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Resources and challenges in the context of climate change

Water for agriculture and energy in Africa: The challenges of climate change

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Executive summary

Even though the current levels of global food production are sufficient to feed the population of Africa, as well as other parts of the world, 212 million people in Africa suffer from hunger and malnutrition. The recent food crisis, and its consequent social instability, have clearly shown the vulnerability of African countries in the face of food market fluctuations.

Being largely arid or semi-arid, Africa s climate has made agricultural improvement difficult. Anticipated temperature increases in parts of Africa could double the challenges related to food production and further warming is expected to significantly reduce crop productivity. These effects are exacerbated by the fact that agriculture and agro-ecological systems in Africa tend to be less capital and technology intensive. The predicted impacts of climate change across the African regions uniformly suggest the need to pursue large improvements in the agricultural systems.

Agricultural productivity is closely associated with direct and indirect energy inputs, and policies are required to consolidate this relationship for the benefit of farmers. Energy development plans rarely take into consideration the present and future energy needs of agriculture, and most rural electrification programmes are mainly directed towards households. With growing awareness of food production challenges and climate change hazards in Africa, reforms need to be brought about to provide incentives in the agriculture sector, revitalizing productivity and attracting new investments.

This report addresses the challenges faced by users of agricultural water resources in Africa in the context of climate change. These include population pressure; land use, such as erosion/siltation; and its impacts on the hydrological cycle. With the global food crises and the growing population continent-wide, more food must be grown for the 212 million malnourished people across Africa and the one billion more expected by 2050.

Water withdrawals in Africa are mostly directed towards agriculture. Agriculture significantly contributes to African national economies, employment and food supplies. However, Africa s climate has put pressure on agricultural development. Some farmers may grow only one or two kinds of crops and risk starvation if not enough rain falls. The hot, humid climate in much of Africa encourages the spread of pests and diseases that destroy livestock and cause various illnesses in people. Also, many countries in Africa continue to be among the lowest per capita energy consumers in the world, which is necessary for agricultural development.

Climate change and global warming are likely to result in water availability problems in some parts of Africa. Changes in precipitation would make extreme weather events more common, leading to more severe and frequent flooding and to lower dry-season water flows in rivers. While precipitation is expected to decrease by 33 percent in some regions and increase by 22 percent in others, the global mean surface temperature is expected to increase between 1.3 C and 1.7 C by 2050 (IPCC). Sea levels are projected to rise between 15 and 59 cm (IPCC). Further warming is consequently expected to reduce crop productivity adversely.

The main effect of climate change on semi-arid or tropical agro-ecological systems is a significant reduction in crop yield, which may force large regions of marginal agriculture out of production in Africa. Such a reduction in crop yield will place more pressure and higher demand for conversion of lands, extraction of water supply for irrigation, introduction of new exotic plant and animal species, more intensive use of chemical inputs and hence pollution and environmental damage, erosion, etc. which may seriously accelerate biodiversity loss and extinction.

Africa s vulnerability to climate change and its inability to adapt to these changes may be devastating to the agriculture sector, the main source of livelihood for the majority of the population. The utmost concern should be for improved understanding of the potential impact of climate changes on African agriculture and to identify ways and means to adapt and mitigate their detrimental impact.

The challenges faced by water resources and the prevailing food situation are recognized as a serious global issue, and Africa has prepared many initiatives in response to them. Initiatives dealing primarily with water for agriculture in Africa involve efforts in one or more of the following categories: formulating long-term water policies and related strategies; increasing water productivity; promoting water availability; controlling agricultural pollution; reforming institutions and management; enhancing stakeholder participation; raising awareness and developing information systems; developing human resources; supporting action-oriented research; and adopting innovative technology.

Opportunities for facing the challenges do, however, exist. These opportunities are in increasing water productivity in both rainfed and irrigated agriculture and increasing the availability of affordable, environmentally acceptable water that generates maximum socio-economic returns; harnessing new water supplies; expanding storage capacity; empowering communities and user groups; ensuring access to food; reforming water management institutions (qualified and skilled people are needed to develop and run these institutions); and make needed investments.

Investments should develop water resources to enable community-based irrigation, modernize existing irrigation and drainage systems, and replace and augment storage capacity in reservoirs and groundwater basins particularly in water-scarce countries. Groundwater recharge programmes should be initiated to help restore groundwater tables. Also, environmental regulations and parallel investments in municipal and industrial waste treatment are needed to improve the quality of river water, reducing dilution requirements and increasing supplies. To feed the approximately 1.8 billion people in Africa in 2050, water allocated to agriculture must be used more efficiently and new water resources developed.

Shared understanding of the problems and their consequences, solutions, and the interconnections and tradeoffs are crucial if actions are to achieve common objectives. The starting point must be to develop common awareness and understanding among current and future decision-makers in Africa. This must be done in schools, in the media, and in workshops, meetings and conferences, allowing those affected to make decisions. Appropriate actions must be taken on economic policy and trade, investment, infrastructure, institutional reform, research and capacity building.

The priorities for the African countries are to develop consistent, comprehensive water and food policies, promote equitable trade, expand water storage and improve water quality. More water storage at or below the surface is essential to achieving the volume of water required for food production and other purposes. Water storage and harvesting techniques should be further developed to enhance productivity in rainfed agriculture, shifting the focus of irrigation development, making irrigated agriculture more productive, reforming irrigation and drainage institutions, developing information systems and knowledge networks, improving water education, building capacity and increasing research.

Introduction

Water in Africa, as a limited resource, must be carefully managed for the benefit of all people and the environment to ensure food security today and in the future. With the global food crises and the growing population continent-wide, more food must be grown for the 212 million malnourished people across Africa and the one billion more people expected by 2050.

Over-exploitation of water resources, mainly for agriculture has, created environmental disasters. Efforts to provide adequate water resources for Africa will, therefore, face several challenges, including population pressure; problems associated with land use such as erosion and/or siltation; and possible ecological consequences of land-use change on the hydrological cycle.

In addition, since water resources are inextricably linked with climate, global warming is likely to have huge impacts on both irrigated and non-irrigated agriculture. Understanding the characteristics of the African climate will therefore allow for weighing the risks reduced of water availability in some African regions and an increase in others and, hence, allow us to assess the impacts on future food production on the continent.

African climate and anticipated future patterns

Much of Africa has a tropical or desert climate, while it may be warm or hot in other areas; humidity and rainfall vary dramatically from one place to another. The map in Figure 1 shows Africa s climate patterns. The map indicates the average January and July temperatures and the average yearly precipitation (rain, melted snow and other forms of moisture). Africa has the largest tropical area of any continent. The equator runs through the middle of Africa, and about 90 percent of the continent lies within the tropics. In countries south of the equator, the seasons are opposite to those of countries that lie to north. However, temperatures are high around the year almost everywhere in Africa. The variations between summer and winter temperatures are slight. In fact, the difference between daytime and night-time temperatures in most parts of the continent is greater than the difference in the average temperatures between the coldest and warmest months.

Africa s highest temperatures occur in the Sahara and in parts of Somalia. The highest temperature ever recorded was 58˚C in the shade at Al Aziziyah, Libya, on 13 September 1922. At Ibn-Salah, Algeria, and along the north coast of Somalia, July temperatures soar to 46˚C or higher almost every day. Night-time temperatures, however, may drop sharply. The Sahara also has the greatest seasonal range of temperatures in Africa. Winter temperatures in the Sahara average from 10 to 16˚C. Near the equator, temperatures may average 24˚C or more around the year. However, temperatures of more than 38˚C are rare. The coolest regions in Africa are the northwest, the highland areas of the east, and parts of the south. In Johannesburg, South Africa, for example, the average temperature in January, the warmest month, is 20˚C. Frost and snowfall are common in the mountains of Africa.

