Re-establishment of the hydro-meteorological monitoring network, further refinement of computer models, dam operation, and legal and institutional frameworks are the main components of this phase. Testing of the new dam operating procedures is expected by early 2004, with the hope that the Zambian government will take a positive decision to commence the new system during 2004. All key stakeholders and water users are part of this process. The Integrated Water Resource Management project is part of the Kafue pilot project being implemented by the Ministry of Energy and Water Development through the Water Resources Action Programme (WRAP). WRAP is trying to develop a national strategy that will improve the management of water resources (surface and groundwater) throughout Zambia. It is hoped that this groundbreaking project will act as an example and catalyst for sustainable water resources management in the whole region, notably the wider Zambezi River basin.

Extract from: Case study on river management: Kafue Flats. http://www.panda.org/about_wwf/what_we_do/freshwater/our_solutions/rivers/irbm/cases/kafue_river_case_study/index.cfm

largely a regulatory matter, the example does indicate the important difference between resource requirements at the macrolevel and microlevels (FAO, 2002).

The wide range of environmental risks associated with irrigation and the bulk storage facilities required in order to secure the necessary water resources are widely reported and are only listed here (Table 16).

TABLE 16
Environmental risks associated with irrigated agriculture

Quality	Health	Quantity	Ecology
• pollution of surface water and groundwater due to excessive chemical applications • reduced absorptive capacity of natural streams • unnaturally high turbidity levels and sedimentation in wetlands and coral reefs	• increase of water-related vector-borne disease • skin problems arising from high chemical loads	• attenuated flood and turbidity cycles leading to disrupted marine food chains which begin at the brackish margins • ditto freshwater wetlands, which can have great economic and cultural significance • reduced environmental stream flows • unsustainable lowering of water tables and associated reductions in flows at seeps and springs • increased intensity of flooding as a result of scheme drainage	• habitat loss • habitat conversion • lost biodiversity • fragmented water bodies and compromised gene-pool integrity of freshwater species including capture fish stocks • waterlogging and breakdown of soil microbial activity • soil deterioration • increased greenhouse gasses • disrupted migratory routes • disrupted floodplain functions

Chapter 6
Getting to 2030: the yield question and natural resources constraints

INTRODUCTION

Given the anticipated impact of irrigated agriculture in sub-Saharan Africa outlined in Chapter 5, what are the **technical** prospects for irrigated production?

The analysis of current irrigated yields and resource utilization in the baseline (Chapter 4) now leads to a consideration of how irrigated production in sub-Saharan Africa can be expected to respond to population and income drivers by 2015 and 2030, given the existing projections for 2015 and 2030 in the AT 2015/2030 analysis. This report is also cognisant of the IFPRI Impact model scenarios for sub-Saharan Africa (Diao, *et al.*, 2003). Both approaches result is broadly similar conclusions about the expected state of agriculture in sub-Saharan Africa. However, the IFPRI sub-Saharan Africa analysis does not address the technical feasibility of productivity increases and thus the analysis is limited with respect to irrigation. The analysis below attempts to fill in this technical detail.

A REGIONAL VIEW OF YIELD GROWTH FORECASTS

Much of sub-Saharan Africa is expected to remain in deficit with respect to cereals, other food crops and, to a lesser extent, non-cereal staples. This study has shown that irrigation can have a significant role to play in addressing these deficits (especially with respect to maize, rice, wheat, animal feeds and cotton) in a region whose water and land resources remain largely unexploited.

However, two important conditions have been identified. First, much of the existing irrigation is underperforming, hence new investments must be able to overcome constraints on irrigation performance (mainly in the public sector) that have been experienced to date. Second, irrigation of staple crops on the scale necessary to address the deficits to any meaningful extent may be unaffordable without a second, higher-value crop. These considerations notwithstanding, it will be difficult to identify such high-value crops appropriate to the scales in question. Some of the production shortfalls could be made good by means of improved or increased rainfed production. However, for the sake of simplicity, the following analysis assumes a purely irrigation-based strategy. For this, it is necessary to differentiate between the relative contributions of productivity-based approaches at existing assets and production-based approaches requiring new investments.

With these issues in mind, this chapter attempts to identify the basic building blocks of an irrigation development strategy that could go beyond currently assumed plans and thereby have a positive impact on the production shortfalls still anticipated for 2030. It concentrates exclusively on cereals for two reasons: (i) the areas involved are likely to be orders of magnitude greater than those necessary for other crops that are significant sources of calorie producers; and (ii) as the analysis is based on single cropping, the same assets could be used for the irrigation of other crops in many cases. However, the analysis set out in this chapter does not address the crucial issue of the low profitability of cereal production. It is concerned with technical rather than economic or financial feasibility.

The AT 2015/2030 analysis make country-specific forecasts of yield increases for irrigated cereals that might be possible by 2015. These can be converted into weighted

TABLE 17
Weighted mean yields projected for 2015

Crop	Target (ref. Table 15)	Central	Eastern	Gulf of Guinea	Indian Ocean Islands	South Africa	Southern	Sudano-Sahelian
			(tonnes/ha)					
Barley	4.25	n.a.	2.50	n.a.	n.a.	3.00	**2.60**	n.a.
Maize	7.50	3.50	**2.79**	**3.28**	n.a.	7.50	**2.86**	**1.76**
Millet	3.75	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	**2.70**
Other cereals	2.50	1.75	1.75	1.75	n.a.	1.75	1.75	1.75
Rice	4.00	**2.73**	**3.69**	**1.19**	3.32	n.a.	**3.02**	**4.05**
Sorghum	1.20	n.a.	**2.56**	2.00	n.a.	n.a.	2.00	**1.95**
Wheat	5.00	3.00	3.50	**4.16**	n.a.	4.00	**6.50**	**2.21**

Notes:
1. Values in bold type derived from the forecasts contained in the 2015/30 analysis.
2. Values in normal type are assumptions made for the purpose of this analysis and based on technical consensus post the original AT 2015/30 analysis.
3. "n.a." refers to crops for which any irrigated production is likely to be insignificant or that are generally incompatible with local farming systems or conditions.

mean forecast yields by crop and by region as shown in Table 17. Values in bold type have been derived from the forecasts contained in the AT 2015/30 analysis while those in normal type are more conservative assumptions made for the purpose of this analysis. The term "n.a." refers to crops for which any irrigated production is likely to be insignificant or that are generally incompatible with local farming systems or conditions. Shortfalls in such crops will either have to be made good by increased rainfed production or by imports. Possibilities for importing from other sub-Saharan Africa regions are explored later in this chapter.

Using these weighted mean future yields, it is possible to estimate the increases in irrigated areas by region that will be necessary beyond those already assumed and to compare these with areas currently under agricultural water management (including irrigation). However, Table 17 shows that the 2015 projected yields are in most cases still significantly less than the target yields assumed in Table 5. Accordingly, the same analysis can be undertaken for additional yield increments, thereby providing an indication of the impact that a productivity-based approach may have on the ultimate investment needs. Therefore, Tables 19–21 consider three scenarios. First, scenario 1 (baseline) in which there are no further yield increases between 2015 and 2030 (Table 18); second, scenario 2, in which gaps between 2015 weighted mean yields and targets reduced by 50 percent between 2015 and 2030 (Table 19); third, scenario 3, in which target yields are achieved throughout by 2030 (Table 20).

The savings in necessary regional increases in irrigated cereal areas associated with Scenarios 2 and 3 are then presented in Table 21. Clearly the scope for irrigated yields to obviate an increse in irrigated areas is significant for some regions.

The results can then be compared with the unused land and water potential (Annex 4) as a first step towards the definition of any irrigation development strategy. This is done at a regional level rather than at a national level to reflect the possibility of some localized cross-border trading, while also addressing national food security based on regional self-sufficiency.

The desirability of a productivity-based approach on existing assets is clearly demonstrated. This is especially so given that such an approach would also increase production on existing assets, further reducing the need for new investments. However, the relative lack of existing assets in Central, Eastern, Gulf of Guinea and the Indian Ocean Islands regions means that purely productivity-based approaches will have more limited impact.

TABLE 18
Scenario 1 – no further yield increases between 2015 and 2030

	Central	Eastern	Gulf of Guinea	Indian Ocean Islands	South Africa	Southern	Sudano-Sahelian	Total SSA
Projected regional and sub-Saharan Africa cereal surpluses and deficits by 2030 (tonnes)								
Barley	-380 700	-270 300	-253 500	-48 400	-300 000	-71 800	-130 300	-1 455 000
Maize	-1 475 900	-1 749 000	-268 000	-339 600	1 000 000	-1 926 800	-830 000	-5 589 300
Millet	-200	-2 400	7 100	-300	0	300	-70 000	-65 500
Other cereals	-16 500	-33 200	-56 200	-14 500	-10 800	-79 900	-174 300	-385 400
Rice	-2 329 100	-1 212 900	-7 848 200	-912 400	-1 078 000	-400 200	-4 233 900	-18 014 700
Sorghum	-76 900	-126 400	0	-3 000	2 800	-40 400	-85 000	-328 900
Wheat	-4 373 200	-3 646 700	-6 249 900	-664 500	-500 000	-1 388 700	-4 311 700	-21 134 700
Yields (from Table 18)								
Barley	n.a.	2.50	n.a.	n.a.	3.00	2.60	n.a.	
Maize	3.50	3.20	3.28	n.a.	7.50	2.86	2.01	
Millet	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	2.70	
Other cereals	1.75	1.75	1.75	n.a.	1.75	1.75	1.75	
Rice	3.70	3.73	3.58	3.32	n.a.	3.11	4.16	
Sorghum	n.a.	1.83	2.00	n.a.	n.a.	2.00	2.05	
Wheat	3.00	3.50	3.97	n.a.	4.00	6.54	2.21	
Irrigated areas necessary to achieve regional self-sufficiency (gaps indicated a need for a rainfed- or import-based strategy) (ha)								
Barley		108 120			100 000	27 615		
Maize	421 686	546 676	81 811		-133 333	673 108	412 270	
Millet							25 926	
Other cereals	9 429	18 971	32 114		6 171	45 657	99 600	
Rice	629 775	324 994	2 193 785	274 883		128 527	1 016 692	
Sorghum		68 945	0			20 200	41 437	
Wheat	1 457 733	1 041 914	1 573 642		125 000	212 340	1 949 899	
	2 518 623	2 109 621	3 881 352	274 883	97 838	1 107 448	3 545 824	
Area currently irrigated (from AQUASTAT) (ha)								
	111 272	611 271	470 260	1 120 133	1 498 000	562 633	2 642 147	
Ratio of necessary to current area	22.63	3.45	8.25	0.25	0.07	1.97	1.34	

TABLE 19
Scenario 2 – yield gaps between 2015 and targets reduced by 50 percent between 2015 and 2030

	Central	Eastern	Gulf of Guinea	Indian Ocean Islands	South Africa	Southern	Sudano-Sahelian	Total SSA
Projected regional and sub-Saharan Africa cereal surpluses and deficits by 2030 (tonnes)								
Barley	-380 700	-270 300	-253 500	-48 400	-300 000	-71 800	-130 300	-1 455 000
Maize	-1 475 900	-1 749 000	-268 000	-339 600	1 000 000	-1 926 800	-830 000	-5 589 300
Millet	-200	-2 400	7 100	-300	0	300	-70 000	-65 500
Other cereals	-16 500	-33 200	-56 200	-14 500	-10 800	-79 900	-174 300	-385 400
Rice	-2 329 100	-1 212 900	-7 848 200	-912 400	-1 078 000	-400 200	-4 233 900	-18 014 700
Sorghum	-76 900	-126 400	0	-3 000	2 800	-40 400	-85 000	-328 900
Wheat	-4 373 200	-3 646 700	-6 249 900	-664 500	-500 000	-1 388 700	-4 311 700	-21 134 700
Yield gaps between 2015 and targets reduced by 50% between 2015 and 2030								
Barley	n.a.	3.38	n.a.	n.a.	3.63	3.43	n.a.	
Maize	5.50	5.35	5.39	n.a.	7.50	5.18	4.76	
Millet	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	3.23	
Other cereals	2.13	2.13	2.13	n.a.	2.13	2.13	2.13	
Rice	3.85	3.87	3.79	3.66	n.a.	3.56	4.16	
Sorghum	n.a.	1.83	2.00	n.a.	n.a.	2.00	2.05	
Wheat	4.00	4.25	4.49	n.a.	4.50	6.54	3.61	
Irrigated areas necessary to achieve regional self-sufficiency (gaps indicated a need for a rainfed- or import-based strategy) (ha)								
Barley		80 089			82 759	20 964		
Maize	268 345	326 936	49 741		-133 333	37 1878	174 494	
Millet							21 705	
Other cereals	7 765	15 624	26 447		5 082	37 600	82 024	
Rice	605 094	313 732	2 071 456	249 316		112 515	1 016 692	
Sorghum		68 945	0			20 200	41 437	
Wheat	1 093 300	858 047	1 393 261		111 111	212 340	1 195 827	
	1 974 504	1 663 373	3 540 905	249 316	65 619	775 496	2 532 179	
Area currently irrigated (from AQUASTAT) (ha)								
	111 272	611 271	470 260	1 120 133	1 498 000	562 633	2 642 147	
Ratio of necessary to current area	17.74	2.72	7.53	0.22	0.04	1.38	0.96	

TABLE 20
Scenario 3 – target yields achieved throughout by 2030

	Central	Eastern	Gulf of Guinea	Indian Ocean Islands	South Africa	Southern	Sudano-Sahelian	Total SSA
Projected regional and sub-Saharan Africa cereal surpluses and deficits by 2030 (tonnes)								
Barley	-380 700	-270 300	-253 500	-48 400	-300 000	-71 800	-130 300	-1 455 000
Maize	-1 475 900	-1 749 000	-268 000	-339 600	1 000 000	-1 926 800	-830 000	-5 589 300
Millet	-200	-2 400	7 100	-300	0	300	-70 000	-65 500
Other cereals	-16 500	-33 200	-56 200	-14 500	-10 800	-79 900	-174 300	-385 400
Rice	-2 329 100	-1 212 900	-7 848 200	-912 400	-1 078 000	-400 200	-4 233 900	-18 014 700
Sorghum	-76 900	-126 400	0	-3 000	2 800	-40 400	-85 000	-328 900
Wheat	-4 373 200	-3 646 700	-6 249 900	-664 500	-500 000	-1 388 700	-4 311 700	-21 134 700
Yield gaps between 2015 and targets reduced by 50% between 2015 and 2030								
Barley	n.a.	4.25	n.a.	n.a.	4.25	4.25	n.a.	
Maize	7.50	7.50	7.50	n.a.	7.50	7.50	7.50	
Millet	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	3.75	
Other cereals	2.50	2.50	2.50	n.a.	2.50	2.50	2.50	
Rice	4.00	4.00	4.00	4.00	n.a.	4.00	4.00	
Sorghum	n.a.	1.20	1.20	n.a.	n.a.	1.20	1.20	
Wheat	5.00	5.00	5.00	n.a.	5.00	5.00	5.00	
Irrigated areas necessary to achieve regional self-sufficiency (gaps indicated a need for a rainfed- or import-based strategy) (ha)								
Barley		63 600			70 588	16 894		
Maize	196 787	233 200	35 733		-133 333	256 907	110 667	
Millet							18 667	
Other cereals	6 600	13 280	22 480		4 320	31 960	69 720	
Rice	582 275	303 225	1 962 050	228 100		100 050	1 058 475	
Sorghum		105 333	0			33 667	70 833	
Wheat	874 640	729 340	1 249 980		100 000	277 740	862 340	
	1 660 302	1 447 978	3 270 243	228 100	41 575	717 217	2 190 702	
Area currently irrigated (from AQUASTAT) (ha)								
	111 272	611 271	470 260	1 120 133	1 498 000	562 633		2 642 147
Ratio of necessary to current area	14.92	2.37	6.95	0.2	0.03	1.27		0.83

TABLE 21
Savings in additional irrigated areas afforded by achieving weighted mean yield targets

Scenario	Central	Eastern	Gulf of Guinea	Indian Ocean Islands	South Africa	Southern	Sudano-Sahelian
	(%)						
2	25	24	5	9	33	30	29
3	39	33	6	17	58	36	40

Up to this point, this analysis has been limited to an estimation of the increase in irrigated yields necessary to achieve regional cereal self-sufficiency under three yield scenarios. As such, it has ignored those cereals that are inappropriate for the farming systems or conditions in a particular region. It is now necessary to consider the additional irrigated-area increases in the regions where it may be appropriate to irrigate these crops. Therefore, Tables 22–24 rework Tables 18–20 such that, with the exception of Indian Ocean Islands region (which is difficult to analyse as it is spread all around continental Africa and in certain cases, i.e. Mauritius and Seychelles, can be assumed to have mature and sustainable trade relationships beyond Africa), shortfalls with respect to an "inappropriate" crop in a particular region are met by increased irrigation production in the closest region where the crop might be irrigated. Thus, for the sake of this analysis (which is synoptic only), the barley needs of the Central, Gulf of Guinea and Sudano-Sahelian regions could be met by increased irrigated production in the Eastern region; millet needs for sub-Saharan Africa could be met from the Sudano-Sahelian Subregion; rice needs in South Africa could be met from the Southern Subregion; and the sorghum needs of the Central Subregion could be met from the Eastern Subregion. These opportunities are indicated in Tables 22–24 where blank cells indicate countries where the crop would be appropriate for irrigation. Cells with values identify the regions, which in addition to filling the indicated gap, could potentially meet demand in the other regions as indicated by the yellow shading.

NATURAL RESOURCES CONSTRAINTS

Are there are enough land and water resources to support the production hypotheses set out above? Considering that gains accruing to a productivity-based strategy are more pronounced between Scenarios 1 and 2, than 2 and 3, Scenario 2 is assumed as the most likely scenarios against which the resource availability can be checked.

The availability of land and water resources at the regional level were considered during execution of the first subcomponent of this study. Data for this were taken from FAO (2005a), which includes estimates of the annually renewable water resources for each country and estimates of irrigation water requirements based on generic farming systems. Table 25 compares the results with the necessary area increments.

With one exception, the land and water resources of sub-Saharan Africa are considerably more than adequate for an irrigation-based strategy targeted at regional calorific self-sufficiency. Further, where regional self-sufficiency is not possible, shortfalls can be made good by exports from elsewhere in sub-Saharan Africa. So far, the analysis has assumed that the Sudano-Sahelian could be an exporting region. However, Table 25 shows that there is insufficient land. This means that the region will be among the net importers. However, given its proximity to the Mediterranean basin and its links with the North American supply chain, it is beyond the scope of this study at this stage to say whether or not it is better for it to import from elsewhere in sub-Saharan Africa or further afield.