Changes in the African climate have been assessed at major river basins (shown in Figure 2). Model results derived from three Global Circulation Models (GCMs) (namely, CSIRO2, HADCM3 and PCM) and considering the two extreme cases named A2 and B2 provide the anticipated deviation of rainfall from average (in percent) for the periods 2030, 2050 and 2080. The results show that there will be major changes in precipitation ranging from a reduction of 33 percent to an increase of 22 percent, which will have implications on spatial and temporal distribution of rainfall in Africa.

Table 1 and Table 2 report the future change in precipitation at different river basins in Africa for climate scenarios A2 and B2.

Table 1: Anticipated rainfall deviation from average (%) in major river basins in Africa using 3 GCMs for the A2 climate scenario

		CSIRO2-B2			HADCM3-B2			PCM-B2		
	HIST.	2030	2050	2080	2030	2050	2080	2030	2050	2080
Central African	0	0	1	1	-4	-6	-10	4	7	13
Congo	0	1	2	3	2	3	6	2	3	6
East African Coast	0	7	11	21	3	6	10	2	4	7
Horn of Africa	0	-4	-6	-11	-11	-17	-29	7	11	22
Kalahari	0	-4	-6	-11	-11	-17	-29	7	11	22
Lake Chad	0	-1	-2	-3	7	12	22	4	6	12
Limpopo	0	-7	-11	-21	-3	-5	-10	-1	-2	-3
Madagascar	0	2	3	6	0	0	0	1	1	2
Niger	0	-1	-2	-4	3	5	10	4	6	12
Nile	0	1	1	2	6	10	18	6	11	20

Table 2: Anticipated rainfall deviation from average (percent) in major river basins in Africa using 3 GCMs for the B2 climate scenario

		CSIRO2-B2			HADCM3-B2			PCM-B2		
	HIST.	2030	2050	2080	2030	2050	2080	2030	2050	2080
Central African	0	1	1	2	-4	-6	-8	5	7	11
Congo	0	1	2	2	1	2	3	3	5	7
East African Coast	0	5	7	10	3	5	7	5	7	9
Horn of Africa	0	0	0	1	-17	-23	-33	8	11	16
Kalahari	0	0	0	1	-17	-23	-33	8	11	16
Lake Chad	0	-2	-3	-4	8	12	18	8	11	16
Limpopo	0	-3	-5	-7	-6	-9	-12	-3	-4	-6
Madagascar	0	2	3	4	1	1	2	2	3	4
Niger	0	-1	-2	-3	7	10	14	5	7	10
Nile	0	0	-1	-1	6	9	13	13	19	27

Figure 1: Africa climate patterns

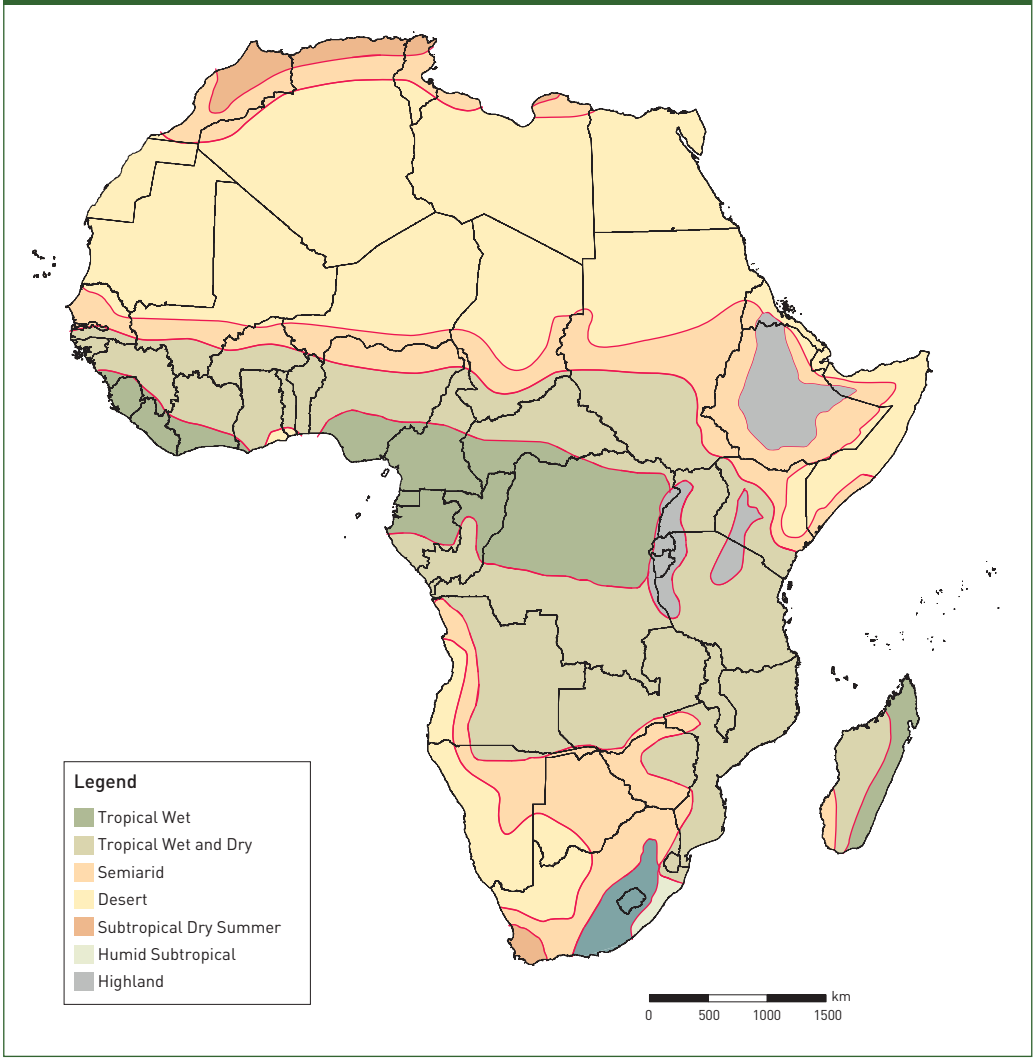


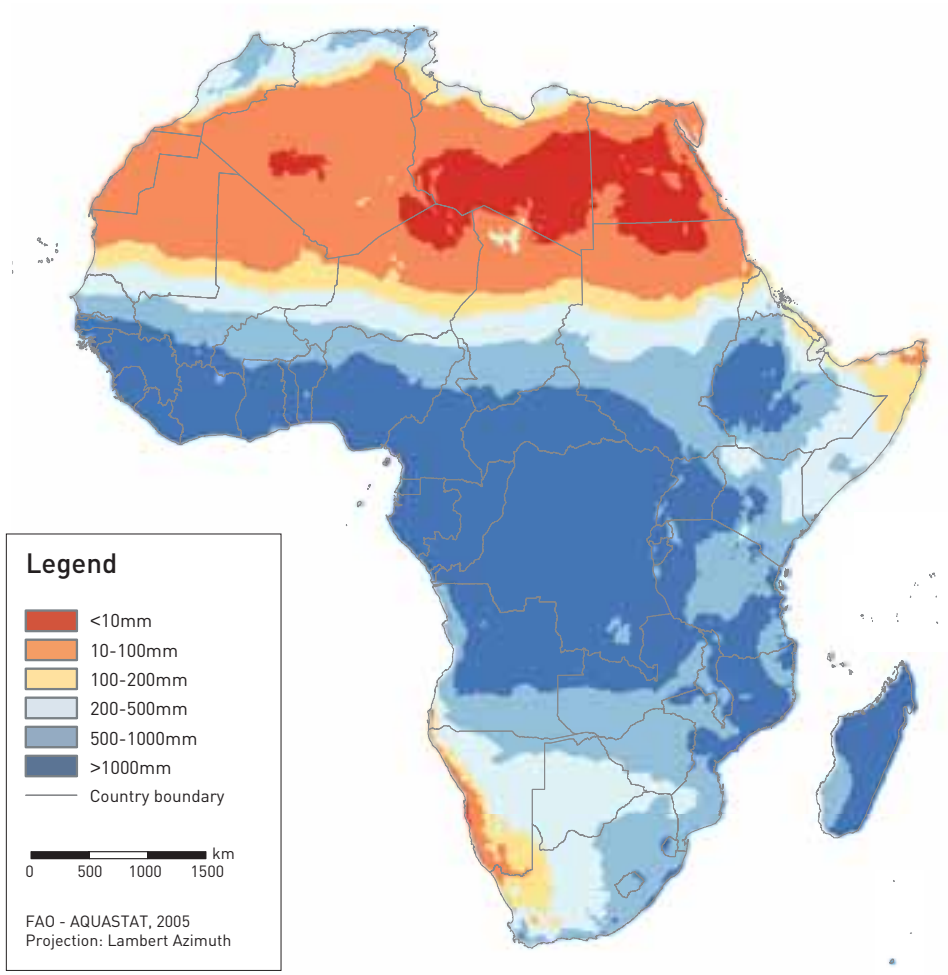
Figure 2: Major river basins in Africa

Water resources in Africa

Africa s share of global freshwater resources, at 10 percent, closely matches its share of world population at 12 percent. The problem stems from the uneven distribution of rainfall (as shown in Figure 3), and from the fact that, for the African continent as a whole, 86 percent of water withdrawals are directed towards agriculture, and this percentage is even higher in the arid and semi-arid part of Africa (FAO AQUASTAT, 2005). In those areas the water withdrawn for agriculture from the hydrologic system may represent a significant part of the water resources.

As can be seen in Table 3, most areas receive either too much rain or too little. In parts of the west coast, for example, annual rainfall averages more than 250 cm. In Monrovia, Liberia, an

Figure 3: Average annual precipitation



Source: New,M., Hulme,M. and Jones, P.D. (1999) Climate Research Unit of the University of East Anglia, UK

average of more than 100 cm of rainfalls during the month of June alone. In contrast, more than half of Africa receives less than 50 cm of rainfall yearly. The Sahara and the Namibia deserts receive an average of less than 25 centimetres a year. In parts of the deserts, rain may not fall for six or seven years in a row. Rain falls throughout the year in the forests of the Congo Basin and the coastal regions of western Africa. However, almost all the rest of Africa has one or two seasons of heavy rainfall separated by dry periods.

In some regions of Africa, the amount of rainfall varies sharply from year to year rather than from season-to-season. Both droughts and floods have increased in frequency and severity over the past 40 years. Over the past fifteen years, Africa has experienced nearly one-third of all water-related disaster events that have occurred worldwide, with nearly 135 million people affected, 80 percent by droughts. Since the late 1960 s, droughts have caused much suffering in Africa. Millions of Africans have died of starvation and related causes. The hardest-hit areas include Ethiopia and the Sahel region on the southern edge of the Sahara.

Table 3: Regional distribution of rainfall and water withdrawals in Africa										
Sub-region	Area	Annual precipitation		Annual internal renewable resources (IRR)			Annual withdrawals for agriculture, community water supply and industry			
	1 000 km^2	mm	million m^3	million m^3	In % of Africa	Per inhabitant (2004)	million m^3	% of Africa	m^3 per inhabitant (2004)	% of IRR
North	5 753	96	549 959	49 495	1	325	93 889	43.7	616	189
Sudano-Sahelian	8 587	311	2 671 364	260 200	4	1 418	54 948	25.7	486	35
Gulf of Guinea	2 119	1,356	2 873 971	951 940	24	4 853	12 395	5.8	63	1.3
Central	5 329	1,425	7 592 517	1 876 180	48	19 845	1 993	0.9	21	0.1
Eastern	2 925	920	2 665 720	280 960	7	1 521	14 215	6.6	77	5
Southern	4 736	659	3 110 159	270 130	7	2 518	21 657	10.0	202	8
Indian Ocean Isl.	592	1,510	895 250	340 951	9	17 042	15 717	7.3	786	4.6
Total	30 041	678	20 358 940	3 929 856	100	4 527	214 814	100	247	5.5

Source: *FAO-AQUASTAT, 2005*

Northern: *Algeria, Egypt, Libyan Arab Jamahiriya, Morocco, Tunisia;*

Sudano-Sahelian: *Burkina Faso, Cape Verde, Chad, Djibouti, Eritrea, Gambia, Mali, Mauritania, Niger, Senegal, Somalia, Sudan;*

Gulf of Guinea: *Benin, C te d Ivoire, Ghana, Guinea, Guinea-Bissau, Liberia, Nigeria, Sierra Leone, Togo;*

Central: *Angola, Cameroon, Central African Republic, Congo, Democratic Republic of the Congo, Equatorial Guinea, Gabon, Sao Tome and Principe;*

Eastern: *Burundi, Ethiopia, Kenya, Rwanda, Uganda, United Republic of Tanzania;*

Southern: *Botswana, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Zambia, Zimbabwe;*

Indian Ocean Islands: *Comoros, Madagascar, Mauritius, Seychelles.*

Because of the lack of rainfall in some countries, large numbers of people are dependent on groundwater as their primary source of freshwater, as shown in Table 4.

Table 4: African countries highly dependent on groundwater resources	
Country	Groundwater use (%)
Algeria	60
Libya	95

Source: Table based on UNEP, 2002. Africa Environment Outlook.

Water supply coverage

With only 64 percent of the population having access to improved water supply, Africa has the lowest proportional coverage of any region in the world. The situation is much worse in rural areas, where coverage is only 50 percent compared with 86 percent in urban areas. Yet more than half of the urban dwellers have inadequate provision if the definition is a house connection or yard tap. The continent is home to 27 percent of the world s population that is without access to improved water supply. Table 5 shows the percentage of African population having access to improved water supply facilities and to household connections.

Table 5: Percentage of access to water supply services in Africa			
Year	Access to improved water supply facilities (%)	Access through household connections (%)	Not served (%)
1990	59	17	41
2000	64	24	36

Source: ONU/WWAP, 2003, UN World Water Development Report.

Sanitation

Only 60 percent of the African population has sanitation coverage, with 80 percent and 48 percent in urban and rural areas respectively. In most of the larger cities in Africa, less than 10 percent of their inhabitants have sewer connections; and only 10 to 30 percent of all urban households solid wastes are collected. The continent houses 13 percent of the world s population that is without access to improved sanitation. Table 6 shows the percentage of African population having access to improved sanitation facilities and to household connections to sewer systems.

Table 6: Percentage of access to sanitation services in Africa

Year	Access to improved sanitation facilities (%)	Access through household connections to sewer systems (%)	Not served (%)
1990	59	11	41
2000	60	13	40

Source: UN World Water Development Report.

Irrigation and cropping pattern zones

Sixty percent of food production is from non-irrigated agriculture. The North African countries, where water is the limiting factor, have developed land and water resources to the limit and further development of the subsector will hinge on adding value through agro-processing (World Bank, 2006). Instead, a large part of irrigation potential remains unused in sub-Saharan Africa. Water for irrigation is a high priority for economic development and stability. However, few countries in Africa can afford the financial investment in efficient irrigation systems, and water losses through leaking pipes and evaporation are as high as 50 percent in South Africa alone.

Irrigation cropping pattern zones in Africa are considered to be homogeneous with respect to crop calendar and cropping intensity. The delineation of the irrigation cropping pattern zones was done by compiling information of various types: distribution of irrigated crops, average rainfall trends and patterns, topographic gradients, presence of large river valleys (Nile, Niger, Senegal), presence of extensive wetlands (the Sudd in Sudan), population pressure, technological differences and crop calendar above and below the equator.