TABLE 22

Sub-Saharan Africa cereal self-sufficiency under Scenario 1 – no further yield increases between 2015 and 2030

	Central	Eastern	Gulf of Guinea	Indian Ocean Islands	South Africa	Southern	Sudano-Sahelian	Total SSA
Projected regional and sub-Saharan Africa cereal surpluses and deficits by 2030 (tonnes)								
Barley		-1 034 800		-48 400	-300 000	-71 800		-1 455 000
Maize	-1 475 900	-1 749 000	-268 000	-339 600	1 000 000	-1 926 800	-830 000	-5 589 300
Millet							-65500	-65 500
Other cereals	-16 500	-33 200	-56 200	-14500	-10 800	-79 900	-174 300	-385 400
Rice	-2 329 100	-1 212 900	-7 848 200	-912 400		-1 478 200	-4 233 900	-18 014 700
Sorghum		-203 300	0	-3 000	2 800	-40 400	-85 000	-328 900
Wheat	-4 373 200	-3 646 700	-6 249 900	-664 500	-500 000	-1 388 700	-4 311 700	-21 134 700
Yields (from Table 18)								
Barley	n.a.	2.50	n.a.	n.a.	3.00	2.60	n.a.	
Maize	3.50	3.20	3.28	n.a.	7.50	2.86	2.01	
Millet	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	2.70	
Other cereals	1.75	1.75	1.75	n.a.	1.75	1.75	1.75	
Rice	3.70	3.73	3.58	3.32	n.a.	3.11	4.16	
Sorghum	n.a.	1.83	2.00	n.a.	n.a.	2.00	2.05	
Wheat	3.00	3.50	3.97	n.a.	4.00	6.54	2.21	
Irrigated areas necessary to achieve regional self-sufficiency (gaps indicated a need for a rainfed- or import-based strategy) (ha)								
Barley		413 920			100 000	27 615		
Maize	421 686	546 676	81 811		-133 333	673 108	412 270	
Millet							24 259	
Other cereals	9 429	18 971	32 114		6 171	45 657	99 600	
Rice	629 775	324 994	2 193 785	274 883		474 736	1 016 692	
Sorghum		110 891	0			20 200	41 437	
Wheat	1 457 733	1 041 914	1 573 642		125 000	212 340	1 949 899	
	2 518 623	2 457 366	3 881 352	274 883	97 838	1 453 656	3 544 157	
Change		yes				yes	yes	
Area currently Irrigated (from AQUASTAT) (ha)								
	111 272	611 271	470 260	1 120 133	1 498 000	562 633	2 642 147	
Ratio of necessary to current area	22.63	4.02	8.25	0.25	0.07	2.58	1.34	

TABLE 23

Sub-Saharan Africa cereal self-sufficiency under Scenario 2 – yield gaps between 2015 and targets reduced by 50 percent between 2015 and 2030

	Central	Eastern	Gulf of Guinea	Indian Ocean Islands	South Africa	Southern	Sudano-Sahelian	Total SSA
Projected regional and sub-Saharan Africa cereal surpluses and deficits by 2030 (tonnes)								
Barley		-1 034 800		-48 400	-300 000	-71 800		-1 455 000
Maize	-1 475 900	-1 749 000	-268 000	-339 600	1 000 000	-1 926 800	-830 000	-5 589 300
Millet							-65 500	-65 500
Other cereals	-16 500	-33 200	-56 200	-14 500	-10 800	-79 900	-174 300	-385 400
Rice	-2 329 100	-1 212 900	-7 848 200	-912 400		-1 478 200	-4 233 900	-18 014 700
Sorghum		-203 300		-3 000	2 800	-40 400	-85 000	-328 900
Wheat	-4 373 200	-3 646 700	-6 249 900	-664 500	-500 000	-1 388 700	-4 311 700	-21 134 700
Yield gaps between 2015 and targets reduced by 50% between 2015 and 2030								
Barley	n.a.	3.38	n.a.	n.a.	3.63	3.43	n.a.	
Maize	5.50	5.35	5.39	n.a.	7.50	5.18	4.76	
Millet	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	3.23	
Other cereals	2.13	2.13	2.13	n.a.	2.13	2.13	2.13	
Rice	3.85	3.87	3.79	3.66	n.a.	3.56	4.16	
Sorghum	n.a.	1.83	2.00	n.a.	n.a.	2.00	2.05	
Wheat	4.00	4.25	4.49	n.a.	4.50	6.54	3.61	
Irrigated areas necessary to achieve regional self-sufficiency (gaps indicated a need for a rainfed- or import-based strategy) (ha)								
Barley		306 607			82 759	20 964		
Maize	268 345	326 936	49 741		-133 333	371 878	174 494	
Millet							20 310	
Other cereals	7 765	15 624	26 447		5 082	37 600	82 024	
Rice	605 094	313 732	2 071 456	249 316		415 590	1 016 692	
Sorghum		110 891	0			20 200	41 437	
Wheat	1 093 300	858 047	1 393 261		111 111	212 340	1 195 827	
	1 974 504	1 931 837	3 540 905	249 316	65 619	1 078 572	2 530 783	
Change		yes				yes	yes	
Area currently irrigated (from AQUASTAT) (ha)								
	111 272	611 271	470 260	1 120 133	1 498 000	562 633		2 642 147
Ratio of necessary to current area	17.74	3.16	7.53	0.22	0.04	1.92	0.96	

TABLE 24
Sub-Saharan Africa cereal self-sufficiency under Scenario 3 – target yields achieved throughout by 2030

	Central	Eastern	Gulf of Guinea	Indian Ocean Islands	South Africa	Southern	Sudano-Sahelian	Total SSA
Projected regional and sub-Saharan Africa cereal surpluses and deficits by 2030 (tonnes)								
Barley		-1 034 800		-48 400	-300 000	-71 800		-1 455 000
Maize	-1 475 900	-1 749 000	-268 000	-339 600	1 000 000	-1 926 800	-830 000	-5 589 300
Millet							-65 500	-65 500
Other cereals	-16 500	-33 200	-56 200	-14 500	-10 800	-79 900	-174 300	-385 400
Rice	-2 329 100	-1 212 900	-7 848 200	-912 400		-1 478 200	-4 233 900	-18 014 700
Sorghum		-203 300		-3 000	2 800	-40 400	-85 000	-328 900
Wheat	-4 373 200	-3 646 700	-6 249 900	-664 500	-500 000	-1 388 700	-4 311 700	-21 134 700
Yield gaps between 2015 and targets reduced by 50% between 2015 and 2030								
Barley	n.a.	4.25	n.a.	n.a.	4.25	4.25	n.a.	
Maize	7.50	7.50	7.50	n.a.	7.50	7.50	7.50	
Millet	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	3.75	
Other cereals	2.50	2.50	2.50	n.a.	2.50	2.50	2.50	
Rice	4.00	4.00	4.00	4.00	n.a.	4.00	4.00	
Sorghum	n.a.	1.20	1.20	n.a.	n.a.	1.20	1.20	
Wheat	5.00	5.00	5.00	n.a.	5.00	5.00	5.00	
Irrigated areas necessary to achieve regional self-sufficiency (gaps indicated a need for a rainfed- or import-based strategy) (ha)								
Barley		243 482			70 588	16 894		
Maize	196 787	233 200	35 733		-133 333	256 907	110 667	
Millet							17 467	
Other cereals	6 600	13 280	22 480		4 320	31 960	69 720	
Rice	582 275	303 225	1 962 050	228 100		369 550	1 058 475	
Sorghum		169 417	0			33 667	70 833	
Wheat	874 640	729 340	1 249 980		100 000	277 740	862 340	
	1 660 302	1 691 944	3 270 243	228 100	41 575	986 717	2 189 502	
Change		yes				yes	yes	
Area currently irrigated (from AQUASTAT) (ha)								
	111 272	611 271	470 260	1 120 133	1 498 000	562 633	2 642 147	
Ratio of necessary to current area	14.92	2.77	6.95	0.20	0.03	1.75	0.83	

TABLE 25
Comparison of Scenario 2 land and water demands with the available resources for sub-Saharan Africa self-sufficiency

Region	Land area			Water			
	Needed	Available	Sufficient?	Needed		Annually renewable	Sufficient?
	(ha)	(ha)		(m^3/ha/year)	(km^3/year)	(km^3/year)	
Central	1 974 504	13 588 728	Yes	14 540	28.71	21 876	Yes
Eastern	1 663 373	5 093 094	Yes	13 990	23.27	281	Yes
Gulf of Guinea	3 540 905	6 923 156	Yes	18 073	63.99	952	Yes
Indian Ocean Islands	249 316	417 881	Yes	15 355	3.83	340	Yes
Southern	1 078 572	3 937 628	Yes	13 961	15.06	270	Yes
Sudano-Sahelian	2 530 783	1 146 400	No	15 360	38.87	160	Yes

Chapter 7
Trends and opportunities

From the baseline analysis, the anticipated impacts of expanded irrigated production and the 2030 projections in Chapter 6, it is possible to arrive at three principal conclusions. First, despite certain exceptions at the national and sometimes regional levels and in the absence of new initiatives, sub-Saharan Africa will continue to depend heavily on imports, particularly in key cereal staples. Second, it can be concluded that: (i) irrigation has a potentially significant and strategic role to play in reducing such import requirements; and (ii) there is land in abundance that could be irrigated, and water in abundance (at least at the macrolevel) with which to irrigate. Finally, the high risks, especially environmental risks, which must be mitigated, may be offset by attractive positive impacts at the economic, production, commercial and social levels.

Therefore, the first two sections of this chapter are concerned with a assessment of the kind of demand for which an sub-Saharan Africa irrigation development strategy might be appropriate between now and 2030, while the remainder of the chapter attempts to address the four questions raised in Chapter 2 in order to see how irrigation could, after all, contribute to strategic food objectives.

THE INTERNATIONAL TRADING ENVIRONMENT

International trade in agricultural commodities is subject to a complex set of international, regional and bilateral intergovernmental agreements, and to individual national schemes that tax and otherwise regulate imports. This section briefly describes the main agreements to which all sub-Saharan Africa countries are subject.

The Generalized System of Preferences

In 1968, the United Nations Conference on Trade and Development recommended a Generalized System of Tariff Preferences (GSP) under which industrialized countries would grant trade preferences to all developing countries. Preferential treatment granted under the GSP should not discriminate between developing countries, except for the benefit of least developed countries (LDCs). The preferential treatment should also be granted autonomously without negotiation and there should be no agreement under which beneficial countries make mutual concessions. In practice, there is significant variation in the preferences granted by individual developed-country schemes, with significant differences in product coverage, rules of origin and the size of tariff reductions.

The Uruguay Round Agreement on Agriculture

The most all embracing of existing trade agreements is the Agreement on Agriculture (AoA), negotiated during the Uruguay Round of the General Agreement on Tariffs and Trade (GATT), which became effective for all members of the World Trade Organization (WTO) in 1995. In April 2004, 147 countries were members of the WTO and a further 28 countries were negotiating to join.

The AoA is envisaged as the first step in a continuous reform process among members of the WTO aimed at the progressive reduction of agricultural support and protection. A new round of WTO negotiations – the Doha Development Round – commenced in 2000.

The negotiation of the AoA was of major importance because, unlike for industry, previous rounds of GATT had not addressed the heavy support and protection afforded to domestically produced agricultural commodities and processed products. This protection and support has been provided through:

- direct protection from imports in the form of import tariffs and quotas;
- the subsidization of exports;
- the subsidization and support of domestic production.

The AoA contains provisions to reduce these means of protection. The WTO has developed a set of rules and procedures for resolving disputes between member countries and regional groupings that cannot be settled by negotiation between the parties concerned. The WTO dispute settlement system works well for developed countries, most of whom have sufficient resources and expertise to have full access to it. However, it needs modification if it is to be used effectively by developing countries, especially those that are small and/or least developed.

The Agreement on the Application of Sanitary and Phytosanitary Standards

The Agreement on the Application of Sanitary and Phytosanitary Standards (known as the "SPS agreement") was also negotiated during the Uruguay Round but is separate from the AoA. It covers all agricultural commodities and products and refers to the use by governments and their agencies of food safety and agricultural health standards. Such an agreement is necessary because standards can impede exports and distort international trade either because they result in the banning of imports or because the cost of compliance reduces the profitability of production, processing and marketing and, therefore, the incentive to export. This agreement is designed to provide a set of multilateral rules that recognize the legitimate need of countries to adopt sanitary and phytosanitary standards while creating a framework for minimizing their distortion of trade.

The agreement represents a significant improvement on the prior situation but in essence it only provides a set of basic ground rules. These give significant leeway for interpretation as there are many areas in which no agreed international standards exist and many emerging areas in which scientific knowledge is incomplete. Moreover, sanitary and phytosanitary standards are costly to implement and countries consequently apply them as part of a risk management strategy. As resources and perceptions of risk differ between countries, the agreement necessarily allows for national measures also to differ. sub-Saharan Africa countries are likely to be particularly hard hit by the tendency for developed countries to focus their controls on national sources that they consider have inadequate sanitary and phytosanitary standards. The necessarily loose nature of the agreement also means that there remains scope for sanitary and phytosanitary standards to be used as a back-door means of protection.

The adverse impact of the protective use of such measures has been compounded in the past decade by a greatly increased public awareness and concern with food safety in developed countries in the wake of a set of internationally publicized health scares relating to food, including bovine spongiform encephalopathy in beef, E. coli in fast food, SARS from caged exotic animals, and bird flu from poultry. Governments have reacted by making significant institutional changes in food safety oversight and reforming pertinent laws and regulations. There has been a tightening of existing standards in developed and middle-income importing countries and new standards are being applied to address previously unknown or unregulated hazards and potential hazards that could arise from new techniques, such as genetic modification of organisms.

The high cost of testing products at the border and the imprecise nature of sample-based testing has led to a growing number of health and safety requirements being based on standards relating to processes by which commodities are produced, processed, stored and marketed. This requires parallel development of a national capacity in exporting countries to certify that particular processes have been followed. This is likely to be particularly difficult for the less-developed sub-Saharan Africa countries as tracing products back to their source is problematic where production is dominated by small-scale farms and where monitoring and certification institutions have yet to be developed.

From this brief discussion, it is evident that such import controls remain an important impediment for sub-Saharan Africa exporters seeking to access developed-country markets.

Trade agreements and preferences

Developed countries employ sets of tariff schedules under which the rate charged depends on the status of the exporting nation. The lowest rates are normally charged under reciprocal trade agreements, with a subsequent hierarchy of rates running from LDCs, developing countries, developed country WTO members, and other countries. Here, the focus is on the world's two largest markets, the European Community (EC) and the United States of America.

The EC was the first to implement a GSP scheme in 1971 and it now operates a scheme that covers the four-fifths of its tariff lines that are subject to most-favoured nation (MFN) import duties. For imports to qualify for GSP treatment, they must conform to rules of origin which seek to ensure that real value-added has been created in the beneficiary country. For the purpose of determining which countries will qualify for GSP treatment, the EC decides each year upon the countries that it will treat as "developing". Within non-LDC countries that qualify for the GSP, the EC excludes exports from the scheme if it deems that they derive from sectors that are sufficiently developed to no longer require preferential EC access.

EC GSP rates are normally equal to its MFN rate less a flat rate reduction specified in percentage points. The general arrangements of the EC's GSP cover about 7 000 products, of which 3 300 are classified as non-sensitive and 3 700 as sensitive. The former enjoy duty-free access, while sensitive products are subject to tariffs that are set at a discount to their MFN rate. Sensitive products are those that the EC considers require border protection in order to enable them to compete with duty-free imports from developing countries.

In February 2001, the European Union Council approved an Everything-but-Arms (EBA) Regulation. Its intention is ultimately to grant duty- and quota-free access to imports of all products other than arms and munitions to countries classified as LDCs. In April 2004, 47 countries were so classified, including 37 from sub-Saharan Africa. The EBA initiative currently covers all dutiable imports other than bananas, sugar and rice, for which there will be transitional periods during which tariff rates will be gradually reduced. The EBA Regulation specifies that the special arrangements for LDCs will be maintained for an unlimited period of time and not be subject to the periodic renewal of the EC GSP scheme. Most sub-Saharan Africa countries also qualify for preferential market access to the EC under the EC–ACP Cotonou Partnership Agreement, signed in June 2000 by the EC and 77 African, Caribbean and Pacific countries.

The policy of the United States of America is to negotiate free-trade agreements with interested sub-Saharan Africa countries. The first such possible agreement, between the United States of America and the countries of the Southern African Customs Union (SACU) is currently under negotiation.

Since May 2000, the United States of America has been giving preferential treatment to imports from African countries under its African Growth and Opportunity Act (AGOA). The AGOA provides African countries with the most liberal access to the market in the United States of America available to any country or region other than those with which the United States of America has a free-trade agreement. To be eligible for the trade benefits of AGOA, African countries must pursue policies acceptable to the Government of the United States of America. In 2004, 37 out of 48 African countries were deemed eligible. This compares with 45 covered by the GSP of the United States of America.

The AGOA provides for duty-free access under the GSP for any article that the Government of the United States of America considers is not import sensitive when imported from sub-Saharan Africa countries. Almost all products of AGOA beneficiary countries now enter the United States of America free of duty. However, agricultural imports into the United States of America remain subject to tariff rate quotas and AGOA beneficiary countries remain subject to any overquota duties for shipments above the applicable quantitative limit. The main impact of AGOA has been on apparel (Box 7). In general, the AGOA is of only minor importance for the

BOX 7

Termination of the WTO Multifibre Arrangement

The textile and clothing sector has traditionally been the first sector to develop in the process of industrialization. The manufacture of textiles and clothing is labour-intensive and countries tend to lose their comparative advantage in this activity as their economies develop and wage rates rise. Developed countries have responded to their loss of comparative advantage by protecting their textile and clothing industries, principally through border measures. From the 1960s, this was done largely outside GATT/WTO through separate arrangements, the last of which – the MFA – commenced in 1974. The MFA allowed developed countries to impose bilateral quotas on imports of textiles and clothing which caused or threatened to cause serious damage to the industry in the importing country. This represented a major departure from GATT principles, particularly the principle of non-discrimination.

The MFA was intended to be temporary, to give importing countries a breathing space in which to adjust their industrial structures. In the event, the MFA was renewed five times through to the late 1980s. During negotiation of the Uruguay Round, it was agreed that the MFA would be phased out through implementation of a transitional WTO Agreement on Textiles and Clothing. This provided for a gradual opening up of developed-country markets, with textiles and clothing becoming subject to the full provisions of the GATT/WTO on 1 January 2005.

Developing countries as a whole will gain significantly from the end of the MFA. However, the MFA benefited high-cost developing country exporters because it provided them in importing country markets with a degree of protection from competition from low-cost exporting countries. This led to heavy investment in manufacture in relatively inefficient producing countries where the MFA provided fewer constraints to exports, most notably Bangladesh. Within sub-Saharan Africa, the African Growth and Opportunity Act (AGOA) gave qualifying countries the right to export textiles and clothing into the United States of America free from both import duties and the bilateral quotas imposed on the major exporting countries under the MFA. This resulted in foreign enterprises investing in textile and clothing production in sub-Saharan Africa countries, especially those with high unemployment. Relative to the country's size, investment was particularly heavy in Lesotho. In 2004, about 50 000 people were employed in the Lesotho textile industry, making it a source of livelihood for about one-sixth of the country's households. Prior to the termination of the MFA, Lesotho accounted for 30 percent of the value of all textiles exported to the United States of America under the AGOA.

The AGOA will continue to provide an advantage for African exports to the United States of America because of the duty-free access that it affords. However, costs in countries such as Lesotho tend currently to be so much higher than in China and Southeast Asian countries that the edge given by the AGOA is proving insufficient in the post-MFA era. Thus, the advantages bestowed by the AGOA were short-lived and the countries that benefited now face a period of painful adjustment. However, the proportion of total population of sub-Saharan Africa that is affected is small. Moreover, much of the textile and clothing manufacture in sub-Saharan Africa is based on imported cotton and synthetics, entirely so in the case of the two most dependent countries, Mauritius and Lesotho. Thus, although having received much international publicity, the termination of the MFA will not have a significant impact on the demand for sub-Saharan Africa irrigated production.

agricultural products of sub-Saharan Africa countries because the majority of GSP tariffs are zero and, consequently, AGOA affords no additional tariff-rate advantages.

MARKET PROSPECTS FOR THE MAIN CROP GROUPS

General considerations

Other than for root crops and highly perishable crops that tend not to be traded across national boundaries, currency exchange rates will remain an important determinant of the profitability of domestic production, including production under irrigation. In response to pressure from the International Monetary Fund (IMF) and other external agencies, there has been a progressive liberalization of exchange rate controls in sub-Saharan Africa and movement towards rates determined by market forces. While generally desirable, it does make the currencies of sub-Saharan Africa countries that rely on a small number of export commodities for the bulk of their foreign exchange earnings particularly vulnerable to changes in world commodity prices. This in turn could be particularly damaging for irrigated staple crops that sell in domestic markets in competition with imports. For example, irrigated producers of rice in a cocoa exporting country could face a fall in domestic market prices should international cocoa prices rise, causing the national currency to revalue and the cost of rice imports specified in the national currency to fall. Countries with significant exports of oil or other minerals could also find that the profitability of production for the domestic market is hampered by strong non-agricultural export earnings. This may be a particularly difficult problem to overcome in countries such as Namibia (whose main exports are minerals and fish) that have traditionally protected their agriculture in the face of a strong exchange rate, but which will be less able to do so as regional and international trade agreements progressively preclude such protection.

The trade data for sub-Saharan Africa in wheat, rice, coarse grains, oils and fats, and sugar for the period 1990–2003 is presented in Annex 6. Box 8 presents the current state of the rice market in sub-Saharan Africa.