Table 7 summarizes the cropping patterns, crop calendar and monthly and yearly cropping intensities divided among different zones in Africa. The figures shown in the table relate to the different crops and, in correspondence to the growing period of the crop, represent the percentage of the irrigated area in that particular zone, assigned to that crop category.

Table 7: Cropping patterns, crop calendar and cropping intensities in Africa													
	cropping intensity (%)												
Main crops	J	F	M	A	M	J	J	A	S	O	N	D	
1. Mediterranean coastal zone													
Vegetables		40	40	40	40	40	40	40	40	40	40		40
Wheat	15	15	15	15	15						15	15	15
Fodder	25	25	25	25						25	25	25	25
Arboriculture	20	20	20	20	20	20	20	20	20	20	20	20	20
Total	60	100	100	100	75	60	60	60	60	85	100	60	100
2. Saharan oases													
Vegetables			30	30	30	30	30	30	30	30	30		30
Wheat	30	30	30	30	30						30	30	30
Fodder	20	20	20	20	20						20	20	20
Arboriculture	20	20	20	20	20	20	20	20	20	20	20	20	20
Total	70	70	100	100	100	50	50	50	50	50	100	70	100
3. Semi-arid to arid savannes in West-East Africa													
Maize/sorghum							90	90	90	90			90
Vegetables	20	20	20	20							20	20	20
Total	20	20	20	20	0	0	90	90	90	90	20	20	110
4. Semi-arid/arid savanna East Africa													
Maize/sorghum				40	40	40	40	40					40
Cotton				30	30	30	30	30	30	30			30
Vegetables	30	30	30							30	30	30	30
Total	30	30	30	70	70	70	70	70	30	60	30	30	100
5. Niger/Senegal rivers													
Rice	100	100	100								100	100	100
Rice						80	80	80	80	80			80
Total	100	100	100	0	0	80	80	80	80	80	100	100	180
6. Gulf of Guinea													
Rice						100	100	100	100	100			100
Rice	50	50									50	50	50
Total	50	50	0	0	0	100	100	100	100	100	50	50	150
7. Southern Sudan													
Rice	100	100	100								100	100	100
Rice				80	80	80	80						80
Total	100	100	100	80	80	80	80	0	0	0	100	100	180
8. Madagascar tropical lowland													
Rice	100	100	100								100	100	100
Rice				30	30	30	30	30					30
Total	100	100	100	30	30	30	30	30	0	0	100	100	130
9. Madagascar highland													
Rice	100	100	100								100	100	100
Vegetables					10	10	10	10	10	10			10
Total	100	100	100	0	10	10	10	10	10	10	100	100	110

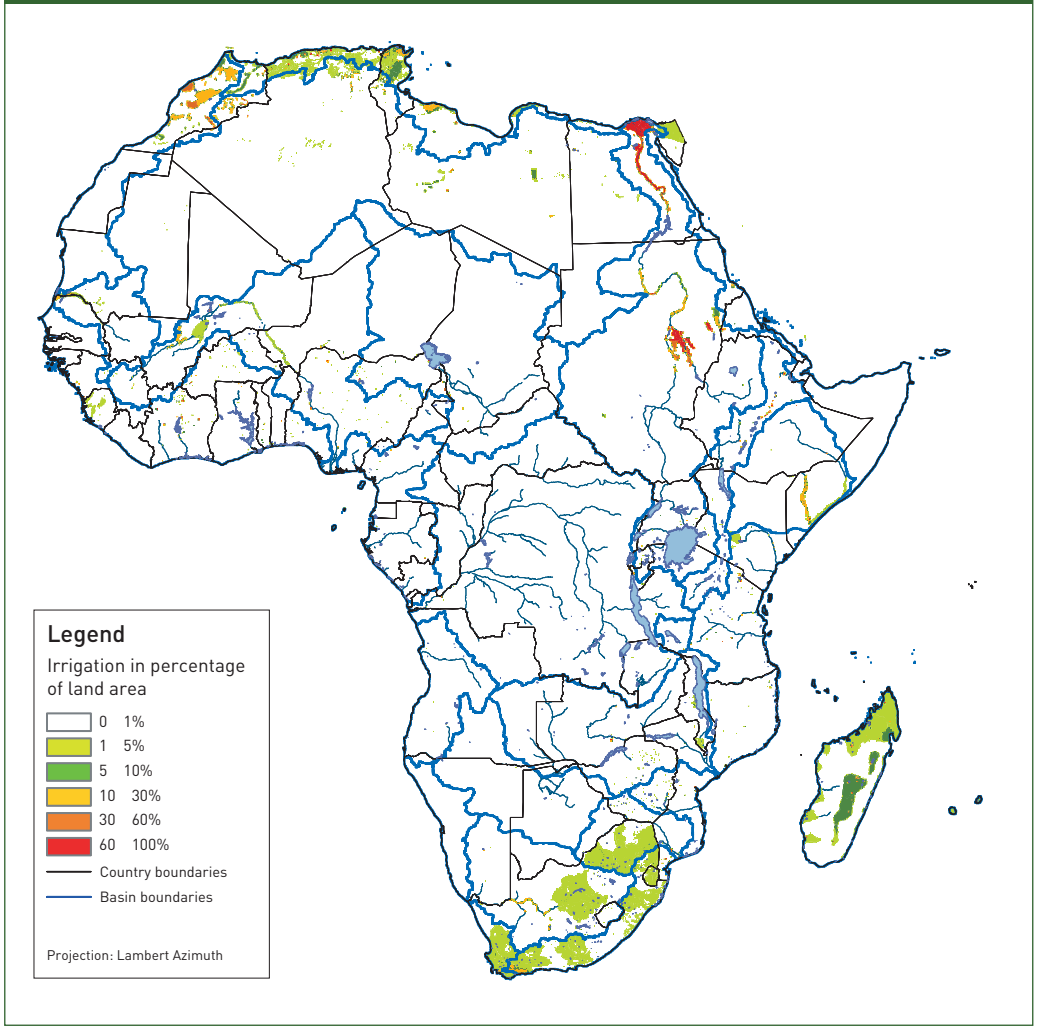
	Cropping intensity (%)												
Main crops	J	F	M	A	M	J	J	A	S	O	N	D	
10. Egyptian Nile and Delta													
Wheat	40	40	40	40	40						40	40	40
Fodder	60	60	60	60						60	60	60	60
Maize					50	50	50	50					50
Rice						30	30	30	30	30			30
Total	100	100	100	100	90	80	80	80	30	90	100	100	180
11. Ethiopian highland													
Maize						40	40	40	40	40	40		40
Vegetables						60	60	60	60	60	60		60
Vegetables	10	10	10	10	10							10	10
Total	10	10	10	10	10	100	100	100	100	100	100	10	110
12. Sudanese Nile area													
Wheat	40	40	40	40							40	40	40
Cotton							50	50	50	50	50	50	50
Sorghum/maize						40	40	40	40	40			40
Sugarcane	10	10	10	10	10	10	10	10	10	10	10	10	10
Total	50	50	50	50	10	50	100	100	100	100	100	100	140
13. Shebelli-Juba river area in Somalia													
Maize				40	40	40	40						40
Maize	30									30	30	30	30
Vegetables				20	20	20	20	20					20
Vegetables	30									30	30	30	30
Rice				15	15	15	15	15					15
Sugarcane	10	10	10	10	10	10	10	10	10	10	10	10	10
Total	70	10	10	85	85	85	85	45	10	70	70	70	145
14. Rwanda - Burundi - Southern Uganda highland													
Vegetables/ Sweet potato	30	30	30	30	30	30	30	30	30	30	30	30	30
Maize/sorghum		25	25	25	25	25							25
Maize/sorghum	15								15	15	15	15	15
Rice		20	20	20	20	20							20
Rice	20								20	20	20	20	20
Total	65	75	75	75	75	75	30	30	65	65	65	65	110
15. Southern Kenya - Northern Tanzania													
Vegetables				40	40	40	40	40	40	40			40
Rice				25	25	25	25	25					25
Cotton					15	15	15	15	15	15			15
Sugarcane	10	10	10	10	10	10	10	10	10	10	10	10	10
Arboriculture	5	5	5	5	5	5	5	5	5	5	5	5	5
Total	15	15	15	80	95	95	95	95	70	70	15	15	95