Cereals

The agricultural resources of sub-Saharan Africa are overwhelmingly focused on the production of food for human consumption and livestock. Despite this, sub-Saharan Africa produces insufficient food to meet the requirements of its population and has to import basic staple foodstuff. Within sub-Saharan Africa as a whole, cereal production

BOX 8

Rice: market prospects in sub-Saharan Africa

FAO currently anticipates a 2.5 percent contraction of world rice trade in calendar 2006 to 28.5 million tonnes, still the second highest level on record. The retrenchment from the 2005 exceptional trade performance is anticipated to result from a general weakening of import demand by countries in Africa, where good crops were harvested in 2005. **Nigeria** accounts for much of that contraction, where shipments are forecast to drop from 2.0 million to 1.6 million tonnes, reflecting a ban on milled rice imports since the beginning of 2006. Though falling, shipments to **Côte d'Ivoire**, **Senegal** and **South Africa** are likely to remain large, in the order of 800 000 tonnes, with imports from all African countries expected to reach 9.2 million tonnes, or 32 percent of the world total, about 1 million tonnes less than in 2005.

FAO Food Outlook: Global Market Analysis No. 1 June 2006
http://www.fao.org/giews/english/index.htm

TABLE 26
Projected national, regional and sub-Saharan Africa net trade in 2030 (1 000 metric tonnes)

	CENTRAL	EASTERN	GULF OF GUINEA	INDIAN OCEAN ISLANDS	SOUTH AFRICA	SOUTHERN	SUDANO-SAHELIAN	TOTAL SSA
	Region Total	Region Total	Region Total	Region Total	Region Total	Region Total	Region Total	
Wheat	-4 373	-3 646 700	-6 249 900	-664 500	-500 000	-1 388 700	-4 311 700	-21 134 700
Rice (milled)	-2 329	-1 212 900	-7 848 200	-912 400	-1 078 000	-400 200	-4 233 900	-18 014 700
Maize	-1 475	-1 749 000	-268 000	-339 600	1 000 000	-1 926 800	-830 000	-5 589 300
Barley	-380 700	-270 300	-253 500	-48 400	-300 000	-71 800	-130 300	-1 455 000
Millet	-200	-2 400	7 100	-300	0	300	-70 000	-65 500
Sorgum	-76 900	-126 400	0	-3 000	2 800	-40 400	-85 000	-328 900
Other	-16 500	-33 200	-56 200	-14 500	-10 800	-79 900	-174 300	-385 400
TOTAL	**-8 652 500**	**-7 040 900**	**-14 668 700**	**-1 982 700**	**-886 000**	**-3 907 500**	**-9 835 200**	**-46 973 500**

Source: FAO (2003).

in 1997/99 was adequate to meet 80 percent of demand. About one-third of the wheat and two-thirds of the rice consumed in sub-Saharan Africa was grown in the region.

Food imports into sub-Saharan Africa are dominated in terms of both value and calorie content by wheat, rice and vegetable oils. The situation is projected to deteriorate in the period through to 2030, with net imports of wheat and rice tripling and with large imports of maize, vegetable oils and sugar also being needed. Table 26 presents projections for 2030 of national, regional and sub-Saharan Africa deficits of each of the main grains. For sub-Saharan Africa as a whole, there is a projected grain deficit of 47 million tonnes, of which 14.1 million tonnes is in the eight countries that comprise the Gulf of Guinea Subregion. This largely reflects the presence of most populous sub-Saharan Africa country – Nigeria – in the region. Nigeria's projected grain deficit is 8.3 million tonnes, or some 18 percent of the sub-Saharan Africa total. This is roughly in line with its projected 17-percent share of the value of the projected 2030 sub-Saharan Africa population. Table 27 analyses the projected 2030 grain deficits into deficits per capita and per agricultural worker. The greatest deficits per capita are in low population countries that are either in semi-arid areas, have suffered from civil war or are heavily urbanized. Per agricultural worker, the greatest projected deficits are in Mauritius, Gabon, Namibia, Congo, South Africa and Mauritania. At the regional level, the smallest projected deficit per agricultural worker is in Eastern Africa, with the highest being in South Africa. However, in per-capita terms, the projected deficit in South Africa is the smallest, reflecting the likelihood that only a projected 2.4 percent of its national labour force will be working in agriculture in 2030.

In terms of the scope for irrigation to contribute to meeting these deficits, it is necessary to bear in mind that the 2030 deficits projected by FAO take account of agricultural expansion projected up to that year, including the projected expansion in irrigation.

A key factor affecting the profitability of irrigated production in the future will be changes that take place in the structure of the market into which the commodity sells. Evidence from a wide range of countries shows that high transport costs, port charges and other marketing costs in sub-Saharan Africa lead to dramatic differences between export- and import-parity grain prices (Westlake, 1987; Smith, 2003; Rosegrant and Perez, 1997). These differences are greatest in landlocked countries, such as Malawi and Zambia, which have a single annual growing season, and where neighbouring countries tend to face similar movements in annual rainfall levels. In such countries, the unit cost of exporting and importing can be of similar magnitude to the unit value of exports at the nearest sea port. Depending on the year, producer prices in such countries can be close to zero or double the price at the nearest sea port, and the vulnerability of domestic markets to import surges can be significant (Westlake, 2005).

Where prices remain determined by imports, there is consequently a greater likelihood of investment in irrigation being profitable than where prices are at export parity. In this regard, a situation of approximate national self-sufficiency may lead to

TABLE 27
National, regional and sub-Saharan Africa grain deficits in relation to population and labour, 2030

	GDP (billion US$)	Population (million)	GDP per capita	Labour force (million)	Agricultural labour force (million)	Ratio of ag. to tot. labour force (%)	Calories per capita	Grain Deficit (m.t.)	Grain deficit per capita (kg)	Grain deficit per agric. worker (kg)
SUB-SAHARAN AFRICA	**1 185.0**	**1 272.9**	**930.9**	**616.9**	**296.5**	**48.1**	**2566**	**46 973 500**	**37**	**158**
SUDANO-SAHELIAN	**299.2**	**212.2**	**1 410.2**	**92.4**	**58.6**	**63.4**	**2530**	**9 835 200**	**46**	**168**
Burkina Faso	13.5	29.2	461.8	12.5	12.8	102.3	2529	985 700	34	77
Chad	7.1	18.7	380.1	6.8	3.3	48.6	2539	143 300	8	43
Eritrea	1.3	7.7	171.1	3.6	2.8	78.1	2186	891 900	115	316
Gambia	1.0	2.2	454.7	1.1	0.9	80.5	2875	368 700	167	418
Mali	11.7	26.9	435.1	13.5	7.7	57.1	2611	529 300	20	69
Mauritania	4.1	6.0	681.6	2.3	1.2	53.2	2953	1 106 800	184	923
Niger	7.5	30.1	249.6	12.0	10.4	86.7	2269	1 018 000	34	98
Senegal	27.0	17.9	1 508.8	8.4	5.8	69.0	2588	2 416 500	135	419
Somalia	1.4	20.8	65.1	11.4	6.4	55.5	2051	1 265 300	61	199
Sudan	224.6	52.6	4 272.0	20.9	7.4	35.5	2794	1 109 700	21	150
GULF OF GUINEA	**237.5**	**336.7**	**705.4**	**161.8**	**38.1**	**23.6**	**2984**	**14 668 700**	**44**	**385**
Benin	9.1	13.3	684.9	6.3	1.7	27.5	2872	689 200	52	397
Cote D'Ivoire	46.3	26.5	1 748.9	10.9	2.4	22.5	2913	1 548 800	58	635
Ghana	34.8	32.8	1 061.1	19.6	11.3	57.8	2828	940 300	29	83
Guinea	11.4	15.6	731.3	8.1	5.4	66.8	2539	688 200	44	127
Liberia	2.2	8.9	246.1	2.9	1.6	57.5	2502	834 900	94	507
Nigeria	127.1	220.4	576.7	106.6	12.0	11.3	3109	8 311 000	38	692
Sierra leone	1.6	10.1	161.9	3.4	1.7	49.8	2456	1 164 800	115	682
Togo	4.9	9.1	542.4	4.1	1.9	45.6	2734	491 500	54	263
CENTRAL	**119.1**	**207.0**	**575.5**	**83.9**	**41.9**	**49.9**	**2265**	**8 652 500**	**42**	**207**
Angola	26.8	32.6	820.8	13.4	9.3	68.9	2400	1 943 000	60	210
Cameroon	45.2	25.8	1 752.3	13.2	3.4	25.5	2649	1 292 700	50	385
Central African Republic	5.0	6.4	779.1	3.1	1.4	43.9	2412	144 200	23	104
Congo	8.3	7.2	1 151.8	2.7	0.6	20.7	2492	695 400	97	1 237
Congo Democratic Republic	19.1	132.6	144.1	50.5	27.1	53.7	2126	4 200 500	32	155
Gabon	14.8	2.4	6 176.8	1.0	0.2	19.0	2878	376 700	157	1 932

TABLE 27
National, regional and sub-Saharan Africa grain deficits in relation to population and labour, 2030 (continued)

	GDP (billion US$)	Population (million)	GDP per capita	Labour force (million)	Agricultural labour force (million)	Ratio of ag. to tot. labour force (%)	Calories per capita	Grain Deficit (m.t.)	Grain deficit per capita (kg)	Grain deficit per agric. worker (kg)
EASTERN	**177.1**	**330.1**	**536.3**	**171.2**	**113.4**	**66.2**	**2317**	**7 040 900**	**21**	**62**
Burundi	3.4	13.8	243.7	7.6	6.7	88.2	2132	216 600	16	32
Ethiopia	31.8	127.0	250.2	66.6	41.4	62.2	2216	2 076 000	16	50
Kenya	32.5	46.9	693.6	28.8	16.6	57.8	2327	2 070 700	44	124
Rwanda	9.4	14.2	661.3	7.7	7.3	94.1	2355	561 000	40	77
United Republic of Tanzania	26.2	65.6	400.2	35.8	24.0	67.1	2450	1 095 000	17	46
Uganda	73.8	62.7	1 177.3	24.8	17.3	70.0	2408	1 021 600	16	59
SOUTHERN	**81.6**	**101.4**	**804.8**	**54.4**	**32.1**	**59.0**	**2451**	**3 907 500**	**39**	**122**
Botswana	13.9	1.9	7 401.7	1.3	0.5	38.7	2781	313 500	167	645
Lesotho	2.2	2.3	986.3	1.9	0.6	30.3	2699	249 700	110	441
Malawi	5.3	21.8	245.0	10.9	8.2	75.3	2532	465 400	21	57
Mozambique	13.7	30.4	449.0	20.6	13.9	67.5	2487	978 000	32	70
Swaziland	2.9	1.2	2 401.3	0.7	0.2	23.1	2899	108 100	90	671
Zambia	9.3	21.3	438.3	7.8	4.4	57.1	2162	1 350 100	63	304
Zimbabwe	24.7	19.6	1 257.2	10.0	4.1	40.9	2528	45 400	2	11
Namibia	9.6	3.0	3 230.9	1.4	0.3	18.7	2485	397 300	133	1 558
SOUTH AFRICA	**241.9**	**43.9**	**5 505.8**	**31.0**	**0.7**	**2.4**	**3209**	**886 000**	**20**	**1 204**
ISLANDS AND OTHERS	**28.5**	**41.5**	**686.6**	**22.0**	**11.7**	**53.0**	**2425**	**1 982 700**	**48**	**170**
Mauritius	14.2	1.4	10 148.7	0.7	0.0	3.6	3298	422 500	302	17 604
Madagascar	9.2	34.3	267.7	18.5	10.4	56.1	2343	634 700.0	18	61
sub-Saharan Africa others	5.1	5.8	884.1	2.8	1.2	44.6	2702	925 500	161	745

prices swinging wildly from import to export parity, making a high-investment activity such as irrigated crop production particularly unsuitable. For the three main grains, the majority of irrigated production in sub-Saharan Africa takes place in countries that are currently net importers.

The magnitude of projected future national deficits of these crops indicates that this situation will continue. Domestic prices, including producer prices, will consequently continue to be determined directly, or indirectly through competition with imports, and domestic producers will continue to receive relatively high import-parity prices.

However, although prices in most sub-Saharan Africa countries have been at import parity, investment in the production of grains under irrigation has not proved to be economically justifiable unless combined with a high-value summer crop, such as paprika or tobacco. While adequate markets for such high-value crops can often be found for individual irrigation schemes, it may not be possible to find remunerative markets for the large output that would result from their being grown on the extensive area of irrigation that would need to be established if irrigation were to be used as a major driver of sub-Saharan Africa grain output increase.

A further key factor that will affect the profitability of grain production in sub-Saharan Africa will be the changes that are agreed to during the current Doha Round of international trade negotiations. Although much of the debate has focused on market access for developing-country exports of agricultural goods and manufactures, it is the impact of these negotiations on the prices at which staples trade internationally that will arguably be of greatest importance to sub-Saharan Africa countries. While less protection of agriculture in developed countries will raise international prices and increase the profitability of production in developing countries, it will have the drawback of also raising the cost of the food imports necessary to make good national grain deficits, thereby raising domestic food prices and harming food security. In this regard, it is noteworthy that the EC has proposed the addition of a developing-country "food security box" to the set of permissible domestic supports provided for in the AoA. This suggests that the EC anticipates that grains will continue to trade at low prices, necessitating maintained or increased support for developing-country producers. No matter what the outcome of the Doha Round and subsequent negotiations, the addition of a food security box would give developing countries greater scope for manoeuvre in terms of supporting domestic food production. It will be important that the contents of such a box be neutral in terms of their support for rainfed and irrigated production. This in turn will require supports that are neutral between investment and recurrent costs.

Of the other main grains produced in sub-Saharan Africa, both millet and sorghum are usually grown in areas of low rainfall that will not sustain maize, wheat or rice. These crops are normally not irrigated and would have lower yields per hectare under irrigation than would maize, wheat or rice. Within much of sub-Saharan Africa, there is also now a widespread taste preference for wheat bread, maize, and rice over millet and sorghum. Given their irrigated yield and taste drawbacks of millet and sorghum and the associated low irrigation benefit-to-cost ratios, there is likely to be only limited irrigation of these crops in the foreseeable future.

Non-cereal staple food crops

The most important of the non-grain staples are cassava, sweet potato, other root crops and plantains. These tend not to be traded over long distances owing to their low value-to-weight ratios and relative perishability. Prices are determined by local supply and demand, and markets usually clear. Unlike grains, where national shortages lead to highly visible imports and national surpluses lead to stock accumulation and exports, there are no significant market surpluses or shortfalls of non-grain staples. For this reason, estimates and projections of supply and demand necessarily indicate approximate self-sufficiency. However, there is scope for market forces to lead to a substitution of root crops and plantains for grains, and vice versa. Until recently, governments in many sub-Saharan Africa countries supported grain production much more intensively than the production of root crops. Following the reduction or withdrawal of such support as part of structural adjustment programmes, market forces and rational decision-making by small-scale subsistence farmers in countries such as Malawi have led to a move in both production and consumption from maize to cassava. Even so, the FAO 2015/2030 projections for sub-Saharan Africa as a whole show a move in the opposite direction with maize and rice production and consumption increasing more rapidly than for root crops and plantains. This may well happen in response to increased consumer preferences for grains with urbanization and also as per-capita incomes expand. However, it would seem that there may well also be a move among large numbers of low-income subsistence rural farm households from grain production to the production of root crops, aimed at maximizing calorie output per hectare. Such a trend would have little impact on the potential to expand irrigation as it is unlikely that root crops and plantains could utilize irrigation investments efficiently because, despite their high yield response, they are perishable and have low value-to-weight ratios.

In addition to root crops, there will be potential for expanding the irrigated output of oilseeds, but this is likely to be limited by strong competition from imported palm oil and from the domestic and regional production of oil crops that do not require irrigation.

Other food crops

Sugar

For sub-Saharan Africa, the greatest uncertainty over future market developments is for sugar (see Box 9). The market for sub-Saharan Africa sugar have depended critically on EC arrangements with African, Caribbean and Pacific (ACP) countries and on tariff quotas in the United States of America, which both allow sub-Saharan Africa countries to export fixed amounts of sugar at higher than world prices. The future of these arrangements is currently highly uncertain. This is particularly the case for the EC–ACP Sugar Protocol under which the EC undertakes for an indefinite period to purchase and import specific quantities of cane sugar that originates in the ACP states at guaranteed prices. The EU has reformed this arrangement radically, in the face of strong opposition from the major ACP producing countries. There is also uncertainty over the Agreement on Special Preferential Sugar under which the EU undertakes to open annually a special tariff quota for the import of raw cane sugar from ACP states. The policy of the United States of America on sugar imports is also in a state of flux following a reversal of trade and domestic support policy for agriculture under the present administration. There is also uncertainty over arrangements that allow Swaziland and other Southern African producers to export sugar into the protected, high-priced South African market. The segmentation of the world market coupled with these uncertainties makes it very difficult for governments and producers to develop sugar investment policies.

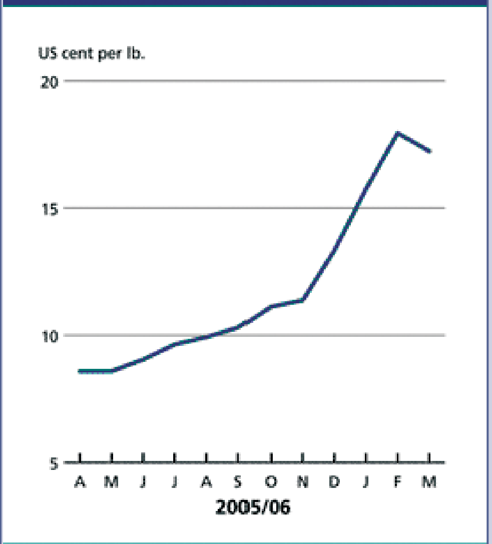
However, there would seem to be one certainty, namely that mean sugar export prices in sub-Saharan Africa will fall in the medium term and are unlikely to regain the average levels seen in recent years. Although prices on the open world market are likely to rise as preferential arrangements are weakened or phased out, it is doubtful for most countries that the rise will be enough to offset the loss of the present substantial price premiums that sub-Saharan Africa nations currently receive on exports to preferential markets. Given the difficulties being experienced by new irrigating producers, which are receiving the full current benefit of national sales to protocol markets, it would seem extremely unlikely that new investment in irrigated sugar-cane production will

BOX 9
Sugar: market prospects in sub-Saharan Africa

World sugar prices have increased significantly since FAO's preliminary forecast in December 2005 for October 2005/September 2006, largely due to a substantial rise in crude oil prices, as well as a world supply deficit for the third consecutive year. EU sugar policy reforms are expected to reduce world exports by about 5 million tonnes and further contribute to strengthening prices. The International Sugar Agreement (ISA) daily price rose from an average US¢11.38 per pound in November 2005 to an average US¢17.24 per pound in March and reached a 25-year high of US¢19.25 per pound on 3 February. Between January and March 2006 sugar prices averaged US¢16.98 per pound, which was 91 percent higher than the same period in 2005.

Looking ahead, world sugar prices should remain firm and stable around their current levels as the supply and demand fundamentals in the world sugar market do not point to prices strengthening further, barring extreme weather events or a continuing rise in crude oil prices. At the New York Board of Trade, the October 2006 Sugar No.11 futures contract averaged US¢17.66 per pound in April 2006.

Figure 25. ISA daily prices (April 2005-March 2006)



In **Africa**, sugar production has been revised upwards to 5.6 million tonnes in 2005/06, reflecting expected increases in Mozambique, Swaziland and Zimbabwe in Ethiopia and the United Republic of Tanzania. Sugar production in Mozambique has risen rapidly from 39 000 tonnes in 1998 to about 240 000 tonnes in 2005/06, largely due to improved productivity at both the farm and mill levels through a rehabilitation programme implemented by the subsector in 2000. In **Swaziland** and **Zimbabwe** sugar output is expected to increase 625 000 tonnes and 478 000 tonnes, respectively, while in **Ethiopia** and the **United Republic of Tanzania**, production is forecast to reach 300 000 tonnes and 280 000 tonnes, respectively. A factor contributing to these expansions has been the expected gains anticipated by the Least Developed Countries (LDCs) from the EU Everything but Arms (EBA) Initiative allowing unlimited and free of duty market access to LDC sugar exports from 2009/10.

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be profitable in the future. The reduction of trade barriers within Africa may mean that there is some potential for regional sales at higher than world prices, but the relative ease with which sugar can be transported suggests that price premiums for regional sales will be small and insufficient to make new irrigated cane production attractive.

Horticultural crops

Although great attention is given by international agencies to high-value horticultural exports, all but a small proportion of fruit and vegetable production in every sub-Saharan Africa country except South Africa is consumed domestically. South Africa exports about one-third of its non-citrus fruit output and trades small amounts of low-quality vegetables with neighbouring countries. For sub-Saharan Africa as a whole, FAO estimates that national imports and exports of vegetables amount to 2.6 and

1.1 percent of production respectively. For fruits, the corresponding proportions were 3.0 and 12.0 percent. About half of fruit exports by sub-Saharan Africa nations were from South Africa. Even in a country such as Kenya, which has been highly successful in penetrating export markets for fruits and vegetables, the weight of vegetable exports in 1997/99 amounted to only 8.6 percent of the weight of production. Kenya's fruit exports were equivalent to more than one-third of national production, but these comprised mainly estate-produced canned pineapples and pineapple juice.

Thus, while the returns to investment in irrigation used to produce high-value fruits, vegetables and cut flowers for export are generally attractive, the volumes involved are very small. These volumes are likely to grow in the future, but from a very small base. Total growth is likely to be constrained by ceilings on airfreight capacity to Europe and the Near East and by the small size of specialized markets for high-value fruits and vegetables, which makes them easily saturated.

Domestic markets for fruits and vegetables will remain the main source of demand for horticultural products. These markets will clear domestically, with retail prices that are unstable in the short term but which necessarily reflect domestic costs of production, preparation and marketing over the long term. The scope that this gives for the expansion of irrigation will depend principally on the relative unit costs of rainfed and irrigated production. The growth of supermarket trading and associated trading practices will give a competitive edge to irrigated production as it facilitates the supply of pre-contracted quantities of uniform quality on a predictable basis.

Livestock and dairy

The share of livestock products in total agricultural production is lower in sub-Saharan Africa than in both non-sub-Saharan Africa developing countries and the world as a whole. However, livestock products are an important element in total agricultural output. Indeed, they have a higher estimated farmgate value than grains in every sub-Saharan Africa region other than the Gulf of Guinea. Moreover, sub-Saharan Africa livestock output is projected to grow more rapidly than crop output, other than in Eastern Africa and the Republic of South Africa.

Livestock production in sub-Saharan Africa depends more on grazing than is the case in the world as a whole. Currently, feed accounts for 3.5 percent of the value of all crops grown compared with 8.1 percent in developing countries and 13.7 percent globally. However, the importance of feed in total sub-Saharan Africa crop production is projected to rise to 4.7 percent in 2030. In absolute terms, feed-crop output is projected to triple.

Within this scenario, there will be potential for a strong expansion in irrigated feed production. Depending on local growing and market conditions, this could involve the production of feed barley and maize and/or alfalfa and other green-fodder crops.

Beverage and industrial crops

The main crop in this category with irrigation potential is cotton. sub-Saharan Africa cotton production is concentrated in the Sahel and West Africa, where all producing countries are net exporters.

Globally, the flow of cotton is principally from developed to developing countries. sub-Saharan Africa is an exception to this. The FAO 2015/30 projections show that all the major producing countries will remain net exporters except for Nigeria, for which production in 2030 is projected to equal national demand. The only cotton importer in sub-Saharan Africa of significance is South Africa, which imports from other producing countries in Southern African, from elsewhere in sub-Saharan Africa and from non-sub-Saharan Africa sources. Although important in the context of Southern Africa, South Africa's net imports were equal to less than 2.3 percent of total sub-Saharan Africa production in the 1997/99 baseline. This is projected to rise to 3.8 percent in

2030. The only other net cotton importer in sub-Saharan Africa is Mauritius, but its imports amount to only around 1 percent of sub-Saharan Africa production.

The AGOA provides for duty- and quota-free imports to the US of apparel made in eligible sub-Saharan Africa countries from fabric, yarn and thread produced in the United States of America. Imports of apparel made from sub-Saharan Africa fabric and yarn are also allowed duty-free entry but are subject to a cap of 3 percent of total apparel imports to the United States of America rising to 7 percent over an 8-year period. For apparel, the access afforded to the market in the United States of America has already led to additional foreign investment in sub-Saharan Africa. For example, a Sri Lankan company has recently invested US$2 million in a new textile factory employing 650 local workers in the United Republic of Tanzania. To the extent that domestically grown cotton is of suitable quality for use in such ventures, the AGOA will give a stimulus to the demand for cotton in sub-Saharan Africa cotton-producing countries.

Most growth in cotton products has been in developed counties. However, these countries increasingly import their textiles and clothing from developing countries, which are now the main market for raw cotton. China has become a major player in the world cotton market. It is the world's largest producer of cotton and exporter of apparel. It has a massive internal market for textiles, and its booming textile industry has also made it an important importer. The United States of America remains the world's largest cotton exporter.

International cotton prices are heavily distorted by subsidies to farmers in the EC and especially in the United States of America, and by import tariffs that average about 10 and 20 percent in developed and developing countries, respectively. To the extent that these subsidies and tariffs are reduced under the Doha Round, world cotton prices could be expected to increase sharply as supply from the United States of America and the EC falls and demand rises, especially in developing countries. Thus, export prices for cotton are likely to remain reasonably attractive. However, in none of the main sub-Saharan Africa exporting countries are producers likely to benefit from a domestic price increase that would result from a switch from export to import parity.

Of the main tropical beverages, the flow of world trade for coffee and cocoa is predominantly from developing to developed countries. As demand for these commodities is price inelastic, any increase in global output reduces the value of world trade and in effect transfers income from poor to rich. Thus, there is no justification for international agencies to finance measures that increase their output, including measures relating to the irrigation. However, tea is both produced and consumed predominantly in developing countries and, consequently, the argument against international support for production expansion does not apply.

For both tea and coffee, price prospects are poor. Both national governments and external agencies are focusing on efforts to diversify into other activities. In the case of coffee, diversification is now an accepted policy of the main international commodity body, the International Coffee Organization. Thus, there would seem little or no prospect for a market-based expansion of irrigation.

Summary

In summary, rice either requires irrigation or has significantly higher yields when irrigated. sub-Saharan Africa is no exception. There are huge national markets in rice, notably the Gulf of Guinea that could be satisfied by domestic production if consumer prices and quality could compete with imports. Where wheat and maize are grown or can potentially be grown, they also generally have much higher and more reliable yields when produced on irrigated land. Thus, there is potential for irrigation to close the large and projected widening gap between sub-Saharan Africa calorie consumption and production. However, in the absence of a substantial sustained increase in world grain prices, grain production needs to be compared with the production of a high-value summer crop in order to be profitable. Given the large areas under irrigation that would be required in order to make a significant dent in staple deficits, it may be difficult to identify complementary summer crops with sufficiently large markets. This is particularly the case given the generally poor market prospects for most non-food crops. Cotton would seem to have the greatest market potential among the main established non-food crops that benefit from irrigation. However, the difficulties in maintaining consistent yields and the high inputs required (in terms of pesticides and fungicides), make scaled-up production a risky venture for many African farmers.

REGIONAL DEMAND AND THE POTENTIAL FOR INTRAREGIONAL TRADE IN MAIZE, WHEAT AND RICE

Within all of sub-Saharan Africa, the only country with a major surplus of maize, wheat or rice in the period 1997/99 was South Africa with an estimated average of 990 000 tonnes of maize per year. Measured in calories, the demand for staple food crops exceeded supply in every sub-Saharan Africa country including South Africa. Annexes 7 and 8 present an analysis of regional calorie surpluses and shortfalls for the baseline and 2030 respectively.

FAO projections to 2030 show these deficits increasing across sub-Saharan Africa and trend data show food import bills rising. Thus, in the absence of very substantial increases in production, there will be little potential for regular trade in basic foodstuffs between sub-Saharan Africa countries. However, there will be potential for cross-border trade where natural markets span borders and for opportunistic trading when good rainfed growing conditions lead to exceptional national surpluses. While the impact on food availability of such surpluses is to be welcomed, they often lead to substantial price instability, both in the country achieving the surplus and in other countries in the region. The potential for this has been demonstrated recently in South Africa, where maize prices both domestically and in neighbouring Swaziland have been highly unstable, as South Africa has swung between surplus and deficit. The apparent grain deficits in the Niger in 2005 were also as a result of regional price volatility, not absolute regional scarcity of grain. Indeed, the harvest in coarse grains (sorghum and millet) in neighbouring Nigeria had been good in 2004/05 with Nigeria exporting to the Sudan through the World Food Programme.

AN APPROPRIATE IRRIGATION SECTOR RESPONSE

The cost of irrigated agriculture in sub-Saharan Africa is high when projects are taken to appraisal where development finance is likely to be limited and carry considerable opportunity costs in the face of all the other developmental challenges that sub-Saharan Africa faces. Furthermore, experience shows that there is a limit to the pace of investment that sectoral economies can absorb. Consequently, it could be argued that it is necessary to restrict irrigation sector activity to those commodity groups on which it is likely to have the greatest impact.

The existing contribution of irrigation to non-cereal staple food production in the region is negligible and is expected to stay that way for the foreseeable future unless commercial production of rice in particular can start to substitute imports. Irrigation of other food crops is significant but dominated by sugar, for which increased production under irrigation is still marginal as the effects of the reforms of the preferential markets have worked through. If irrigated sugar cane should then prove attractive, it may be more appropriate for the private sector to promote and develop perhaps, where advantageous, on the basis of nucleus estates and outgrowers. Of the other food crops that are irrigated, most comprise high-value horticulture; but the quantities involved will be small and often produced by commercial entities. Even so, there may be a significant opportunity for governments to create an enabling environment for increased private-sector investments in the major staples. However, in the absence of acceptable subsidy systems, this is likely to require the identification of marketable high-value options as second crops to complement the lower values associated with the bulk staples – not an easy task.

For all the beverage and industrial crops other than fibres, production in sub-Saharan Africa will exceed the regional requirements throughout the period under consideration. Fibres will move from a small surplus in 1997/99 to a projected small deficit in 2030. Cotton will remain in surplus regionally. The only significant importer in the region will be South Africa, whose imports are projected to be equivalent to some 3.8 percent of sub-Saharan Africa production in 2030 – strategically negligible at the regional level. Mauritius is also expected to remain a net importer, but equally on a minor scale. Nigeria, the other big importer, is expected to become self-sufficient by 2030.

THE PROSPECTS FOR FINANCING IRRIGATION

This leaves cereals and livestock feed as the dominant crop sectors for which irrigation basic solutions can be anticipated.

This is by way of acknowledging that, in addition to the desirability of requesting, participating in and contribution to publicly funded programmes, they can also implement schemes on their own or with the assistance of NGOs. There are also cases where NGOs cooperate with international development banks and bilaterals.

There will be opportunities for both the public sector, private farmers and commercial investors to become involved in the financing and implementation of irrigation schemes. However, different strategies will be necessary. Before suggesting what these may be, it is helpful to re-articulate and answer the four questions asked in Chapter 2.

Thus, whether or not increased irrigated production should be included in any publicly funded strategy to reduce the need for sub-Saharan Africa to import agricultural commodities up to 2030 would depend on:

- whether specific public expenditure represents a variable economic opportunity not only in terms of its own profitability but also when compared with the opportunity costs of water and development finance;
- the existence of a convincing and transparent legal, policy and regulatory framework to promote the economic mobility of water;
- there being adequate capacity among the planning and service institutions;
- the level of awareness and demand emanating from the beneficiaries along with their commitment to O&M and recurring-cost recovery;
- the compatibility of the proposed investment with accepted environmental responsibility.

The **extent** to which increased irrigated production can be included in any publicly funded strategy will hinge on how much can be done by when, while satisfying economic and environmental criteria. This will be determined primarily by two sectors:

First, the rate at which the institutional landscape is able to absorb and make good use of both technology and finance. Second, a rational ranking of investment opportunities with a cutoff point. Ranking will depend on their attractiveness as investments, levels of expected participation, ease of implementation, and the availability of water resources. Unless there are specific social agendas involved, such as improving social connectivity and addressing highly local food security challenges, this is likely to result in the following system of priorities:

a. where yields are low, to increase them by means of farmer training, improved service delivery, scheme improvement and incentivization via market liberalization (which may result in short-term dips, for which short-term targeted subsidies might be required and there are doubts that many governments would have the ability or financial resources to stabilizes and support prices in this way);
b. scheme rehabilitation, upgrading and expansion;
c. new run-of-river schemes;
d. new storage-based schemes.

Key lessons that can be learned from past mistakes concern matters of governance, institutional capacities, poor planning and implementation of schemes, problems after the commissioning of schemes, and environmental degradation.

With respect to governance, the lesson is that sustainable, productive public-sector irrigation is unlikely to be achieved while inadequate legal and policy frameworks persist. Moreover, this is often exacerbated by low levels.

With respect to institutions, the lesson is that with inadequate capacity (in its broadest sense) and supply-driven mindsets, be characterized by low levels of participation and consultation; feasibility studies will often be excessively optimistic; and poor preparation will be followed by poor quality, badly supervised implementation. This situation is not helped by many development partners' preference for disbursement-oriented monitoring indicators.

In addition, it is now clear that low institutional capacity also leads to post-commissioning problems. These include: inadequate incentives, often because rural access and marketing arrangements have not been developed in parallel with the irrigation schemes; suitable technology being perceived as unaffordable; and affordable credit being either inaccessible or operated to the advantage of the lender or by lenders with limited familiarity with the feasible farming systems at the locations in question. Poor, unaccountable and ineffective service delivery results in low service-cost recovery. Inadequately sensitized and prepared communities prove unable to operate their schemes. A lack of suitable allocative mechanisms reduces access to water at the resource level while a lack of robust enforcement of regulations reduces equitability at the scheme level and raises environmental risks and uncertainty at both.

Finally, irrigation is not sustainable unless operated as an environmental entity dependent on the broader environmental system. In this respect, irrigation has both passive and active relationships with the environment. In addition to the potential environmental costs associated with irrigation, the schemes themselves can be compromised by changing hydrology as a consequence of catchment degradation upstream and reduced reservoir storage caused by sedimentation for the same reasons. Equally, poor pest and varietal management on one scheme can have disastrous effects on well-run schemes nearby.

The extent to which these risks can be mitigated in the future depends on a variety of factors, many of which will require greater amounts of political capital than have been available hitherto. Therefore, perhaps the most important mitigating measure would be increased public awareness leading to small-farmer empowerment and well-informed grassroots demand for irrigation. Thus, as a result of the increased political flexibility, increases in the political capital necessary to respond to new kinds of demand could be anticipated. In addition, public awareness would be expected to promulgate and enforce a sound, transparent well-disseminated regulatory framework.

More confident policies will also lead to improved donor coordination. In addition, the use of institutional reform and strengthening programmes along with framework investment strategies rather than "shopping lists" will avoid the ad hoc "hit-and-run" approaches of the past. Such framework plans will be more successful where they include or are accompanied by programmes of legal and policy framework reform, especially concerning: land tenure, water rights, the establishment of user groups, and the rights and obligations of the users of public-sector irrigation facilities. Similarly, subsidiarized, streamlined, demand-driven, accountable, service-oriented and strengthened institutions will be necessary in order to ensure the sustainable management and further development of the sector.

Finally, environmental risks will be mitigated by stronger regulation, but by regulation based on improved monitoring and forecasting functions, ideally in ways involving the communities themselves.

In summary, a three-pronged publicly funded strategy is called for. The first prong will concern: institutional reform and capacity building; improvement of the pertaining legal, policy and regulatory framework; and the establishment of a suitably enabling investment environment. The second will be targeted at obtaining the best performance out of existing assets, while the third will be concerned with the creation of new ones. In this respect, the exigencies of economics, social upheaval and environmental risk would suggest that simple, run-of-river schemes are likely to be quicker and easier to implement than large, complex storage- or transfer-based proposals.

This chapter has proposed no specific strategy for the private sector. This is intentional, partly because this study is concerned primarily with investigating the scope for increased public investment in irrigation. However, in addition, civil society is generally being encouraged to plan its own development. With this in mind, the role of government in the future is more likely to focus on the provision of public goods facilitation, regulation and arbitration rather than direct public expenditure in and public operation of irrigation schemes (Box 10).

BOX 10

Foreword from Zambia's Irrigation Policy and Strategy Document, 2004

This Strategy Document has been the subject of various consultations within the public and private sector. It has benefited from comments received at the national workshop held in Lusaka on the 13th and 14th of January 2004. These comments have been incorporated to produce a final document for submission as a Cabinet Memorandum with a recommendation for adoption by Government.

It should also be noted that this Strategy is aimed to provide Government guidance to all levels and types of investment. The Irrigation Task Force established by the Zambia National Farmers Union and MACO in late 2003 to source finance for the expansion of commercial irrigation to buffer domestic production shortfalls (in response to the 2002/3 drought) is seen as a key financing initiative in line with the directions established by this Strategy.

In addition there are several initiatives from multi-lateral donors that are being developed in early 2004 that will have implications for the implementation of this Strategy. First is the African Development Bank funded Smallholder Agricultural Production and Market Support Project. The identification report for this proposed loan was prepared in October 2003. Second, the preparation of 'bankable projects' under the NEPAD CAADP umbrella in which land and water management is the first 'pillar' of the agriculture programme. Both initiatives are assisted by FAO Investment Centre (TCI). Finally, the World Bank funded Agricultural Development Support Programme (ADSP) for Zambia. The delivery of improved services to boost irrigation production can be expected to feature in the project.

Taken together – the Irrigation Task Force and the multi-lateral donor supported projects – these emerging initiatives could be considered the prime elements of the investment action plan recommended as the followup to this Strategy. The question remains as to what degree of balance across the whole irrigated sub-sector, that is advocated for in this Strategy, can be maintained as the preferences of donors and sector players become apparent. The danger being that development in the sub-sector becomes concentrated in one or two areas leaving others to lag or that the building blocks for sustainable development are not put in place at the right time – the staging of investment. Clearly, this will remain a risk. It is not the intention of this initiative to ask for absolute conformance to the Strategy. Rather it is up to Government to direct its efforts to ensure that continued expansion in commercial irrigation brings with it commercialisation of emergent and traditional farmers. There are high political and economic risks in not achieving a balanced progression of all Zambian farmers who depend upon irrigation as their lead input.

Dr. Nicholas J. Kwendakwema, Permanent Secretary
Ministry of Agriculture and Cooperatives

Source: Ministry of Agriculture and Cooperatives, Department of Agriculture.

Chapter 8
Conclusions and recommendations

This report has attempted to establish a perspective on the demand for irrigated production in the sub-Saharan Africa region with projections to 2030. It has considered the economic impacts of expanded production in particular and has indicated where opportunities for such expansion exist at a regional level.

The conclusions of this report need to be taken in the context of an overall decline of the agriculture sector in sub-Saharan Africa. As far as the irrigated sub-sector is concerned, there is very little evidence of publicly funded irrigation assets performing as designed. At the same time, most of the small scale private irrigation is not organised efficiently to supply markets and sustain growth. At a regional level, there is a fundamental structural mis-match between styles of production and the character of national and regional demand. This can be expected to seriously hinder an appropriate regional response. Transport and marketing costs for bulk production are high and with very little value-added processing, the scope for regional markets development will be limited unless spatial and value chain 'friction' is overcome. It appears very easy for imported grain products to enter the regional hinterland, but very difficult for domestic production to get out.

It is not possible to be highly specific about the demand for irrigated production *per se* beyond broadly concluding that the most pressing demand is in cereals, notably maize, rice and wheat, for which both rainfed and irrigated production present options. Despite this, only rice, sugar and vegetables offer immediate targets for new investment given current irrigation costs and world prices for higher quality rice.

The economic factors and incentives to concentrate production through irrigation exist in terms of pure calorie demand. While this may be no surprise, current trends in commercial food import bills indicate that public and private initiatives in irrigated development are highly lagged, with real growth rates in irrigated areas averaging only 0.9 percent/year and with a continuing legacy of non-performing irrigation schemes. Indeed, in many specific cases, growth rates are actually negative.

The prime conclusion is that the sub-Saharan Africa region can obviate the need for expansion of its irrigated areas simply by closing yield gaps on production from existing equipped irrigated areas. However, while an agronomic solution in the short to medium term can offset the costs of expanding the irrigated area, investment in the post-harvest and value-added chain will remain a prioirty.

The prime conclusion is that the sub-Saharan Africa region can obviate the need for expansion of its irrigated areas simply by closing yield gaps on production from existing equipped irrigated areas.