Cropping intensity (%)													
Main crops	J	F	M	A	M	J	J	A	S	O	N	D	
16. Malawi - Mozambique - Southern Tanzania													
rice	40	40	40								40	40	40
Maize				40	40	40	40	40					40
Vegetables				20	20	20	20	20	20	20	20		20
Sugarcane	10	10	10	10	10	10	10	10	10	10	10	10	10
Total	50	50	50	70	70	70	70	70	30	30	70	50	110
17. West and Central African humid areas above equator													
Rice						60	60	60	60				60
Rice	30	30	30	30	30								30
Vegetables	40	40	40	40								40	40
Sugarcane	10	10	10	10	10	10	10	10	10	10	10	10	10
Total	80	80	80	80	40	70	70	70	70	10	10	50	140
18. Central African humid areas below equator													
Rice	20	20	20	20								20	20
Rice					10	10	10	10	10				10
Vegetables					65	65	65	65	65	65	65		65
Arboriculture	10	10	10	10	10	10	10	10	10	10	10	10	10
Total	30	30	30	30	85	85	85	85	85	75	75	30	105
19. Rivers affluent on Angola - Namibia - Botswana border													
Maize	60	60	60	60								60	60
Vegetables	40	40	40	40	40						40	40	40
Total	100	100	100	100	40	0	0	0	0	0	40	100	100
20. South Africa - Namibia - Botswana desert and steppe													
Sorghum/maize	50	50	50									50	50
Vegetables	30	30	30	30								30	30
Arboriculture	20	20	20	20	20	20	20	20	20	20	20	20	20
Total	100	100	100	50	20	20	20	20	20	20	20	100	100
21. Zimbabwe highland													
Cotton	30	30	30	30	30						30	30	30
Wheat						40	40	40	40	40			40
Vegetables					20	20	20	20	20	20			20
Sugarcane	25	25	25	25	25	25	25	25	25	25	25	25	25
Total	55	55	55	55	75	85	85	85	85	85	55	55	115
22. South Africa - Lesotho Swaziland													
Wheat						35	35	35	35	35	35		35
Maize	25	25	25	25	25							25	25
Pasture/fodder	50	50	50	50	50	50	50	50	50	50	50	50	50
Total	75	75	75	75	75	85	85	85	85	85	85	75	110
23. Awash river area in Ethiopia													
Cotton						25	25	25	25	25	25	25	25
Maize							25	25	25	25	25		25
Sugarcane	30	30	30	30	30	30	30	30	30	30	30	30	30
Arboriculture	5	5	5	5	5	5	5	5	5	5	5	5	5
Total	35	35	35	35	35	60	85	85	85	85	85	60	85

The irrigated areas, shown in Figure 4, correspond to that part of the water managed areas equipped with hydraulic structures: full or partial control irrigation, equipped wetland or valley bottoms and areas equipped for spate irrigation, namely the areas that have modified the natural flow regime of the rivers or groundwater. The data used concern only the equipped irrigated areas which do not necessarily correspond to the actually irrigated area as shown in Figure 4.

On a continental scale, inadequacy of rainfall is not the fundamental issue facing water resources in Africa. The key issues appear to be related to management of the available resources. It is an issue related to the adequacy of the enabling environment under which water resources are managed at local, national and inter-country levels. Issues and challenges should, therefore, be identified and alternative approaches found to provide the water needed to produce the necessary food.

Figure 4: Irrigated areas in Africa



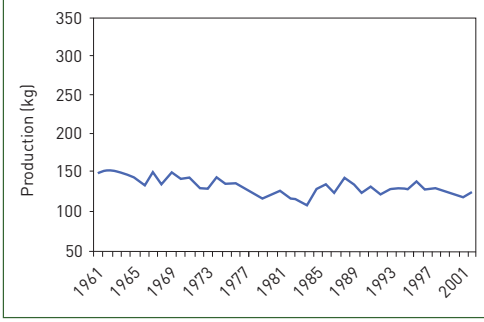
Source: FAO, Aquastat, 2005

Water for food

Africa s climate has made agricultural improvement difficult. In areas with limited and unreliable rainfall, farmers may be uncertain about what crops to plant. Some farmers grow a number of crops with different moisture needs in the hope of having at least one successful harvest. Other farmers may grow only one or two kinds of crops and risk starvation if not enough rain falls. In areas with too much rainfall, heavy downpours wash away nourishing substances from the soil. The hot, humid climate in much of Africa encourages the spread of insects that destroy livestock and cause various diseases in people.

An impending food crisis in Africa is already apparent. There are 2.9 million hunger-related deaths per year and 315 million people in sub-Saharan Africa live on less than US$1 a day. The number of undernourished Africans is rising steeply while the total number of undernourished people worldwide has fallen. At the time of independence, most of sub-Saharan Africa was self-sufficient in food. In less than 40 years, the subcontinent went from being a net exporter of basic food staples to reliance on imports and food aid. In 1966-1970, for example, net exports averaged 1.3 million tonnes per year, three-quarters of which were non-cereals. By the late 1970s, sub-Saharan Africa imported 4.4 million tonnes of staple food per year, a figure that had risen to 10 million tonnes per year by the mid-1980s. Cereal imports increased from 2.5 million tonnes per year in the mid-1960s to more than 15 million tonnes in 2000 and 2001. Since independence, agricultural output per capita remained stagnant and declined in many places. Africa is the only continent where cereal production per capita was less in 2001 than in 1961 (Figure 5). Notwithstanding the seriousness of the situation, it should also be noted that after independence sub-Saharan Africa faced the highest rate of population growth ever recorded. Growth actually took place over the last decades, but it has not been rapid enough.

Figure 5: Cereal production per capita in sub-Saharan Africa



The rise in grain prices on the global market has led to widespread rapid increase in domestic food prices. With their still fragile economies, most African countries were hard hit by this sharp rise in food prices, which triggered food riots in several countries. The multiplication of export bans, quotas and export taxes are exacerbating the problem. The production shift to biofuels and ethanol has also driven up the price of fertilizers, they are now beyond the reach of smallholder farmers. This phenomenon could affect development efforts made by African states. Despite the fact that the severe food crisis that hit the continent in 2005 and early 2006 may have eased, food shortages persist, particularly in East and Southern Africa. There have already been alarming effects in the health sector, with the increasing malnutrition, which may hamper all poverty reduction efforts. Also, the public finance systems in Africa cannot continue bearing the additional burden imposed on them to absorb the shock of this food price increase. An enduring solution is deemed necessary; to devise vigorous and quick initiatives to help African countries cope with this crisis. Such initiatives should be effective in the medium-and long-term, to address this food price crisis.

The prevailing global food crises calls for the revitalization African agriculture and the enhancement of water-use technologies to improve food security, contribute to sustainable and equitable growth and the achievement of the Millennium Development Goals (MDGs) on the continent. Now, more than 20 percent of African countries are considered water-poor.

Although agriculture consumes more freshwater than does any other use, it also significantly contributes to national economies, employment and food supplies. It constitutes approximately 30 percent of Africa s GDP and contributes about 40 percent of the total export value, with 70 percent of the continent s population depending on the sector for their livelihood. Production is subsistence in nature with a high dependence on rain. Thus, in most African countries, it remains an important way for poor people to sustain and improve their livelihoods. Rainfed and irrigated agriculture depend on the secure, adequate quantity and quality of water, either surface or underground. The challenge is, therefore, to optimize the use of currently available water and to make new water available during dry seasons and to reverse the draw down of groundwater tables.

The irrigation potential of the continent is estimated at more than 42.5 million ha, considering irrigation potential by basin and renewable water resources. One-third of this potential is concentrated in two very humid countries: Angola and the Democratic Republic of the Congo. The North African countries have developed land and water resources to the limit. Further development of the subsector will hinge on adding value through agro-processing (World Bank, 2006). With the exception of the Republic of South Africa, irrigated production and associated infrastructure in sub-Saharan Africa has lagged far behind, showing negligible growth over the past decade. Africa s dependence on cereal imports is expected to continue to grow, with a widening net trade deficit.

However, increasing demands for limited freshwater resources, without putting in place the right incentives for agricultural production, may be a serious hindrance to meeting the future demand for food. In Africa as a whole, food consumption exceeded domestic production by 50 percent in the drought-prone mid-1980s and by more than 30 percent in the mid-1990s. Food production capacity and productivity is further weakened due to widespread HIV/AIDS in Africa.

This has raised calls for water-stressed countries to buy the virtual water they need for food as grain on the international market or to get it as foreign aid. Food aid constitutes a major proportion of net food trade in Africa, and in many countries it constitutes more than half of net imports. In Kenya and Tanzania, for instance, food aid constituted two-thirds of food imports during the 1990s.

With some 150 million people at risk, Africa will be facing more challenging times in securing food for its growing population, given that some of the hardest hit countries are either in conflict or emerging from conflict and are seeking to build capacity that will enable them to deal with their multiple challenges. Some of the countries at risk such as Ethiopia, Niger, Somalia and Kenya are facing environmental challenges that could spell further danger to their development efforts.

Energy requirements for sustainable agriculture

Many countries in Africa continue to be amongst the lowest per capita energy consumers in the world. In all sectors, industry, agriculture, transport, household and commercial, a lack of minimum energy inputs has led to continued low productivity and impaired economic growth. It is also clear that in all sectors, energy is but one of the many important inputs for production, conversion, processing and commercialization.

However - and especially in the agricultural sector of most African countries - increased yields and production due to energy and other inputs can lead to important benefits such as improved incomes, new employment opportunities and agro-industrial growth, which will in themselves tend to increase energy requirements. Food security issues, particularly in Africa, have acquired a revived and new emphasis. Thirty countries in sub-Saharan Africa alone, suffered from low or critically low levels of food security in the period between 1991 and 1993. Achieving the aim that all people at all times have access to the food they need for a healthy, active life , will necessarily imply increasing the quality and quantity of energy inputs. Major energy issues that affect agriculture production are summarized below:

Energy and agricultural linkages

Agricultural productivity is closely associated with direct and indirect energy inputs, and policies are required to consolidate this relationship for the benefit of farmers. Energy development plans rarely take into consideration the present and future energy needs of agriculture, and most rural electrification programmes are mainly directed to households.

Large dams and their impacts

Some of the biggest dams are located in Africa. The region includes more than 1,200 dams, more than 60 percent of which are located in South Africa (539) and Zimbabwe (213). More than 50 percent were constructed to facilitate irrigation, only 6 percent for electricity generation. Outside of West Africa, only the richest 20 percent of households have electricity. Table 8 lists the large dams and reservoirs in Africa.

Large dams have had several negative impacts, including displacement of people, increasing erosion and flooding, loss of land, loss of income from downstream fisheries, etc. The development of micro-hydropower facilities is seen as a more sustainable means of managing water resources.

Table 8: Large dams and reservoirs in Africa

Reservoir	Country	Basin
Owen Falls	Uganda, Kenya, United Rep. of Tanzania	Victoria-Nile
Nasser	Egypt	Nile
Kariba	Zambia, Zimbabwe	Zambezi
Volta	Ghana	Volta

The four reservoirs listed above are among the five biggest in the world.
Source: Quoted in the UN World Water Development Report, 2003, Shiklomanov.

Energy prices

Energy price policies seldom regard the economic conditions of rural populations. If rural development is to be achieved, energy inputs must be made available, and this might require special efforts from society as a whole - e.g. subsidizing energy inputs in order to maintain the expected low costs and high quality of agricultural produce, as generally demanded by urban populations.

Social equity

Policies promoting social equity between rural and urban populations and between men and women, particularly in rural areas, are generally non-existent, leading to migration, injustice and social instability. In energy terms, what is needed is a reduction in human drudgery (e.g. water and fuel collection) and better services. Facilitating energy and other inputs required by agriculture represents greater recognition, in both economic and social terms, of the vital role played by Africa s rural people in feeding society.

Land tenure

Policies concerning the ownership of land, and regulations to control its use, have important implications for biomass conversion to energy. Legislation regarding property rights - both of land and of produce, such as biomass from forests - is generally weak in Africa and is considered an important barrier to the healthy development of sustainable bio-energy production and use.

There are, however, some energy issues that constrain agricultural development. These issues are summarized below.

Methodological issues

There is a need for coordination of agriculture, energy, electrification and rural development plans. Also, institutional links and responsibilities need to be strengthened due to the very limited linkages between the various sectors involved in the definition of energy policies for agriculture; in the actual implementation of energy projects for agricultural activities; and in the development of technologies related to the double role of agriculture as an energy consumer and producer. Also, the coordination of planning at the local, regional and national levels, in addition to considering end-use analysis as the basis for planning and projections, has an important role.

Technology development

Efficient energy utilization: there is significant potential for cost-effective energy efficiency improvements in key areas such as tobacco curing, agricultural pump sets and food, beverage, and textile industries, where reductions of up to 50, 20 and 30 percent respectively in energy use could be economical and achievable.

Biomass energy conversion: the potential role of agriculture as a major energy producer will only be tapped if technologies to convert biomass (wood, residues, purposely grown) are developed, tested and economically assessed. Among technologies that seem to offer good possibilities are: gasification, pyrolysis, fermentation (alcohol and biogas) and modern combustion.

Renewable energy sources: although efforts have been pursued in many African countries to develop and utilize energy sources such as solar and wind energy, their potential is far from being realized. Amongst promising solar and wind technologies are: water lifting and pumping using

solar thermal and photovoltaic systems and windmills; and heat and cold production for drying and other processes using solar dryers and thermodynamic systems.

Awareness raising: political awareness and capacity building are of importance to energy efficiency and also in view of linking energy to agricultural production.

Recommendations for sustainable agriculture

Energy requirements for specific objectives: Planners and policy makers need to be able to link energy requirements with specific objectives of agricultural and rural development, such as food security, agro-industry development and sustainable farming practices. This requires data indicating the energy intensiveness of different farming techniques for important food and other crops.

Energy availability to match food security targets: The goal of regional food security could require significantly increasing agricultural energy provisions, particularly if emphasis is placed on improving yield through conventional high-input techniques. Agro-industry could become the fastest growing sector, in terms of energy requirements, with the agricultural sector as the next fastest growth sector.

Energy implications of low-input farming techniques: low-input farming techniques, such as integrated pest management, low-tillage cultivation, use of residues, green manures, and other organic fertilizers, may play an important role in sustainable agricultural development. There are several local success stories and new initiatives in low-input, high-yield agriculture. However, the energy implications of these techniques have yet to be systematically documented. More research is needed to enable clear comparisons with well established high-input methods.