As far as the natural resource base is concerned, while land and water do not pose technical limits at a regional level, they can be a local absolute constraint. Even so, where this is the case, these constraints can be exacerbated by institutional and/or regulatory shortcomings rather than a lack of resources or areas equipped for irrigation.

It is the systemic factors in the irrigated subsector – high costs, rising labour rates and the impact of HIV/AIDS, and the overall structure of the industry – that mean it is not geared to produce high volumes of high-quality cereals where they are needed. For example, the small artisanal production centres , notably for rice in the Gulf of Guinea and Sudano-Sahelian regions, cannot produce to the scale and quality demanded/preferred by urban dwellers. At the same time, the incentives for commercial growers to produce staples under irrigation in the South and Eastern regions are generally limited by the need to do this as part of a rotation with a high-value cash crop (not least to obtain credit or to be eligible for inputs such as fertilizer).

It is difficult to see how large-scale, low-margin cereal production can generate the service fees sufficient to guarantee service cost recovery unless indirect subsidies are factored into farmgate prices that are supported by governments as buyers of first resort. Some central costs can be mitigated by participatory irrigation management; but this has not proved to be the universal panacea that was once hoped.

Beyond economic and technical considerations, the overall picture is one of a general failure to structure the irrigated subsector to balance and buffer the volatility of the rainfed sector in a consistent fashion (to maintain domestic producer and consumer price stability) while also developing regional and export markets in both irrigated staples and cash crops.

Beyond economic and technical considerations, the overall picture is one of a general failure to structure the irrigated subsector to balance and buffer the volatility of the rainfed sector in a consistent fashion (to maintain domestic producer and consumer price stability) while also developing regional and export markets in both irrigated staples and cash crops.

This strategic failure to match the structure of the irrigated subsector to changing demand patterns in sub-Saharan Africa may not always be overcome despite rising demand and rising food import bills. Some absolute issues such as agroclimatic suitability cannot be addressed through more public expenditure or private investment. However, others such as the relative involvement of public and private agents or the provision of marketing chains can be addressed where political capital is adequate. What then can be offered as recommendations to at least improve the structure of irrigated production? This study makes the following recommendations:

- Ensure that the scaling is right. This applies to the scaling of small-scale irrigation initiatives to address local demand as much as to identifying profitable irrigated farming systems. Matching the structure of the irrigated subsector to the structure of demand is key. It is crucial to be clear about the style of irrigation that will make an impact, and the scale at which producers will enter the market. This implies a regional response rather than a set of individual national responses.
- Realize the value of the existing asset base where supply chains, storage and processing can be concentrated to address specific, well-identified markets. The conditions conducive for scaling up irrigated production (including the incentive for both small-scale and large-scale private investment) will take time to coalesce.
- Prior to new public expenditure or the encouragement of private investment, ensure that the full implications of price impacts are taken into account.
- Assess the costs of supplying into crop markets sensibly. In addition to financial costs, there will also be significant political costs accruing to the kind of changes necessary to establish the enabling environment for successful, sustainable irrigation. These will involve: the devolution of planning and decision-making functions to civil society; the commercialization (in the sense of efficient, cost-effective and transparent service delivery) of public services in the sector; the deregulation of markets; the attraction of private investment; and the establishment of reliable water rights systems and allocation mechanisms.

With these provisions in mind and the political and institutional constraints notwithstanding, irrigated production opportunities in sub-Saharan Africa can be realized where natural resources and markets coincide. However, this can only be achieved through focusing a great deal more attention on production costs, price formation, effective water allocation mechanisms, economically efficient water use, and strong, responsive institutions.

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Annex 1
The FAO typology for areas under agricultural water management

AREA UNDER AGRICULTURAL WATER MANAGEMENT

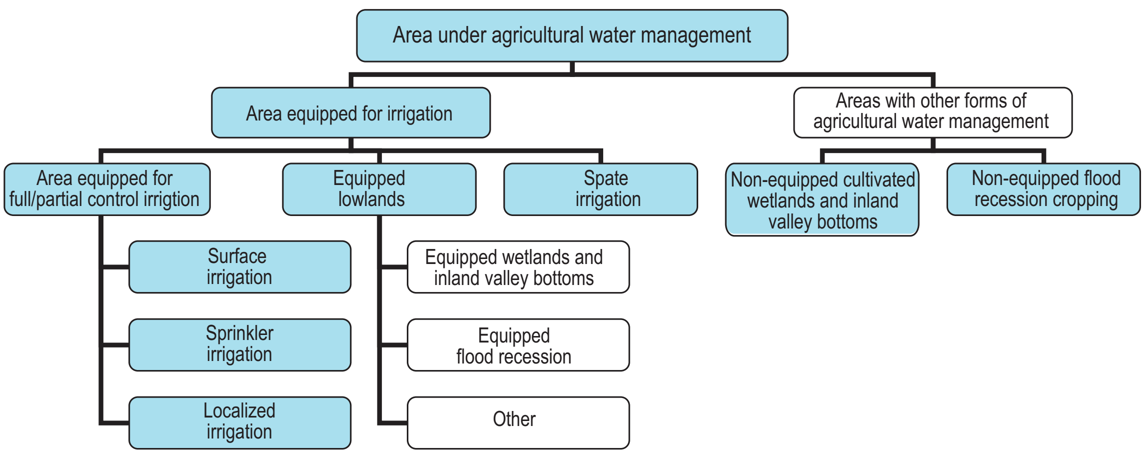
This typology considers all the land to which, in addition to eventual rainfall, water is added and managed for agricultural purposes. The level of management and control of the water may vary considerably between the different agricultural water management types described under the variables. This section does not include water harvesting. However, while spate irrigation is sometimes considered a type of water harvesting (called floodwater harvesting), AQUASTAT prefers to include it as per Figure A1.1. The reason for this is that spate irrigation often requires the construction of heavy structures, using, for example, gabions or concrete. The figures should refer to the physical area equipped. Thus, areas with double cropping are only counted once.

Irrigation potential (1 000 ha)

Area of land that is potentially irrigable. Country/regional studies assess this value according to different methods. For example, some consider only land resources suitable for irrigation, while others consider land resources plus water availability. Others include in their assessment economic aspects (such as distance and/or difference in elevation between the suitable land and the available water), environmental aspects, etc.

Details of the computation method should be included in the comments. In any case, the figure should include the area already under agricultural water management.

FIGURE A1.1
AQUASTAT classification of areas under agricultural water management



Note: Areas in light blue are the variables that are disseminated in the new AQUASTAT database, including the respective variable number.

Area equipped for irrigation: full control – surface (excluding equipped lowland areas (1 000 ha)

Surface irrigation systems are based on the principle of moving water over the land by simple gravity in order to wet it, either partially or completely, before infiltrating. They can be subdivided into furrow, borderstrip and basin irrigation (including submersion irrigation of rice). Surface irrigation does not refer to a method of transporting the water from the source up to the field, which may be done by gravity or by pumping. Manual irrigation using buckets or watering cans should also be included here.

Area equipped for irrigation: full control – sprinkler (1 000 ha)

A sprinkler irrigation system consists of a pipe network through which water moves under pressure before being delivered to the crop via sprinkler nozzles. The system basically simulates rainfall in that water is applied through overhead spraying. Therefore, these systems are also known as overhead irrigation systems.

Area equipped for irrigation: full control – localized (1 000 ha)

Localized irrigation is a system where the water is distributed under low pressure through a piped network, in a predetermined pattern, and applied as a small discharge to each plant or adjacent to it. There are three main categories: drip irrigation (where drip emitters are used to apply water slowly to the soil surface); spray or microsprinkler irrigation (where water is sprayed to the soil near individual plants or trees); and bubbler irrigation (where a small stream is applied to flood small basins or the soil adjacent to individual trees). To refer to localized irrigation, the following other terms are also sometimes used: micro-irrigation, trickle irrigation, daily flow irrigation, drop irrigation, sip irrigation, and diurnal irrigation.

Detailed statistics per type of localized irrigation should be included in the comments column.

Area equipped for irrigation: full control – total (1 000 ha)

This is the sum of surface irrigation, sprinkler irrigation and localized irrigation.

Area equipped for irrigation: lowland areas (1 000 ha)

It includes:

- cultivated wetland and inland valley bottoms (IVBs), which have been equipped with water control structures for irrigation and drainage (intake, canals, etc.);
- areas along rivers where cultivation occurs making use of water from receding floods and where structures have been built to retain the receding water;
- developed mangroves.

Where separate figures for these three different categories are available, they should be placed in the comments column.

Area equipped for irrigation: spate irrigation (1 000 ha)

Spate irrigation can also be referred to as floodwater harvesting. It is a method of random irrigation using the floodwaters of a normally dry watercourse or riverbed (wadi). These systems are generally characterized by a very large catchment upstream (200 ha – 50 km^2) with a ratio of catchment area to cultivated area of 100:1 to 10 000: 1. There are two types of floodwater harvesting or spate irrigation: (i) floodwater harvesting within streambeds, where turbulent channel flow is collected and spread through the wadi in which the crops are planted; cross-wadi dams are constructed with stones, earth, or both, often reinforced with gabions; and (ii) floodwater diversion, where the floods or spates from the seasonal rivers are diverted into adjacent embanked fields for direct application. A stone or concrete structure raises the water level within the wadi to be diverted to the nearby cropping areas.

Area equipped for irrigation: total (1 000 ha)

Area equipped to provide water to crops. It includes areas equipped for full control irrigation, equipped lowland areas, and areas equipped for spate irrigation. It does not include non-equipped cultivated wetlands and inland valley bottoms or non-equipped flood recession cropping areas.

As definitions and classifications on irrigation may vary between countries, any relevant comment should be added in the comments column.

Area equipped for irrigation: part actually irrigated (1 000 ha)

This is the part of the area equipped for irrigation that is actually irrigated in a given year. Often, part of the equipped area is not irrigated for various reasons, such as lack of water, absence of farmers, land degradation, damage, and organizational problems. It only refers to physical areas. Irrigated land that is cultivated twice a year is counted once.

Non-equipped cultivated wetlands and inland valley bottoms (1 000 ha)

This refers to wetlands and IVBs that have not been equipped with water control structures but are used for cropping when covered with water. They are often found in Africa. They have limited (mostly traditional) arrangements to regulate water and control drainage.

In some countries, a distinction is made between the part of wetlands and IVBs that are equipped and the part of the wetlands and IVB that are cultivated but are not considered equipped. In this case, the figure relative to the first part is included in the category "equipped lowland areas", and the figure relative to the second part in this category "non-equipped cultivated wetlands and inland valley bottoms".

In other countries, no distinction is made between the wetlands and IVBs that are equipped and those that are not. In this case, the total figure should be included in this category: "non-equipped cultivated wetlands and inland valley bottoms".

Non-equipped flood recession cropping area (1 000 ha)

This refers to areas along rivers where cultivation occurs in the areas exposed as floods recedes and where nothing is undertaken to retain the receding water. The special case of floating rice is included in this category.

Total area under agricultural water management (1 000 ha)

It is the sum of total area equipped for irrigation and areas with other forms of agricultural water management.

Annex 2
Composition of sub-Saharan Africa regions

Composition of sub-Saharan Africa regions

Central	Eastern	Gulf of Guinea	Indian Ocean Islands
Angola	Burundi	Benin	Mauritius
Cameroon	Ethiopia	Cote D'Ivoire	Madagascar
Central African Republic	Kenya	Ghana	Sub-Saharan Africa and others
Congo	Rwanda	Guinea	
Congo Democratic Republic	United Republic of Tanzania	Liberia	
Gabon	Uganda	Nigeria	
		Sierra Leone	
		Togo	

South Africa	Southern	Sudano-Sahelian
South Africa	Botswana	Burkina Faso
	Lesotho	Chad
	Malawi	Eritrea
	Mozambique	Gambia
	Swaziland	Mali
	Zambia	Mauritania
	Zimbabwe	Niger
	Namibia	Senegal
		Somalia
		Sudan

Annex 3

The SUA commodity groups

CEREALS

Wheat				Paddy Rice				Maize				Barley			
Primary	ICS code	Processed	ICS code	Primary	ICS code	Processed	ICS code	Primary	ICS code	Processed	ICS code	Primary	ICS code	Processed	ICS code
wheat	0015	flour	16	paddy rice	0027	husked	28	maize	0056	flour	58	barley	0044	pot	45
		macaroni	18			milled/husked	29	pop corn	0068	starch	64			pearled	46
		bread	20			milled paddy	31			beer	66			malt	49
		bulgur	??			broken	32							extracts	50
		wholemeal	21			starch	34							beer	51
		pastry	22			flour	38								
		starch	23			breakfast cereals	41								

Millet				Sorghum				Other Cereals			
Primary	ICS code	Processed	ICS code	Primary	ICS code	Processed	ICS code	Primary	ICS code	Processed	ICS code
millet	0079	flour	80	sorghum	0083	flour	84	rye	0071	rye flour	72
		beer	82			beer	86	oats	0075	rolled oats	76
								buckwheat	0089	buckwheat flour	90
								quinoa	0092	flour of foni	95
								fonio	0094	flour of triticale	98
								trticale	0097	flour of mixed grain	104
								canary seed	0101	flour of cereals nes	111
								mixed grains	0103	cereal pre. Nes	113
								cereals nes	0108		

NON-CEREAL STAPLE FOOD CROPS

Potatoes				Sweet Potatoes				Cassava				Other Roots			
Primary	ICS code	Processed	ICS code	Primary	ICS code	Processed	ICS code	Primary	ICS code	Processed	ICS code	Primary	ICS code	Processed	ICS code
potatoes	0116	flour	117	Sweet Potatoes	0122			cassava	0125	flour	126	yautia	0135	roots & tubers nes flour	150
		frozen	118	yams	0137					tapioca	127	taro	0136	roots & tubers dried	151
		starch	119							dried	128	roots & tubers nes	0149		
		tapioca	121							starch	129				

Plantains				Pulses			
Primary	ICS code	Processed	ICS code	Primary	ICS code	Processed	ICS code
plantains	**0489**			**beans dry**	**0176**	**pulses, flour**	**212**
				broad beans dry	0181		
				peas dry	0187		
				chick-peas	0191		
				cow peas dry	0195		
				pigeon peas	0197		
				lentils	0201		
				bambara beans	0203		
				vetches	0205		
				lupins	0210		

OTHER FOOD CROPS

Sugar				Vegetables				Bananas				Citrus Fruit			
Primary	ICS code	Processed	ICS code	Primary	ICS code	Processed	ICS code	Primary	ICS code	Processed	ICS code	Primary	ICS code	Processed	ICS code
sugar, centrifugal, raw	0162	cane	156	cabbages	0358	tomato juice conc	389	bananas	0486			oranges	0490	orange juice single strength	491
sugar, non-centrifugal	0163	beets	157	artichokes	0366	tomator juice single s	390					tangerines	0495	orrange juice concentrated	492
sugar & syrups nes	0167	refined	164	asparagus	0367	tomato paste	391					m&arines	0495	tangerine juice	496
		confectionary	168	lettuce	0372	peeled tomatoes	392					clementines	0495	lemon juice single strength	498
		flavoured	171	spinach	0373	dried mushrooms	450					satsuma	0495	lemon juice concentrated	499
				cassava leaves	0378	canned mushrooms	451					lemons	0497	grapefruit juice single strength	509
				tomatoes	0388	veg. prod fresh or dried	460					limes	0497	grapefruit juice concentrated	510
				Cauliflower	0393	veg. nes dried	464					grapefruit	0507	citrus juice single strength	513
				pumpkins	0394	veg. Nes canned	465					pomelo	0507	citrus juice concentrated	514
				squash	0394	juice of veg. nes	466					citrus fruit nes	0512		
				gourds	0394	veg. dehydrated	469								
				cucumbers	0397	veg. pr. by vinegar	471								
				gherkins	0397	veg. nes prep.	472								
				eggplants	0399	veg. frozen	473								
				chillies, green	0401	veg. in temp. preservative	474								
				peppers, green	0401										
				onions green	0402										
				shallots green	0402										
				onions dry	0403										
				garlic	0406										
				beans green	0414										
				peas green	0417										
				broad beans greem	0420										
				string beans	0423										
				carrots	0426										
				okra	0430										
				green corn	0446										
				mushrooms	0449										
				chicory roots	0459										
				carobs	0461										
				vegetables fresh nes	0463										

OTHER FOOD CROPS Cont'd

Other Fruit				Vegetable oil and oil seeds in oil equivalent			
Primary	**ICS code**	**Processed**	**ICS code**	**Primary**	**ICS code**	**Processed**	**ICS code**
apples	0515	applejuice single strength	518	oil of soyabeans	0237	soyabeans	236
pears	0521	applejuice concentrated	519	oil of groundnuts	0244	soyabeans sauce	239
quinces	0523	dry apricots	527	oil of coconuts	0252	soyabeans paste	240
apricots	0526	plums dried	537	palm oil	0257	soyabeans curd	241
sour cherries	0530	plumjuice singe strength	538	oil of palm kernels	0258	groundnuts in shell	242
cherries	0531	plummjuice concentrated	539	oil of olive	0261	groundnuts shelled	243
peaches	0534	raisins	561	butter of karite nuts	0264	prep.groundnuts	246
nectarines	0536	must of grapes	563	oil of castor beasn	0266	coconuts	249
plums	0541	wine	564	oil of sunflower seed	0268	coconuts dessicated	250
stone fruits nes fresh	0544	vermouths & similar	565	oil of rapeseed	0271	copra	251
strawberries	0547	figs dried	570	tung oil	0276	palm kernels	256
raspberries	0549	pineapples canned	575	oil of safflower	0281	olives	260
gooseberries	0550	mango juice	583	oilo of sesame seed	0290	olives preserved	262
currants	0542	fruit tropical dried nes	604	oil of mustard seed	0293	karite nuts	263
pome fruit nes fresh	0552	fruit dried nes	620	oil of poppy seed	0297	castor beasn	265
blueberries	0554	fruit juice nes	622	vegetable tallow	0306	sunflower seed	267
cranberries	0558	fruit prep. nes	623	stillingia oil	0307	rapeseed	270
berries nes	0560	flour of fruit	642	oil of kapok	0313	tung nuts	275
grapes	0567			oil of cottonseed	0331	safflower seed	280
watermelons	0568			oil of linseed	0334	sesame seed	289
canteloupes	0569			oil of hempseed	0337	mustard seed	292
other melons	0571			oil of vegetable origin nes	0349	flour of mustard	295
figs	0572					poppy seed	296
mangoes	0571					kapok seed in shell	311
avocados	0572					kapok seed shelled	312
pineapples	0574					cottonseed	329
dates	0577					linseed	333
persimmons	0587					hempseed	338
cashewapples	0591					oilseeds nes	339
papaya	0600						
fruit tropical nes, fresh	0603						
fruit nes, fresh	0619						

DAIRY AND LIVESTOCK

Beef and Buffalo meat				Mutton and Goatmeat				Pigmeat				Poultry Meat			
Primary	ICS code	Processed	ICS code	Primary	ICS code	Processed	ICS code	Primary	ICS code	Processed	ICS code	Primary	ICS code	Processed	ICS code
beef	0867	cattle	866	mutton	0977	sheep	976	pigmeat	103	pigs	1034	chicken meat	1058	chickens	1057
veal	0867	beef, boneless	870	lamb	0977	goats	1016			pork	1038	duckmeat	1069	meat, chickens, prep	1060
buffalo meat	0947	veal, boneless	870	goatmeat	1017					bacon/ham of pigs	1039	goose meat	1073	meat chickens canned	1061
		beef dried salt smoked	872							pigmeat sausages	1041	turkey meat	1080		
		beef extracts	873							pigmeat preparations	1042	meat of poultry (exc hen)	1089		
		veal extracts	873												
		beef sausages	874												
		veal sauges	874												
		beef preparations	875												
		beef, canned	876												
		veal, canned	876												
		buffaloes	946												

Milk, Whole				Eggs			
Primary	ICS code	Processed	ICS code	Primary	ICS code	Processed	ICS code
cow milk whole fresh	0882	st&ardised cow's mlik	883	hen's eggs	1062	eggs liquid, hen's	
buffalo milk	0951	skimmed cow's milk	888	eggs excl hen's eggs	1091	eggs dry whole yolks, hen	
sheep milk	0982	whole condensed cow's milk	891				
goat milk	1020	whole evaporated cow's milk	894				
camel mlik	1130	skimmed evaporated cow's milk	895				
		skimmed condensed cow's mlik	896				
		whole dry cow's milk	897				
		skimmed dry cow's mlik	898				
		dry butter milk	899				
		cheese, cow's milk whole	901				
		cheese cow's mlik skimmed	904				
		reconstituted milk	908				
		casein	917				

TROPICAL BEVERAGES AND INDUSTRIAL CROPS

Cocoa Beans				Coffee Green				Tea				Tobacco			
Primary	ICS code	Processed	ICS code	Primary	ICS code	Processed	ICS code	Primary	ICS code	Processed	ICS code	Primary	ICS code	Processed	ICS code
cocoa beans	0661	cocoa paste	662	coffee green	0656	coffee roasted	657	tea	0667			tobacco leaves	0826	cigarettes	826
		cocoa powder & cake	665			coffee extracts	659	mate	0671					cigars	829
		chocolate products nes	666					tea nes	0674					cheroots	829
														tobacco porducts nes	831

Cotton Lint				Hard Fibres				Rubber			
Primary	ICS code	Processed	ICS code	Primary	ICS code	Processed	ICS code	Primary	ICS code	Processed	ICS code
cotton lint	0767			kapok fibre	0778			rubber, natural	0836	rubber natural, dry	837
				jute	0780						
				jute-like fibres	0782						
				sisal	0789						
				agave fibre nes	0800						
				abaca	0809						
				fibre crops nes	0821						

Annex 4

AQUASTAT data for the sub-Saharan Africa regions

TABLE A4.1

Agricultural water use typology for Central region

	TOTALS (ha)			
AREA UNDER AGRICULTURAL WATER MANAGEMENT>	455 939			
AREA EQUIPPED FOR IRRIGATION>	132 439			
Area equipped for full control irrigation	125 652			
Surface	120 221			
Sprinkler	5 430			
Localized	1			
Area under spate irrigation		2 800		
Area of equipped lowlands			3 987	
Equipped wetlands and inland valley bottoms				
Equipped flood recession				
Other				
Area with other forms of agricultural water management				323 500
Non-equipped cultivated wetlands and inland valley bottoms				322 500
Non-equipped flood recession				1 000

TABLE A4.2

Agricultural water use typology for Eastern region

	TOTALS (ha)			
AREA UNDER AGRICULTURAL WATER MANAGEMENT>	849 338			
AREA EQUIPPED FOR IRRIGATION>	616 143			
Area equipped for full control irrigation	593 103			
Surface	522 520			
Sprinkler	68 571			
Localized	2 012			
Area under spate irrigation		0		
Area of equipped lowlands			23 040	
Equipped wetlands and inland valley bottoms				
Equipped flood recession				
Other				
Area with other forms of agricultural water management				233 195
Non-equipped cultivated wetlands and inland valley bottoms				233 195
Non-equipped flood recession				

TABLE A4.3
Agricultural water use typology for Gulf of Guinea region

	TOTALS (ha)			
AREA UNDER AGRICULTURAL WATER MANAGEMENT>	1 443 777			
AREA EQUIPPED FOR IRRIGATION>	565 257			
Area equipped for full control irrigation	360 088			
Surface	311 348			
Sprinkler	47 220			
Localized	1 520			
Area under spate irrigation		0		
Area of equipped lowlands			205 169	
Equipped wetlands and inland valley bottoms				
Equipped flood recession				
Other				
Area with other forms of agricultural water management				878 520
Non-equipped cultivated wetlands and inland valley bottoms				196 606
Non-equipped flood recession				681 914

TABLE A4.4
Agricultural water use typology for Indian Ocean Islands region

	TOTALS (ha)			
AREA UNDER AGRICULTURAL WATER MANAGEMENT>	1 117 653			
AREA EQUIPPED FOR IRRIGATION>	1 107 903			
Area equipped for full control irrigation	1 107 903			
Surface	1 086 413			
Sprinkler	19 468			
Localized	2 022			
Area under spate irrigation		0		
Area of equipped lowlands			0	
Equipped wetlands and inland valley bottoms				
Equipped flood recession				
Other				
Area with other forms of agricultural water management				9 750
Non-equipped cultivated wetlands and inland valley bottoms				
Non-equipped flood recession				9 750

TABLE A4.5
Agricultural water use typology for the Republic of South Africa

	TOTALS (ha)			
AREA UNDER AGRICULTURAL WATER MANAGEMENT>	1 498 000			
AREA EQUIPPED FOR IRRIGATION>	1 498 000			
	1 498 000			
Surface	500 000			
Sprinkler	820 000			
Localized	178 000			
Area under spate irrigation		0		
Area of equipped lowlands			0	
Equipped wetlands and inland valley bottoms				
Equipped flood recession				
Other				
Area with other forms of agricultural water management				0
Non-equipped cultivated wetlands and inland valley bottoms				
Non-equipped flood recession				

TABLE A4.6
Agricultural water use typology for Southern region (excl. RSA)

	TOTALS (ha)			
AREA UNDER AGRICULTURAL WATER MANAGEMENT>	755 837			
AREA EQUIPPED FOR IRRIGATION>	565 427			
Area equipped for full control irrigation	464 902			
Surface	232 710			
Sprinkler	202 358			
Localized	29 834			
Area under spate irrigation		0		
Area of equipped lowlands			100 525	
Equipped wetlands and inland valley bottoms				
Equipped flood recession				
Other				
Area with other forms of agricultural water management				190 410
Non-equipped cultivated wetlands and inland valley bottoms				181 900
Non-equipped flood recession				8 510

TABLE A4.7
Agricultural water use typology for Sudano-Sahelian region

	TOTALS (ha)			
AREA UNDER AGRICULTURAL WATER MANAGEMENT>	2 945 290			
AREA EQUIPPED FOR IRRIGATION>	2 619 950			
Area equipped for full control irrigation	2 098 238			
Surface	2 090 384			
Sprinkler	7 654			
Localized	200			
Area under spate irrigation		299 520		
Area of equipped lowlands			222 192	
Equipped wetlands and inland valley bottoms				
Equipped flood recession				
Other				
Area with other forms of agricultural water management				325 340
Non-equipped cultivated wetlands and inland valley bottoms				67 356
Non-equipped flood recession				257 984

Annex 5

Regional SUAs

The data in this annex are derived from the SUAs of the FAO perspective study – *World agriculture: towards 2015/2030. An FAO perspective.*

All data are nominal values as explained in Chapter 3.

The other data are as follows:

GDP:	Gross domestic product in US$ million
TOT POP:	Total population in thousands
AG POP:	Agricultural population in thousands
LAB FOR:	Total labour force in thousands
AG LAB:	Agricultural labour in thousands
TOT CAL:	Calories in number per person per day

CENTRAL	FOOD	INDUSTRY	FEED	SEED	WASTE	DISCR.	DEMAND	IMPORT	EXPORT	TRADE	PRODN	SSR
1997/99												
Cereals	728	0	8	19	42	-13	783	283	1	-282	494	0.63
Non-cereal food crops	3 503	83	63	57	380	0	4 085	172	50	-121	3 934	0.96
Staple food crops	2 828	0	70	52	317	-13	3 253	306	3	-303	2 928	0.90
Non-food crops	32	138	0	0	7	-5	171	26	309	284	453	2.65
Livestock	1 293	0	1	4	9	0	1 306	249	2	-247	1 060	0.81
All food commodities	5 523	83	71	80	430	-13	6 175	703	54	-649	5 487	0.89
All agric. commodities.	5 555	221	71	80	437	-17	6 346	729	363	-366	5 941	0.94
GDP	**32 995**	**TOT POP**	**82 643**	**AG POP**	**49 511**	**LAB FOR**	**32 532**	**AG LAB**	**21 890**	**TOT CAL**	**1 870**	
2015												
Cereals	1 411	0	32	36	74	-23	1 530	621	0	-621	908	0.59
Non-cer. food crops	6 296	101	112	108	580	1	7 199	284	57	-227	6 971	0.97
Staple food crops	5 027	0	142	97	486	-23	5 728	635	1	-634	5 094	0.89
Non-food crops	57	290	0	0	8	-9	346	82	489	407	752	2.18
Livestock	2 376	0	1	9	15	0	2 401	499	0	-499	1 902	0.79
All food commodities	10 083	101	145	153	669	-22	11 129	1 405	57	-1 348	9 781	0.88
All agric. commodities	10 140	392	145	153	677	-32	11 474	1 487	546	-941	10 533	0.92
GDP	**64 232**	**TOT POP**	**136 431**			**LAB FOR**	**58 088**	**AG LAB**	**31 411**	**TOT CAL**	**2 072**	
2030												
Cereals	2 522	0	70	58	121	-26	2 744	1 310	0	-1 310	1 434	0.52
Non-cer. food crops	10 043	159	202	170	845	1	11 420	664	63	-602	10 818	0.95
Staple food crops	8 100	0	268	151	711	-26	9 204	1 329	1	-1 328	7 876	0.86
Non-food crops	95	502	0	0	9	-9	597	182	613	431	1 028	1.72
Livestock	4 382	0	2	23	28	0	4 434	1 053	0	-1 053	3 382	0.76
All food commodities	16 946	159	274	252	993	-25	18 598	3 027	63	-2 965	15 633	0.84
All agric. commodities	17 041	661	274	252	1 002	-35	19 195	3 209	676	-2 533	16 661	0.87
GDP	**11 9141**	**TOT POP**	**207 022**			**LAB FOR**	**83949**	**AG LAB**	**41874**	**TOT CAL**	**2265**	

EASTERN	FOOD	INDUSTRY	FEED	SEED	WASTE	DISCR.	DEMAND	IMPORT	EXPORT	TRADE	PRODN	SSR
1997/99												
Cereals	2 381	2	71	63	149	0	2 667	365	22	-342	2 271	0.85
Non-cereal food crops	5 732	158	274	131	553	-5	6 843	644	157	-487	6 322	0.92
Staple food crops	5 825	6	345	174	507	-3	6 855	399	44	-356	6 422	0.94
Non-food crops	123	132	0	0	15	0	270	19	977	958	1 242	4.60
Livestock	4 385	1	7	16	71	0	4 479	22	7	-14	4 465	1.00
All food commodities	12 497	160	353	210	774	-5	13 989	1 030	187	-844	13 059	0.93
All agric. commodities.	12 621	292	353	210	788	-5	14 259	1 050	1 164	114	14 300	1.00
GDP	**44 383**	**TOT POP**	**157 304**	**AG POP**	**119 149**	**LAB FOR**	**69 523**	**AG LAB**	**58 291**	**TOT CAL**	**1 912**	
2015												
Cereals	3 857	2	160	105	217	0	4 340	640	0	-640	3 700	0.85
Non-cer. food crops	10 104	100	363	243	838	-7	11 641	974	52	-922	10 719	0.92
Staple food crops	9 627	7	523	305	761	-5	11 218	656	5	-651	10 567	0.94
Non-food crops	232	324	0	0	20	0	575	17	1 233	1 217	1 792	3.11
Livestock	7 155	2	11	32	103	0	7 304	44	3	-42	7 262	0.99
All food commodities	21 116	104	534	380	1 157	-7	23 285	1 658	54	-1 604	21 681	0.93
All agric. commodities	21 348	428	534	380	1 178	-7	23 860	1 675	1 288	-387	23 473	0.98
GDP	**91 380**	**TOT POP**	**238 187**			**LAB FOR**	**123 087**	**AG LAB**	**85 694**	**TOT CAL**	**2 115**	
2030												
Cereals	5 875	2	279	160	312	0	6 628	1 023	0	-1 023	5 605	0.85
Non-cer. food crops	15 268	88	569	385	1 176	-7	17 479	1 479	52	-1 427	16 052	0.92
Staple food crops	14 266	8	847	464	1 090	-5	16 672	1 054	4	-1 049	15 622	0.94
Non-food crops	362	568	0	0	29	0	958	30	1 550	1 520	2 478	2.59
Livestock	11 155	2	16	58	141	0	11 372	85	3	-82	11 290	0.99
All food commodities.	32 299	92	863	604	1 629	-7	35 479	2 587	55	-2 532	32 947	0.93
All agric. commodities.	32 660	660	863	604	1 657	-7	36 437	2 617	1 604	-1 013	35 425	0.97
GDP	**177 070**	**TOT POP**	**330 141**			**LAB FOR**	**171 233**	**AG LAB**	**113 374**	**TOT CAL**	**2 317**	

GULF OF GUINEA

	FOOD	INDUSTRY	FEED	SEED	WASTE	DISCR.	DEMAND	IMPORT	EXPORT	TRADE	PRODN	SSR
1997/99												
Cereals	3 863	44	255	104	799	0	5 066	918	21	-897	4 189	0.83
Non-cereal food crops	10 054	317	360	1 174	3 158	9	15 072	388	291	-97	14 973	0.99
Staple food crops	8 180	99	615	1 200	3 356	-1	13 448	925	25	-901	12 568	0.93
Non-food crops	41	528	0	0	41	0	610	52	1 901	1 849	2 473	4.05
Livestock	2 973	7	18	37	35	-1	3 069	638	7	-632	2 438	0.79
All food ccommodities	16 890	368	633	1 315	3 992	9	23 206	1 944	318	-1 626	21 600	0.93
All agric. commodities	16 931	896	633	1 315	4 033	9	23 817	1 995	2 219	224	24 072	1.01
GDP	**67 671**	**TOT POP**	**166 522**	**AG POP**	**76 172**	**LAB FOR**	**68 071**	**AG LAB**	**30 255**	**TOT CAL**	**2 684**	
2015												
Cereals	6 295	39	510	163	1 029	0	8 036	1 604	1	-1 603	6 433	0.80
Non-cer. food crops	16 077	740	694	740	3 376	19	21 646	597	267	-330	21 316	0.98
Staple food crops	12 640	93	1 204	764	3 578	-2	18 277	1 617	1	-1 616	16 661	0.91
Non-food crops	75	776	0	0	47	0	898	66	2 490	2 424	3 322	3.70
Livestock	5 480	0	36	70	61	-1	5 645	916	0	-916	4 729	0.84
All food commodities	27 853	779	1 239	973	4 465	18	35 327	3 117	269	-2 848	32 479	0.92
All agric. commodities	27 927	1 555	1 239	973	4 512	18	36 225	3 183	2 759	-425	35 800	0.99
GDP	**129 374**	**TOT POP**	**253 210**			**LAB FOR**	**118 751**	**AG LAB**	**34 851**	**TOT CAL**	**2 800**	
2030												
Cereals	9 015	39	1 023	231	1 196	0	11 504	2 460	1	-2 459	9 045	0.79
Non-cer. food crops	23 112	1 427	1 246	956	3 730	20	30 491	1 036	346	-690	29 801	0.98
Staple food crops	17 412	93	2 268	965	3 837	-2	24 573	2 482	1	-2 481	22 092	0.90
Non-food crops	107	1 065	0	0	54	0	1 227	115	3 111	2 996	4 223	3.44
Livestock	9 545	0	71	125	104	-1	9 843	1 386	0	-1 385	8 457	0.86
All food ccommodities	41 671	1 467	2 339	1 312	5 030	19	51 837	4 882	348	-4 534	47 303	0.91
All agric. commodities	41 778	2 532	2 339	1 312	5 084	19	53 063	4 997	3 459	-1 538	51 526	0.97
GDP	**237 529**	**TOT POP**	**336 728**			**LAB FOR**	**161 834**	**AG LAB**	**38 131**	**TOT CAL**	**2 984**	

INDIAN OCEAN ISLANDS												
	FOOD	INDUSTRY	FEED	SEED	WASTE	DISCR.	DEMAND	IMPORT	EXPORT	TRADE	PRODN	SSR
1997/99												
Cereals	543	5	40	21	73	0	682	138	5	-133	546	0.80
Non-cereal food crops	724	72	39	14	66	-2	914	159	104	-55	851	0.93
Staple food crops	802	13	78	32	101	0	1 025	149	8	-141	882	0.86
Non-food crops	29	50	0	0	6	0	85	21	29	8	100	1.17
Livestock	877	5	0	5	9	0	896	105	17	-89	807	0.90
All food commodities	2 144	83	79	39	149	-2	2 492	403	126	-277	2 204	0.88
All agric. commodities	2 173	133	79	39	155	-2	2 577	423	155	-269	2 304	0.89
GDP	**8 040**	**TOT POP**	**19240**	**AG POP**	**12968**	**LAB FOR**	**8 398**	**AG LAB**	**6 036**	**TOT CAL**	**7 223**	
2015												
Cereals	870	6	72	32	98	0	1 079	231	0	-231	848	0.79
Non-cer. food crops	1 294	127	68	25	99	-6	1 606	304	95	-209	1 397	0.87
Staple food crops	1 310	11	137	51	140	0	1 648	245	0	-245	1 403	0.85
Non-food crops	47	94	0	0	8	0	148	32	30	-2	146	0.99
Livestock	1 465	8	0	8	13	0	1 495	132	0	-132	1 362	0.91
All food commodities	3 629	141	140	65	210	-6	4 180	667	95	-572	3 608	0.86
All agric. commodities	3 676	234	140	65	218	-6	4 328	699	125	-574	3 754	0.87
GDP	**15 770**	**TOT POP**	**29712**			**LAB FOR**	**15 844**	**AG LAB**	**9 045**	**TOT CAL**	**7 765**	
2030												
Cereals	1 302	6	115	48	122	0	1 594	319	0	-319	1 275	0.80
Non-cer. food crops	1 904	160	104	36	133	-5	2 331	448	90	-357	1 974	0.85
Staple food crops	1 930	10	214	76	176	0	2 405	338	0	-338	2 067	0.86
Non-food crops	66	138	0	0	9	0	214	41	29	-12	201	0.94
Livestock	2 219	8	0	13	17	0	2 257	182	0	-182	2 075	0.92
All food commodities	5 425	174	219	96	273	-5	6 182	949	90	-859	5 323	0.86
All agric. commodities.	5 491	312	219	96	282	-5	6 395	990	119	-871	5 525	0.86
GDP	**28 470**	**TOT POP**	**41 465**			**LAB FOR**	**21 982**	**AG LAB**	**11 652**	**TOT CAL**	**8 343**	

REPUBLIC OF SOUTH AFRICA	FOOD	INDUSTRY	FEED	SEED	WASTE	DISCR.	DEMAND	IMPORT	EXPORT	TRADE	PRODN	SSR
1997/99												
Cereals	1 136	21	480	23	48	-7	1 701	294	191	-104	1 417	0.83
Non-cereal food crops	1 807	248	47	15	117	11	2 245	447	701	254	2 518	1.12
Staple food crops	1 324	30	512	34	59	-7	1 951	338	202	-136	1 635	0.84
Non-food crops	45	141	0	0	0	-1	184	150	65	-85	100	0.54
Livestock	3 351	12	26	28	36	0	3 453	385	100	-285	3 166	0.92
All food commodities	6 293	282	552	66	201	5	7 399	1 126	992	-135	7 101	0.96
All agric. commodities	6 338	422	552	66	201	4	7 583	1 276	1 057	-219	7 200	0.95
GDP	**22 149**	**TOT POP**	**54 794**	**AG POP**	**36 005**	**LAB FOR**	**24 063**	**AG LAB**	**18 238**	**TOT CAL**	**2 033**	
2015												
Cereals	1 245	43	766	26	58	-9	2 128	292	101	-191	1 937	0.91
Non-cer. food crops	2 099	265	60	20	128	18	2 590	161	728	568	3 158	1.22
Staple food crops	1 457	58	806	39	70	-9	2 421	331	102	-229	2 192	0.91
Non-food crops	55	268	0	0	0	0	323	202	0	-202	121	0.38
Livestock	4 298	5	31	45	47	1	4 426	448	29	-419	4 007	0.91
All food commodities.	7 642	313	857	91	233	10	9 144	900	858	-42	9 103	1
All agric. commodities	7 697	581	857	91	233	10	9 468	1 102	858	-244	9 224	0.97
GDP	**155 276**	**TOT POP**	**44 616**			**LAB FOR**	**2 5343**	**AG LAB**	**1 067**	**TOT CAL**	**2 996**	
2030												
Cereals	1 273	64	1024	28	67	-10	2 446	312	124	-188	2 258	0.92
Non-cer. food crops	2 331	278	75	24	141	23	2 872	49	844	796	3 668	1.28
Staple food crops	1 495	86	1074	43	81	-10	2 768	357	124	-233	2 536	0.92
Non-food crops	59	374	0	0	0	0	434	290	0	-290	144	0.33
Livestock	5216	2	36	54	49	2	5 359	448	29	-419	4 941	0.92
All food commodities	8 821	345	1 135	106	258	14	10 677	809	998	189	10 866	1.02
All agric. commodities	8 880	719	1 135	106	258	14	11 111	1 098	998	-101	11 010	0.99
GDP	**241 915**	**TOP POP**	**43 938**			**LAB FOR**	**31 047**	**AG LAB**	**736**	**TOT CAL**	**3 209**	