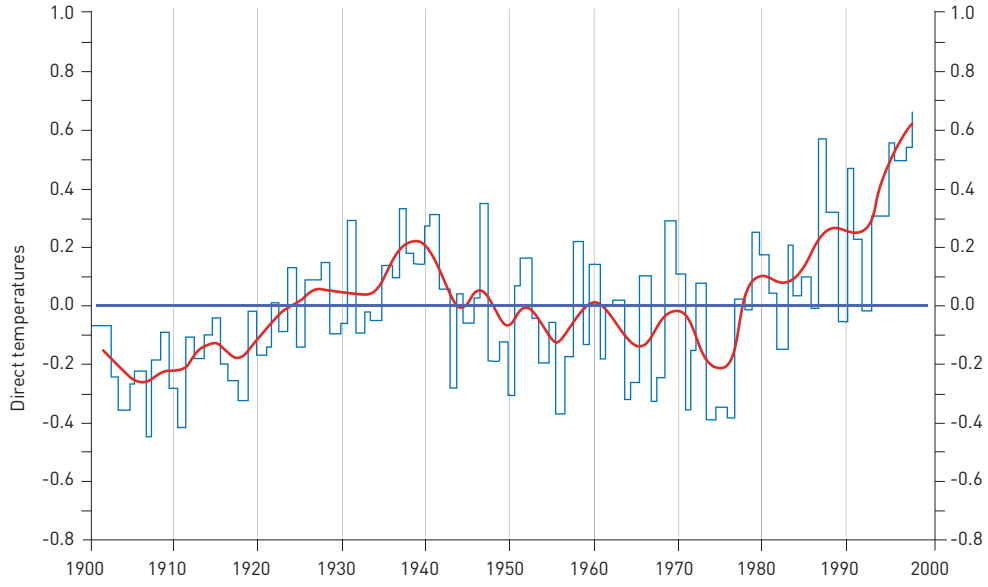
Consideration of the full food chain in assessing energy requirements: in order to promote food security strategies with the necessary energy inputs, policies and methodologies the critical linkages between agricultural production, agriculture-based industries (food, beverages, tobacco and textiles), distribution and commercialization and the rest of the economy should be considered. Agricultural growth is the most important contributor to manufacturing and service activity in sub-Saharan Africa, not only stimulating agro-industries, but the rest of the economy as well. In this context, energy from biomass is an added benefit.

Hazardous agriculture in light of climate change

Climate change and global warming are likely to make precipitation patterns in Africa increasingly variable, reducing water availability in some regions and increasing it in others. The shift would have a huge impact on both irrigated and non-irrigated agriculture. Changes in precipitation would make extreme weather events more common, leading to more severe and frequent flooding and to lower dry-season water flow in rivers. Past investments in water control measures and infrastructure will lose their value if reservoirs are no longer filled and irrigation canals do not run.

Observational records (Figure 6) show that the African continent has been warming through the twentieth century at the rate of about 0.05 C per decade with slightly higher warming in the June-November seasons than in December-May. By the year 2000, the five warmest years in Africa had all occurred since 1988, with 1988 and 1995 being the two warmest years. This rate of warming is not dissimilar to that experienced globally, and the periods of most rapid warming - 1910 to 1930s and the post-1970s - occurred simultaneously in Africa and the rest of the world.

Figure 6: Temperature curves in Africa during the twentieth century

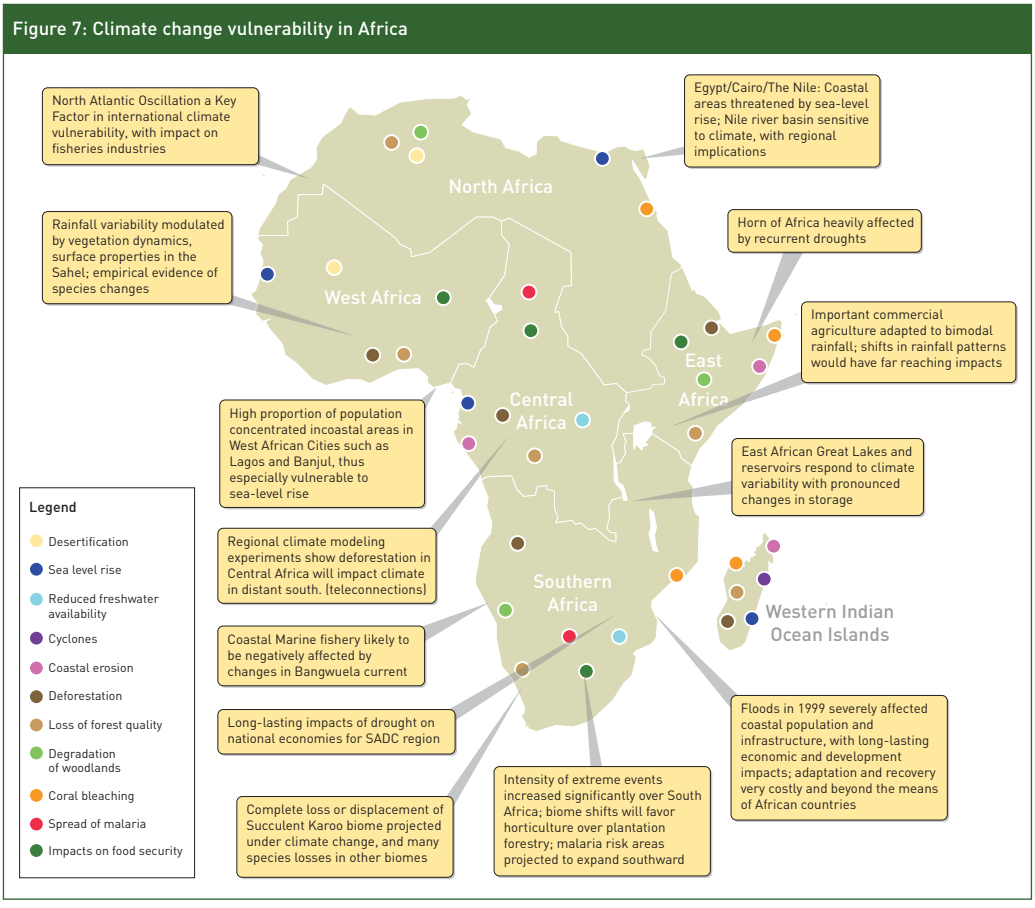


During the twentieth century, the global average surface temperature increased by about 0.6 C and global sea level increased by about 15 to 20 cm. The IPCC AR4 projects that the global average temperature will rise another 1.1 to 5.4 C by 2100, depending on how much the atmospheric concentrations of greenhouse gases increase during this time. This temperature rise will result in continued increases in sea level and overall rainfall, changes in rainfall patterns and timing, and decline in snow cover, land ice and sea ice extent. The expected warming is greatest over the

interior of semi-arid margins of the Sahara and central-southern Africa. It is also expected that temperature rise in Africa will correspond to global temperature rise, and that adverse impacts on agriculture will be spread across the diverse regions of Africa, putting a huge proportion of the African continent at greater risk.

Multiple stresses make most of Africa highly vulnerable to environmental changes. As shown in Figure 7, climate change will increase vulnerability of an already stressed continent. Analysis of the impacts of climate change suggests that agro-ecological systems are the most vulnerable sectors. Agriculture in low latitude developing countries is expected to be especially vulnerable because the climate of many of these countries is already too hot. In many parts of Africa, agro-ecological systems are characterized by recurring droughts, soil degradation and water supply shortages. These effects are exacerbated by the fact that agriculture and agro-ecological systems are especially prominent in the economies of African countries and the systems tend to be less capital and technology intensive.

Figure 7: Climate change vulnerability in Africa



The main effect of climate change on semi-arid or tropical agro-ecological systems is a significant reduction in crop yield, which may well force large regions of marginal agriculture out of production in Africa. Such a reduction in crop yield will also place more pressure and higher demand for conversion of land, extraction of water supply for irrigation, introduction of new exotic plant and animal species, intensive use of chemical inputs and hence pollution and environmental damage, erosion, seriously accelerating biodiversity loss and extinction.

The climate patterns Illustrated in Figure 7, coupled with the current inadequacy of public infrastructure (such as roads, long-term weather forecasts, and agricultural research and extension), suggests a need to ensure climate change adaptation through pursuing massive changes in the agricultural systems of low latitude (mostly developing) countries.