SOUTHERN	FOOD	INDUSTRY	FEED	SEED	WASTE	DISCR.	DEMAND	IMPORT	EXPORT	TRADE	PRODN	SSR
1997/99												
Cereals	1 053	5	100	24	77	-1	1 258	276	65	-211	934	0.74
Non-cereal food crops	1 761	63	45	67	199	-9	2 125	344	233	-111	1 995	0.94
Staple food crops	1 812	5	144	64	220	-3	2 242	295	79	-216	1 912	0.85
Non-food crops	21	136	0	0	0	-1	156	48	684	636	814	5.22
Livestock	1 112	0	13	9	16	0	1 150	152	282	131	1 289	1.12
All food commodities.	3 926	68	157	100	292	-11	4 532	772	580	-192	4 218	0.93
All agric. commodities	3 946	204	157	100	292	-12	4 688	820	1 264	444	5 032	1.07
GDP	**24 931**		**56 485**		**3 6819**		**24 699**		**18 528**		**4 124**	
2015												
Cereals	1 605	4	162	40	102	-1	1 912	394	15	-379	1 533	0.80
Non-cer. food crops	2 706	118	74	103	247	-14	3 235	403	164	-239	2 996	0.93
Staple food crops	2 720	4	235	97	272	-3	3 325	413	20	-394	2 931	0.88
Non-food crops	35	240	0	0	0	0	275	33	701	668	943	3.43
Livestock	1 725	0	17	18	23	0	1 783	153	306	153	1 936	1.09
All food commodities	6 036	122	254	161	372	-15	6 930	950	485	-465	6 465	0.93
All agric. commodities	6 071	362	254	161	372	-15	7 206	983	1 186	203	7 409	1.03
GDP	**4 6214**		**77 517**				**40 634**		**24 579**		**4 529**	
2030												
Cereals	2 295	4	292	58	136	-1	2 784	551	13	-538	2 246	0.81
Non-cer. food crops	3 963	221	129	164	308	-15	4 769	587	200	-387	4 382	0.92
Staple food crops	3 814	4	418	137	330	-3	4 700	579	18	-561	4 140	0.88
Non-food crops	51	374	0	0	0	0	425	53	920	867	1 292	3.04
Livestock	2 800	0	25	31	35	0	2891	202	365	163	3 054	1.06
All food commodities	9 057	224	446	253	479	-16	10 443	1 339	578	-761	9 682	0.93
All agric. commodities	9 108	598	446	253	479	-16	10 868	1 392	1 498	106	10 974	1.01
GDP	**81 628**		**10 1423**				**54 427**		**32 095**		**4 935**	

SUDANO-SAHELIAN												
	FOOD	INDUSTRY	FEED	SEED	WASTE	DISCR.	DEMAND	IMPORT	EXPORT	TRADE	PRODN	SSR
1997/99												
Cereals	2 348	51	52	72	211	0	2 734	612	19	-593	2 083	0.76
Non-cereal food crops	2 800	347	3	187	292	-3	3 625	567	342	-225	3 414	0.94
Staple food crops	2 788	51	54	155	281	-1	3 328	642	25	-617	2 689	0.81
Non-food crops	239	234	0	0	0	0	474	65	514	449	913	1.93
Livestock	5 113	75	26	13	161	0	5 388	128	320	192	5 563	1.03
All food commodities.	10 260	473	80	273	664	-3	11 747	1 307	681	-626	11 060	0.94
All agric. commodities	10 499	707	80	273	665	-3	12 221	1 372	1194	-178	11 973	0.98
GDP	**57 324**	**TOT POP**	**91 983**	**AG POP**	**67 203**	**LAB FOR**	**39 413**	**AG LAB**	**30 302**	**TOT CAL**	**2 202**	
2015												
Cereals	3 944	51	120	124	311	0	4 550	1 039	16	-1 023	3 527	0.78
Non-cer. food crops	4 996	439	4	291	372	-3	6 100	713	128	-585	5 515	0.90
Staple food crops	4 732	51	124	249	400	-1	5 556	1 068	19	-1 049	4 507	0.81
Non-food crops	370	449	0	0	0	0	819	90	603	512	1 331	1.63
Livestock	9 037	75	43	29	248	0	9 431	201	376	176	9 607	1.02
All food commodities	17 976	566	168	443	931	-3	20 081	1 952	520	-1 432	18 649	0.93
All agric. commodities	18 346	1014	168	443	931	-3	20 900	2 042	1 122	-920	19 980	0.96
GDP	**138 593**	**TOT POP**	**147 602**			**LAB FOR**	**67 795**	**AG LAB**	**44 579**	**TOT CAL**	**2 347**	
2030												
Cereals	6 054	51	213	191	426	0	6 936	1 601	16	-1 586	5 350	0.77
Non-cer. food crops	7 934	571	7	447	480	-3	9 436	1 308	124	-1 184	8 252	0.87
Staple food crops	7 310	51	219	394	547	-1	8 521	1 650	16	-1 635	6 886	0.81
Non-food crops	483	718	0	0	1	0	1 202	159	721	562	1 764	1.47
Livestock	14 394	75	61	51	330	0	14 911	288	443	155	15 066	1.01
All food commodities	28 382	697	281	689	1 237	-3	31 282	3 197	582	-2 615	28 667	0.92
All agric. commodities.	28 865	1415	281	689	1 237	-3	32 484	3 356	1 303	-2 053	30 431	0.94
GDP	**299 228**	**TOT POP**	**212192**			**LAB FOR**	**9 2428**	**AG LAB**	**58 628**	**TOT CAL**	**2 530**	

Annex 6

Trade data for sub-Saharan Africa – wheat; rice; coarse grains; oils and fats; sugar

TABLE A6.1
Wheat data for sub-Saharan Africa 1990–2003

Wheat	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Imports (million tonnes)	4 873 202	5 605 338	5 708 596	5 640 756	6 254 744	5 314 820	5 538 890	6 558 602	8 508 680	7 600 125	9 840 546	9 489 315	10 009 540	10 694 000
Import value (US$000)	973 410	905 419	1 051 764	982 219	1 085 488	1 145 637	1 301 376	1 244 803	1 537 158	1 255 057	1 489 217	1 486 474	1 626 317	1 984 333
Exports (million tonnes)	211 934	70 531	161 996	220 389	84 740	309 086	203 764	242 874	318 858	212 518	240 051	270 657	286 911	365 712
Export value (US$000)	51 349	15 879	36 349	29 289	15 240	56 266	47 543	64 293	66 302	39 788	51 470	48 360	40 132	70 733
Import unit value (US$)	200	162	184	174	174	216	235	190	181	165	151	157	162	186
Export unit value (US$)	242	225	224	133	180	182	233	265	208	187	214	179	140	193
Domestic supply (million tonnes)	6 296 677	6 927 692	7 503 312	7 761 008	7 771 092	7 669 479	8 216 762	8 888 247	9 961 894	10 122 840	11 557 380	12 119 710	13 336 550	13 336 550
Food (million tonnes)	5 995 884	6 580 856	7 127 319	7 381 723	7 363 538	7 272 302	7 804 799	8 429 343	9 258 322	9 583 798	10 997 740	11 563 020	12 649 010	12 649 010
Supply/capita/year (kg)	13	14	14	15	14	14	14	15	16	16	18	19	20	20
Food calories/capita/day	102	109	114	115	113	109	114	119	127	128	143	147	158	158
Calories per 100 g	291	291	290	289	292	294	293	291	290	289	289	291	292	299
Food calories (million)	17 423 831	19 143 235	20 636 414	21 341 433	21 512 243	21 406 398	22 839 469	24 554 609	26 893 378	27 707 284	31 776 224	33 623 688	36 905 759	37 801 382
Domestic calories (million)	18 297 925	20 152 156	21 725 063	22 437 991	22 702 894	22 575 509	24 045 012	25 891 393	28 937 099	29 265 684	33 393 215	35 242 467	38 911 780	39 856 086
Domestic supply value (US$million)	1 258	1 119	1 382	1 351	1 349	1 653	1 931	1 687	1 800	1 672	1 749	1 899	2 167	2 475
Food aid (million tonnes)	1 545 970	2 293 041	2 076 744	1 165 095	1 554 479	1 156 227	682 719	1 002 251	1 328 282	1 162 061	2 117 514	1 545 674	1 172 970	2 436 319
Share of calories (%)	5	5	5	5	5	5	5	6	6	6	7	7	7	7
Commercial imports (million tonnes)	3 327 232	3 312 297	3 631 852	4 475 661	4 700 265	4 158 593	4 856 171	5 556 351	7 180 398	6 438 064	7 723 032	7 943 641	8 836 570	8 257 681
Imported calories (million)	14 161 356	16 305 523	16 528 648	16 308 092	18 272 952	15 644 448	16 208 657	19 105 155	24 715 834	21 972 377	28 432 696	27 593 636	29 204 631	31 958 864
Imports value/domestic supply value (%)	77	81	76	73	80	69	67	74	85	75	85	78	75	80
Derived value (US$000)	664 606	535 029	669 140	779 342	815 714	896 406	1 140 969	1 054 579	1 297 194	1 063 158	1 168 763	1 244 349	1 435 737	1 532 260
Aid bill (US$)	308 804	370 390	382 624	202 877	269 774	249 231	160 407	190 224	239 964	191 899	320 454	242 125	190 580	452 073
Share of aid (%)	41	39	25	23	27	30	25	35	37	36	43	41	31	47
Share of import bill (%)	14	12	12	14	15	14	17	16	17	16	18	17	18	18
Share of comm. imp. cereal bill (%)	53	50	45	49	50	50	55	51	55	58	61	54	55	58
Share of export earnings (%)	1	0	0	0	0	0	0	1	1	0	1	0	0	1

Source: FAO Trade and Food Security Database (2005).

TABLE A6.2
Rice trade data for sub-Saharan Africa 1990–2003

Rice	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Imports (million tonnes)	2 714 254	3 092 970	3 476 864	3 382 145	3 539 753	3 341 572	3 170 283	3 709 137	3 905 992	4 065 190	4 177 678	5 978 784	5 805 532	5 039 302
Import value (US$000)	806 873	908 434	1 044 567	930 779	961 376	1 042 291	1 069 037	1 112 709	1 221 078	1 197 740	1 087 085	1 302 054	1 190 699	1 127 493
Exports (million tonnes)	20 666	5 141	184 062	65 387	46 027	7 205	46 042	27 971	33 267	29 672	18 263	48 477	131 233	79 239
Export value (US$000)	6 961	2 191	25 440	18 840	14 986	3 027	16 584	11 686	12 499	11 247	6 386	13 962	24 888	19 115
Import unit value (US$)	297	294	300	275	272	312	337	300	313	295	260	218	205	224
Export unit value (US$)	337	426	138	288	326	420	360	418	376	379	350	288	190	241
Domestic supply (million tonnes)	9 259 668	9 593 241	9 888 421	9 972 887	9 469 178	9 883 727	10 417 430	11 245 840	11 387 830	12 062 150	12 561 770	13 618 840	13 100 810	13 100 810
Food (million tonnes)	7 923 760	8 224 940	8 398 240	8 497 667	8 061 700	8 562 079	9 073 209	9 851 771	9 966 295	10 575 770	11 066 300	11 926 560	11 388 240	11 388 240
Supply/capita/year (kg)	17	17	17	17	16	16	17	18	17	18	18	19	18	18
Food calories/capita/day	169	170	169	166	153	159	164	174	171	177	180	190	177	177
Calories per 100 g	363	363	364	363	362	363	364	364	364	363	363	363	363	372
Food calories (million)	28 787 051	29 874 755	30 551 065	30 857 857	29 203 495	31 056 117	33 015 809	35 838 464	36 240 970	38 388 146	40 140 380	43 272 820	41 372 031	42 376 042
Domestic calories (million)	33 640 410	34 844 720	35 972 036	36 214 871	34 302 082	35 849 959	37 907 192	40 909 765	41 410 174	43 783 438	45 564 842	49 412 874	47 593 581	48 748 575
Domestic supply value (US$million)	2 753	2 818	2 971	2 745	2 572	3 083	3 513	3 374	3 560	3 554	3 269	2 966	2 687	2 931
Food aid (million tonnes)	290 905	538 950	656 184	445 990	392 200	184 705	232 229	221 515	193 528	174 395	237 578	349 247	259 071	286 554
Share of calories (%)	8	8	8	8	7	7	8	8	8	8	8	9	8	8
Commercial imports (million tonnes)	2 423 349	2 554 020	2 820 680	2 936 155	3 147 553	3 156 867	2 938 054	3 487 622	3 712 464	3 890 795	3 940 100	5 629 537	5 546 461	4 752 748
Imported calories (million)	9 860 895	11 234 334	12 648 114	12 281 694	12 822 749	12 120 450	11 536 101	13 492 982	14 203 567	14 755 910	15 153 536	21 692 663	21 090 761	18 751 420
Imports value/domestic supply value (%)	29	32	35	34	37	34	30	33	34	34	33	44	44	38
Derived value (US$000)	720 395	750 139	847 427	808 041	854 856	984 678	990 728	1 046 256	1 160 578	1 146 357	1 025 264	1 225 995	1 137 564	1 063 379
Aid bill (US$)	86 478	158 295	197 140	122 738	106 519	57 613	78 309	66 453	60 500	51 383	61 821	76 059	53 135	64 114
Share of aid (%)	11	16	13	14	10	7	12	12	9	10	8	13	9	7
Share of import bill (%)	15	16	15	15	16	15	15	15	15	17	16	17	14	13
Share of comm. imp. cereal bill (%)	39	39	35	32	33	38	33	32	29	35	31	38	35	34
Share of export earnings (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Source: FAO Trade and Food Security Database (2005).

TABLE A6.3
Coarse grain trade data for sub-Saharan Africa 1990–2003

Coarse grains	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Imports (million tonnes)	1 223 367	1 731 657	4 978 784	3 268 015	3 197 174	2 152 952	1 664 101	2 401 384	2 815 020	1 438 734	1 687 738	1 980 556	2 644 261	1 997 994
Import value (US$000)	225 334	286 699	875 595	563 573	534 130	436 241	343 436	466 831	603 706	285 572	298 403	304 690	472 075	346 238
Exports (million tonnes)	1 196 112	655 080	176 789	1 522 993	1 761 632	1 048 277	643 997	600 239	632 348	563 965	328 140	255 672	449 190	350 615
Export value (US$000)	171 020	80 228	30 879	197 309	225 007	163 304	110 952	92 390	78 394	68 950	34 554	39 040	72 841	56 597
Import unit value (US$)	184	166	176	172	167	203	206	194	214	198	177	154	179	173
Export unit value (US$)	143	122	175	130	128	156	172	154	124	122	105	153	162	161
Domestic supply (million tonnes)	51 483 075	52 702 187	53 933 047	56 009 615	59 745 110	62 180 544	63 496 338	63 295 453	64 711 526	66 198 830	65 819 090	66 271 790	68 353 250	68 353 250
Food (million tonnes)	39 167 276	39 952 004	40 764 501	42 170 520	45 054 332	46 684 079	47 944 432	48 220 296	49 069 753	50 287 822	50 257 690	50 753 550	52 069 480	52 069 480
Supply/capita/year (kg)	84	83	83	83	87	87	87	86	85	85	83	82	82	82
Food calories/capita/day	706	701	696	700	726	733	733	719	714	714	696	686	686	686
Calories per 100 g	308	308	308	308	307	308	308	308	308	308	308	308	308	316
Food calories (million)	120 503 736	123 185 073	125 640 352	129 883 962	138 494 004	143 584 609	147 444 345	148 410 855	151 144 806	154 957 160	154 881 549	156 395 772	160 390 824	164 283 166
Domestic calories (million)	158 395 055	162 498 050	166 227 155	172 507 968	183 652 473	191 246 551	195 271 391	194 808 682	199 324 644	203 985 424	202 837 866	204 214 834	210 550 098	215 659 698
Domestic supply value (US$million)	9 483	8 726	9 485	9 659	9 981	12 599	13 104	12 305	13 878	13 140	11 637	10 195	12 203	11 845
Food aid (million tonnes)	686 465	1 024 969	3 371 424	1 567 667	1 631 498	1 158 495	676 087	624 319	742 041	612 823	731 258	789 916	968 349	859 451
Share of calories (%)	34	33	33	33	34	34	34	33	33	33	32	31	31	31
Commercial imports (million tonnes)	536 902	706 688	1 607 360	1 700 348	1 565 676	994 457	988 014	1 777 065	2 072 979	825 911	956 480	1 190 640	1 675 912	1 138 543
Imported calories (million)	3 763 864	5 339 264	15 345 120	10 065 390	9 827 899	6 621 760	5 117 639	7 390 901	8 670 833	4 433 323	5 201 184	6 103 033	8 145 178	6 303 823
Imports value / domestic supply value (%)	2	3	9	6	5	3	3	4	4	2	3	3	4	3
Derived value (US$000)	98 893	117 002	282 679	293 227	261 567	201 501	203 905	345 463	444 569	163 934	169 112	183 169	299 197	197 301
Aid bill (US$)	126 441	169 697	592 916	270 346	272 563	234 739	139 530	121 368	159 137	121 638	129 291	121 521	172 878	148 937
Share of aid (%)	17	18	39	30	27	28	22	22	25	23	17	20	28	15
Share of import bill (%)	2	3	5	5	5	3	3	5	6	2	3	2	4	2
Share of comm. imp. cereal bill (%)	9	11	20	19	17	12	11	16	16	7	8	8	10	8
Share of export earnings (%)	2	1	0	3	2	1	1	1	1	1	0	0	1	0

Source: FAO Trade and Food Security Database (2005).

TABLE A6.4
Oils and fats trade data for sub-Saharan Africa 1990–2003

Element – unit	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Imports (million tonnes)	1 028 776	1 080 107	1 330 756	1 153 259	1 272 441	1 250 992	1 454 867	1 468 582	1 502 497	1 708 936	1 802 360	2 202 773	2 306 693	2 578 851
Import value (US$000)	650 208	662 865	824 369	724 828	813 574	985 055	1 082 801	998 683	1 141 211	1 251 050	1 059 590	1 159 475	1 308 066	1 611 068
Exports (million tonnes)	873 386	710 838	868 983	968 534	1 079 777	866 797	1 171 492	1 243 109	1 299 192	1 067 248	1 440 292	1 113 835	1 138 750	1 254 866
Export value (US$000)	430 574	331 204	351 830	357 182	469 016	454 207	585 168	594 010	604 955	519 264	547 891	430 566	422 338	522 296
Import unit value (US$)	632	614	619	629	639	787	744	680	760	732	588	526	567	625
Export unit value (US$)	493	466	405	369	434	524	500	478	466	487	380	387	371	416
Domestic supply (million tonnes)	13 350 762	13 800 918	13 750 292	14 084 296	14 721 665	15 496 213	16 511 914	17 131 237	17 337 134	18 334 512	18 312 284	19 428 382	20 230 794	20 230 794
Food (million tonnes)	5 892 399	6 086 329	6 294 276	6 541 095	6 707 793	6 795 311	6 978 357	7 182 240	7 498 865	7 842 842	8 047 774	8 311 322	8 602 779	8 602 779
Supply/capita/year (kg)	13	13	13	13	13	13	13	13	13	13	13	13	14	14
Food calories/capita/day	239	243	246	249	248	243	243	244	248	252	251	252	255	255
Calories per 100 g	691	700	705	706	706	699	699	701	700	698	695	692	694	711
Food calories (million)	40 734 138	42 622 278	44 353 213	46 168 015	47 341 044	47 506 460	48 760 789	50 338 909	52 508 236	54 741 587	55 920 545	57 509 281	59 681 176	61 129 511
Domestic calories (million)	92 293 780	96 647 179	96 892 747	99 409 052	103 899 904	108 335 026	115 375 870	120 069 478	121 397 353	127 971 497	127 244 242	134 432 559	140 349 709	143 755 696
Domestic supply value (US$million)	8 438	8 470	8 518	8 852	9 413	12 202	12 289	11 650	13 168	13 422	10 766	10 227	11 472	12 639
Food aid (million tonnes)	130 390	130 686	182 901	166 852	176 571	118 386	121 349	82 086	105 718	91 946	185 317	128 656	132 950	172 735
Share of calories (%)	11	11	12	12	12	11	11	11	11	12	11	11	12	12
Commercial imports (million tonnes)	898 386	949 421	1 147 855	986 407	1 095 870	1 132 606	1 333 518	1 386 496	1 396 779	1 616 990	1 617 043	2 074 117	2 173 743	2 406 116
Imported calories (million)	7 111 926	7 563 938	9 377 299	8 139 873	8 980 406	8 745 765	10 165 783	10 293 003	10 520 722	11 928 058	12 523 831	15 241 844	16 002 520	18 324 764
Imports value/domestic supply value (%)	8	8	10	8	9	8	9	9	9	9	10	11	11	13
Derived value (US$000)	567 799	582 663	711 067	619 961	700 678	891 835	992 485	942 862	1 060 914	1 183 740	950 644	1 091 754	1 232 673	1 503 156
Aid bill (US$)	82 409	80 202	113 303	104 867	112 896	93 219	90 315	55 821	80 297	67 310	108 946	67 721	75 393	107 912
Share of aid (%)	11	8	7	12	11	11	14	10	12	13	15	11	12	11
Share of import bill (%)	12	13	13	11	13	14	15	14	14	17	14	15	15	18
Share of export earnings (%)	5	4	5	5	5	4	5	5	5	5	5	4	4	4

Source: FAO Trade and Food Security Database (2005).

TABLE A6.5
Sugar data for sub-Saharan Africa 1990–2003

Sugar	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Imports (million tonnes)	1 297 815	1 413 481	1 705 846	1 659 104	1 905 278	2 206 382	2 071 481	2 269 967	3 100 968	2 935 984	2 805 675	3 584 252	3 956 390	3 751 812
Import value (US$000)	540 811	467 939	569 539	546 405	664 070	834 575	807 612	783 525	958 355	704 861	680 190	923 334	941 797	846 250
Exports (million tonnes)	1 709 203	1 509 175	1 581 425	1 320 790	1 579 265	1 375 964	1 525 104	1 657 919	1 646 357	1 459 010	2 082 398	1 613 732	1 515 986	1 512 669
Export value (US$000)	856 339	749 619	811 890	678 189	815 978	821 876	874 533	798 294	802 721	683 044	568 399	612 792	554 267	701 211
Import unit value (US$)	417	331	334	329	349	378	390	345	309	240	242	258	238	226
Export unit value (US$)	501	497	513	513	517	597	573	482	488	468	273	380	366	464
Domestic supply (million tonnes)	3 954 314	4 219 188	4 248 336	4 288 526	4 382 558	5 028 734	4 805 363	5 211 009	5 781 222	5 865 607	6 260 180	6 796 988	7 470 330	7 470 330
Food (million tonnes)	3 817 559	4 067 784	4 102 200	4 179 729	4 253 660	4 845 050	4 690 581	4 973 470	5 472 061	5 550 716	5 991 408	6 532 053	6 957 447	6 957 447
Supply/capita/year (kg)	8	8	8	8	8	9	9	9	9	9	10	10	11	11
Food calories/capita/day	79	82	81	80	79	88	83	85	92	91	96	102	106	106
Calories per 100 g	354	355	355	355	354	355	354	354	355	355	355	355	355	363
Food calories (million)	13 524 553	14 428 109	14 571 341	14 838 791	15 073 633	17 198 353	16 621 489	17 626 252	19 416 998	19 681 442	21 284 306	23 201 257	24 687 197	25 286 303
Domestic calories (million)	14 009 038	14 965 127	15 090 428	15 225 040	15 530 407	17 850 371	17 028 229	18 468 103	20 514 021	20 797 966	22 239 110	24 142 282	26 507 066	27 150 336
Domestic supply value (US$million)	1 648	1 397	1 418	1 412	1 528	1 902	1 873	1 799	1 787	1 408	1 518	1 751	1 778	1 685
Food aid (million tonnes)	29 722	26 285	22 268	20 201	26 734	10 151	13 964	8 532	8 869	6 198	16 151	5 794	7 377	19 199
Share of calories (%)	4	4	4	4	4	4	4	4	4	4	4	5	5	5
Commercial imports (million tonnes)	1 268 093	1 387 196	1 683 578	1 638 903	1 878 544	2 196 231	2 057 517	2 261 435	3 092 099	2 929 786	2 789 524	3 578 458	3 949 013	3 732 613
Imported calories (million)	4 597 799	5 013 506	6 059 301	5 890 118	6 751 706	7 831 939	7 340 476	8 044 888	11 003 439	10 410 260	9 967 080	12 730 937	14 038 509	13 635 670
Imports value/domestic supply value (%)	33	34	40	39	43	44	43	44	54	50	45	53	53	50
Derived value (US$000)	528 426	459 237	562 104	539 752	654 752	830 736	802 168	780 580	955 614	703 373	676 275	921 841	940 041	841 920
Aid bill (US$)	12 385	8 702	7 435	6 653	9 318	3 840	5 444	2 945	2 741	1 488	3 916	1 493	1 756	4 330
Share of aid (%)	2	1	0	1	1	0	1	1	0	0	1	0	0	0
Share of import bill (%)	11	10	10	10	12	13	12	12	12	10	10	13	12	10
Share of export earnings (%)	10	9	10	9	9	7	7	7	6	6	6	6	5	6

Source: FAO Trade and Food Security Database (2005).Table 25

Annex 7

Analysis of annual regional calorie surpluses and shortfalls by staple crop group, 1997/99

1997/99						
	Demand (billion calories)			Production (billion calories)		
	Food	Other	Total	Food/others	Surplus/Deficit	SSR*
CENTRAL REGION						
Wheat	3 384	92	3 476	45	-3 431	0.01
Rice	2 032	148	2 180	1 117	-1 063	0.51
Maize	7 127	1 112	8 239	7 818	-421	0.95
Barley	358	0	358	1	-357	0.00
Millet	574	57	632	602	-29	0.95
Sorgum	1 640	-187	1 453	1 429	-23	0.98
Other	20	0	20	0	-20	0.00
TOTAL	15 135	1 222	16 357	11 012	-5 344	0.67
Potato	74	28	102	90	-12	0.88
Sweet potato	1 375	367	1 743	1 744	1	1.00
Cassava	19 849	2 760	22 609	22 489	-121	0.99
Other root crops	802	392	1 195	1 196	1	1.00
Plantain	2 374	513	2 887	2 887	0	1.00
TOTAL	24 475	4 061	28 536	28 405	-131	1.00

* SSR = Self-sufficiency ratio

1997/99						
	Demand (billion calories)			Production (billion calories)		
	Food	Other	Total	Food/others	Surplus/Deficit	SSR*
EASTERN REGION						
Wheat	7 463	547	8 010	4 336	-3 674	0.54
Rice	2 605	278	2 883	2 122	-761	0.74
Maize	26 017	3 465	29 482	26 175	-3 307	0.89
Barley	2 543	314	2 857	2 643	-214	0.93
Millet	2 982	517	3 499	3 443	-56	0.98
Sorgum	7 148	925	8 074	7 838	-236	0.97
Other	5 200	478	5 678	5 666	-13	1.00
TOTAL	53 959	6 524	60 483	52 223	-8 260	0.86
Potato	861	286	1 147	1 151	4	1.00
Sweet potato	4 688	547	5 235	5 202	-33	0.99
Cassava	9 319	1 349	10 668	10 679	11	1.00
Other root crops	3 751	405	4 156	4 156	0	1.00
Plantain	7 317	3 063	10 380	10 380	0	1.00
TOTAL	25 937	5 650	31 586	31 568	-18	1.00

* SSR = Self-sufficiency ratio

1997/99						
	Demand (billion calories)			Production (billion calories)		
	Food	Other	Total	Food/others	Surplus/Deficit	SSR*
GULF OF GUINEA REGION						
Wheat	6 497	275	6 772	256	-6 516	0.04
Rice	18 411	3 009	21 420	14 622	-6 798	0.68
Maize	15 571	9 991	25 562	25 476	-86	1.00
Barley	193	0	193	0	-193	0.00
Millet	12 859	4 880	17 740	17 708	-32	1.00
Sorgum	16 855	6 503	23 359	23 342	-17	1.00
Other	611	153	764	684	-79	0.90
TOTAL	70 997	24 812	95 809	82 088	-13 721	0.86
Potato	72	30	101	91	-11	0.89
Sweet potato	15 935	18 619	34 554	34 564	10	1.00
Cassava	22 289	21 785	44 074	44 093	19	1.00
Other root crops	2 587	3 431	6 018	6 024	6	1.00
Plantain	4 082	435	4 517	4 517	0	1.00
TOTAL	44 964	44 300	89 264	89 289	25	1.00

* SSR = Self-sufficiency ratio

1997/99 SOUTH AFRICA AND INDIAN OCEAN REGIONS						
	Demand (billion calories)			Production (billion calories)		
	Food	Other	Total	Food/others	Surplus/Deficit	SSR*
SOUTH AFRICA						
Wheat	7 870	541	8 411	5 752	-2 660	0.68
Rice	1 941	0	1 942	7	-1 934	0.00
Maize	13 757	12 535	26 292	27 047	755	1.03
Barley	435	556	990	417	-574	0.42
Millet	25	15	40	34	-6	0.85
Sorgum	670	319	989	975	-14	0.99
Other	21	150	171	95	-75	0.56
TOTAL	24 719	14 116	38 835	34 326	-4 508	0.88
Potato	854	278	1 132	1 148	16	1.01
Sweet potato	46	7	53	56	2	1.05
Cassava	0	4	4	0	-4	0.00
Other root crops	0	77	77	0	-77	0.00
Plantain	0	0	0	0	0	-
TOTAL	900	366	1 266	1 204	-62	0.95
INDIAN OCEAN ISLANDS						
Wheat	844	120	964	24	-940	0.02
Rice	5 922	1 497	7 419	6 495	-924	0.88
Maize	612	332	944	614	-329	0.65
Barley	46	2	49	0	-49	0.00
Millet	70	20	91	91	0	1.00
Sorgum	74	7	80	74	-6	0.92
Other	10	12	22	6	-17	0.25
TOTAL	7 579	1 990	9 570	7 303	-2 266	0.76
Potato	148	82	230	215	-16	0.93
Sweet potato	305	215	520	520	0	1.00
Cassava	1 969	449	2 418	2 418	-1	1.00
Other root crops	193	102	295	293	-2	0.99
Plantain	23	6	29	29	0	1.00
TOTAL	2 639	854	3 493	3 475	-18	0.99

* SSR = Self-sufficiency ratio

1997/99						
	Demand (billion calories)			Production (billion calories)		
	Food	Other	Total	Food/others	Surplus/Deficit	SSR*
SOUTHERN REGION						
Wheat	2 805	130	2 935	1 189	-1 746	0.41
Rice	926	77	1 003	658	-345	0.66
Maize	18 498	4 512	23 010	18 160	-4 850	0.79
Barley	103	19	123	28	-94	0.23
Millet	687	98	785	773	-12	0.98
Sorgum	1 477	188	1 666	1 473	-193	0.88
Other	155	-6	149	3	-146	0.02
TOTAL	24 652	5 019	29 671	22 284	-7 387	0.75
Potato	851	279	1 131	1 089	-42	0.96
Sweet potato	102	11	114	114	0	1.00
Cassava	5 483	1 564	7 047	7 047	0	1.00
Other root crops	327	68	395	395	0	1.00
Plantain	145	16	161	161	0	1.00
TOTAL	6 909	1 938	8 847	8 805	-42	1.00

* SSR = Self-sufficiency ratio

1997/99						
	Demand (billion calories)			Production (billion calories)		
	Food	Other	Total	Food/others	Surplus/Deficit	SSR*
SUDANO-SAHELIAN REGION						
Wheat	5 549	886	6 435	1 470	-4 965	0.23
Rice	6 632	456	7 088	3 080	-4 008	0.43
Maize	3 661	501	4 163	3 677	-486	0.88
Barley	146	36	182	101	-81	0.55
Millet	11 367	3 121	14 488	14 526	37	1.00
Sorgum	17 117	2 502	19 619	18 256	-1 363	0.93
Other	732	82	814	568	-246	0.70
TOTAL	45 204	7 586	52 790	41 678	-11 112	0.79
Potato	65	12	77	55	-22	0.72
Sweet potato	483	86	569	567	-2	1.00
Cassava	461	58	520	506	-14	0.97
Other root crops	212	21	233	143	-90	0.61
Plantain	0	0	0	0	0	-
TOTAL	1 222	177	1 398	1 271	-127	0.91

* SSR = Self-sufficiency ratio

Annex 8

Analysis of regional calorie surpluses and shortfalls by staple crop group, 2030

2030						
	Demand (billion calories)			Production (billion calories)		
	Food	Other	Total	Food/others	Surplus/Deficit	SSR*
CENTRAL REGION						
Wheat	12 582	317	12 898	199	-12 700	0.02
Rice	7 784	411	8 195	2 587	-5 608	0.32
Maize	25 647	4 595	30 241	25 595	-4 646	0.85
Barley	976	0	977	1	-976	0.00
Millet	1 389	139	1 528	1 527	-1	1.00
Sorgum	3 496	-346	3 150	2 928	-221	0.93
Other	54	0	54	0	-54	0.00
TOTAL	51 927	5 116	57 043	32 837	-24 206	0.58
Potato	212	76	288	285	-3	0.99
Sweet potato	4 029	854	4 883	4 884	1	1.00
Cassava	53 404	7 392	60 796	60 796	0	1.00
Other root crops	1 527	671	2 198	2 200	2	1.00
Plantain	6 151	975	7 126	7 126	0	1.00
TOTAL	65 322	9 969	75 291	75 292	1	1.00

* SSR = Self-sufficiency ratio

2030						
	Demand (billion calories)			Production (billion calories)		
	Food	Other	Total	Food/others	Surplus/Deficit	SSR*
EASTERN REGION						
Wheat	21 637	1 343	22 980	12 390	-10 590	0.54
Rice	8 389	699	9 088	6 168	-2 921	0.68
Maize	60 751	10 452	71 204	65 698	-5 506	0.92
Barley	5 766	626	6 393	5 700	-693	0.89
Millet	6 219	1 032	7 251	7 244	-7	1.00
Sorgum	16 151	2 050	18 201	17 837	-364	0.98
Other	12 062	1 224	13 286	13 178	-108	0.99
TOTAL	130 975	17 427	148 402	128 213	-20 188	0.86
Potato	2 836	822	3 658	3 658	0	1.00
Sweet potato	11 614	1 077	12 691	12 691	0	1.00
Cassava	21 073	3 772	24 845	24 841	-4	1.00
Other root crops	8 704	896	9 599	9 599	0	1.00
Plantain	16 973	5 876	22 850	22 785	-64	1.00
TOTAL	61 199	12 443	73 643	73 574	-68	1.00

* SSR = Self-sufficiency ratio

2030						
	Demand (billion calories)			Production (billion calories)		
	Food	Other	Total	Food/others	Surplus/Deficit	SSR*
GULF OF GUINEA REGION						
Wheat	18 190	641	18 831	682	-18 150	0.04
Rice	46 642	4 971	51 613	32 715	-18 898	0.63
Maize	37 685	25 618	63 303	62 459	-844	0.99
Barley	650	0	650	0	-650	0.00
Millet	26 346	9 668	36 013	36 034	20	1.00
Sorgum	32 524	11 781	44 305	44 305	0	1.00
Other	1 308	235	1 544	1 361	-183	0.88
TOTAL	163 345	52 914	216 259	177 555	-38 704	0.82
Potato	185	64	249	228	-21	0.92
Sweet potato	31 351	12 530	43 881	43 881	0	1.00
Cassava	42 983	28 378	71 361	71 342	-20	1.00
Other root crops	3 751	2 761	6 512	6 512	0	1.00
Plantain	7 015	569	7 585	7 585	0	1.00
TOTAL	85 286	44 302	129 588	129 547	-41	1.00

* SSR = Self-sufficiency ratio

2030 SOUTH AFRICA AND INDIAN OCEAN ISLANDS REGIONS						
	Demand (billion calories)			Production (billion calories)		
	Food	Other	Total	Food/others	Surplus/Deficit	SSR*
SOUTH AFRICA						
Wheat	8 827	809	9 636	8 184	-1 452	0.85
Rice	2 603	0	2 603	7	-2 596	0.00
Maize	14 568	26 890	41 458	44 606	3 148	1.08
Barley	603	1 000	1 603	835	-769	0.52
Millet	16	15	32	32	0	1.00
Sorgum	643	596	1 239	1 247	8	1.01
Other	10	74	84	49	-35	0.58
TOTAL	27 271	29 385	56 656	54 960	-1 696	0.97
Potato	1 028	465	1 493	1 490	-3	1.00
Sweet potato	41	10	51	51	0	1.00
Cassava	0	4	4	0	-4	0.00
Other root crops	0	123	123	0	-123	0.00
Plantain	0	0	0	0	0	-
TOTAL	1 068	603	1 671	1 540	-131	0.92
INDIAN OCEAN ISLANDS						
Wheat	1 859	123	1 982	52	-1 930	0.03
Rice	14 180	3 039	17 219	15 022	-2 197	0.87
Maize	1 690	1 015	2 704	1 635	-1 069	0.60
Barley	122	3	125	1	-124	0.01
Millet	163	64	226	226	-1	1.00
Sorgum	204	19	222	214	-9	0.96
Other	22	42	63	16	-47	0.26
TOTAL	18 238	4 305	22 543	17 166	-5 377	0.76
Potato	404	190	594	564	-29	0.95
Sweet potato	881	533	1 415	1 417	2	1.00
Cassava	4 512	920	5 432	5 432	0	1.00
Other root crops	382	209	591	591	0	1.00
Plantain	36	6	42	42	0	1.00
TOTAL	6 216	1 857	8 073	8 046	-27	1.00

* SSR = Self-sufficiency ratio

2030						
	Demand (billion calories)			**Production (billion calories)**		
	Food	**Other**	**Total**	**Food/others**	**Surplus/Deficit**	**SSR***
SOUTHERN REGION						
Wheat	6 642	229	6 871	2 838	-4 033	0.41
Rice	2 602	202	2 803	1 840	-964	0.66
Maize	38 008	10 730	48 738	42 672	-6 066	0.88
Barley	216	29	245	61	-184	0.25
Millet	1 647	281	1 928	1 929	1	1.00
Sorgum	3 535	492	4 027	3 911	-116	0.97
Other	243	24	268	8	-260	0.03
TOTAL	52 893	11 988	64 881	53 259	-11 621	0.82
Potato	2 089	552	2 641	2 583	-58	0.98
Sweet potato	204	22	226	226	0	1.00
Cassava	10 751	2 931	13 682	13 681	0	1.00
Other root crops	482	69	552	552	0	1.00
Plantain	281	31	312	312	0	1.00
TOTAL	13 807	3 605	17 413	17 354	-58	1.00

* SSR = Self-sufficiency ratio

2030						
	Demand (billion calories)			**Production (billion calories)**		
	Food	**Other**	**Total**	**Food/others**	**Surplus/Deficit**	**SSR***
SUDANO-SAHELIAN REGION						
Wheat	16 244	1 282	17 527	3 844	-13 683	0.22
Rice	18 651	1 406	20 056	10 928	-9 128	0.54
Maize	11 071	1 453	12 523	10 644	-1 879	0.85
Barley	482	29	511	177	-334	0.35
Millet	30 471	6 995	37 466	37 041	-425	0.99
Sorgum	35 596	6 011	41 607	41 593	-14	1.00
Other	1 886	177	2 063	1 496	-567	0.73
TOTAL	114 401	17 354	131 754	105 724	-26 030	0.80
Potato	291	52	342	271	-71	0.79
Sweet potato	1 264	189	1 453	1 450	-3	1.00
Cassava	1 322	138	1 460	1 460	0	1.00
Other root crops	319	41	360	333	-26	0.93
Plantain	0	0	0	0	0	-
TOTAL	3 195	420	3 615	3 515	-100	0.97

* SSR = Self-sufficiency ratio

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