Five main climate change related drivers, namely, temperature, precipitation, rise in sea level, atmospheric carbon dioxide content and incidence of extreme events, may affect the agriculture sector in the following ways:

- Reduce crop yields and agricultural productivity: there is growing evidence that in the tropics and subtropics, where crops have reached their maximum tolerance, crop yields are likely to decrease due to an increase in temperature.
- Increase incidence of pest attacks: an increase in temperature may be conducive to a proliferation of pests that are detrimental to crop production.
- Limit the availability of water: it is expected that the availability of water in most parts of Africa will decrease as a result of climate change. In particular, there will be a severe downward trend in the rainfall in Southern African countries and in the dry areas of countries around the Mediterranean Sea.
- Exacerbate drought periods: an increase in temperature and a change in the climate throughout the continent are predicted to cause recurrent droughts in most of the regions.
- Reduce soil fertility: an increase in temperature is likely to reduce soil moisture, moisture storage capacity and the quality of the soil, which are vital nutrients for agricultural crops.
- Reduce livestock productivity and increase production costs: climate change will affect livestock productivity directly by influencing the balance between heat dissipation and heat production and indirectly through its effect on the availability of feed and fodder.
- Affect availability of human resources: climate change is likely to cause the manifestation of vector and vector-borne diseases, where an increase in temperature and humidity will create the ideal conditions for malaria, sleeping sickness and other infectious diseases that will directly affect the availability of human resources for the agriculture sector.

The impact of these adverse climate changes on agriculture is exacerbated in Africa by the lack of adaptation strategies, which are increasingly limited due to the lack of institutional, economic and financial capacity to support such actions.

Africa s vulnerability to climate change and its inability to adapt to these changes may be devastating to the agriculture sector, the main source of livelihood for the majority of African peoples. The utmost concern should therefore be for a better understanding of the potential impact of the current and projected climate changes on African agriculture and to identify ways and means to adapt and mitigate its detrimental impact.

Attempts to overcome the challenges

Today s water and food situation is recognized as a serious global issue and Africa has prepared many initiatives in response to it. Initiatives dealing primarily with water for agriculture in Africa involve efforts in one or more of the following categories: formulating long-term water policies and related strategies; increasing water productivity; promoting water availability; controlling agricultural pollution; reforming institutions and management; enhancing stakeholder participation; raising awareness and developing information systems; developing human resources; supporting action-oriented research; and adopting innovative technology.

1. **Formulating long-term water policies and related strategies**: every African country has unique legal, institutional, economic, social, physical and environmental conditions that influence its water management policies and strategies. The formulation of national strategies for integrated water management depends on many factors, including a country s size and political organization, its hydrological conditions, its regional context, and the diversity of its stakeholders. Many African countries have only subsector water policies (for irrigation, water supply, etc.), which are often inconsistent, thus calling for agricultural water policies that integrate the management of natural resources including water, soil and biological resources.

   National policies in Africa, especially agricultural policies, make the link between globalized food markets and local water markets. One of the main causes of the food crisis in many African countries are the subsidies paid by industrialized countries to their farmers. Agricultural subsidies in Europe and North America are as high as six times foreign aid to African countries. Subsidies, combined with trade barriers imposed by industrialized countries, prevent African countries from successfully competing in global markets.

2. **Enhancing water availability:** in planning and implementing agricultural projects, African countries try to bridge the gap between population growth and large urban populations on the one hand, and food production and rural development on the other. Several land reclamation projects are, therefore, carried out in conjunction with efforts to provide sufficient water supplies while protecting the environment and ensuring economic and financial support.

   Water stress situations result mainly from limited supplies (as in arid regions) or poor reticulation and inequitable distribution through supply networks, or both. Accordingly, tackling both problems can be done by augmenting water supplies and controlling the demand for water (see point 3).

   To supply more irrigation water, desalination is still too costly a process, and weather modification and cloud seeding techniques raise environmental and social concerns, so that increased storage capacity remains the favoured option. Two main approaches are used in Africa: building dams or reservoirs and artificially recharging aquifers with water for future use. Promoting groundwater storage is important because of its many advantages, including the potential removal of some contaminants and minimal evaporation losses, and because of the continuing opposition to dams.

3. **Increasing water productivity**: to boost the productivity of existing cultivated land, modern irrigation and drainage systems are used. In rainfed areas without water management systems, improvements in agricultural growth can be achieved through watershed management that increases farm productivity.

   Efforts to control the demand for irrigation water represent an alternative to conventional supply-driven water management, which has long responded to shortages by relying on capital investment in new supply and distribution networks. Demand management focuses on reducing water consumption, and thus improving water use efficiency. Demand management measures include:
   - introducing short-age crop varieties;
   - introducing pricing mechanisms to reduce irrigation water demand;
   - developing water-saving irrigation techniques;
   - modernizing irrigation systems;
   - introducing salt-tolerant crops in areas that are arid, saline or served by brackish water; and
   - reallocating irrigation water to crops that consume less water.

   Demand can also be controlled by harvesting and reusing water. Water reuse is becoming an integral part of many national water programmes, particularly in water-short areas. Water reuse efforts require widening the concept of water use efficiency to include basin-wide efficiency and the multiplier effects of water. However, in some cases severe water shortages can lead to hazardous practices, including the use of improperly treated domestic and/or industrial wastewater for irrigation, leading to adverse health impacts and long-term soil contamination.

4. **Controlling agricultural pollution:** agriculture-induced pollution can affect groundwater, seawater or both. Public awareness of irrigation and drainage issues should, therefore, be promoted by strengthening African countries technical knowledge base on waterlogging, salinity and other quality issues.

5. **Reforming institutions and governance:** sustainable agricultural development should be based on balanced plans for resource supplies and demand. African decision-makers are therefore reviewing relevant policies, legislation, regulations and institutions, taking into account the various factors that influence the effectiveness of irrigation and drainage - including the availability of investments for rehabilitating infrastructure and for financing operation and maintenance. The reforms resulting from such reviews should streamline the development of similar future projects using sound, integrated water management.

6. **Enhancing stakeholders participation:** inadequate stakeholder participation is one of the main challenges for water and agriculture management. Such participation provides a variety of views and helps gain public support and the political and financial backing required to sustain projects. To reduce risks of inefficient and inequitable performance, decentralization and subsidiarity reforms in the agriculture sector may include irrigation management transfers, which reassign to farmers the main responsibilities for irrigation (including community issues and full or partial cost recovery initiatives). However, attempts to equitably distribute water among rural populations may be hindered by the

under-representation of women in water resources development and management. Accordingly, recent water management efforts that take gender issues into account have used integrated frameworks that address the interactions between gender and social equity, acknowledging the key role that women play in providing food for their families.

7. **Raising awareness and developing information systems:** lack of information and knowledge can aggravate the effects that irrigated agriculture has on the environment - for example, contributing to groundwater and drainage problems - and accentuate the threats of climate change to agriculture. The challenge is to minimize negative impacts and promote positive impacts, fulfilling the seventh Millennium Development Goal of ensuring environmental sustainability.

   Groundwater has tremendous value in both rural and urban areas for poverty alleviation, livelihoods, drought security, agricultural yields, domestic water supplies and the environment. Indiscriminate exploitation and its consequences, along with pollution, will threaten groundwater resources. Similarly, irrigation without drainage, excessive irrigation, and inefficient irrigation and drainage systems can result in severe waterlogging and salinity problems, which lower crop yields and agricultural productivity. Such problems, as well as those associated with climate change, are unlikely if awareness about hazardous practices and preventive measures is widespread throughout the different levels of the decision-making hierarchy and among farmers.

   To address the potential effects of climate change on agricultural production, information on related uncertainties has been expanded and public awareness raised on possible risks and responses. Regional and national dialogues on water and climate are now being promoted, together with information sharing between the water and climate communities. Efforts are also being made to raise awareness and strengthen capacities for a sound assessment of the impacts of and adaptation to climate change in Africa. Such measures are intended to help reduce vulnerability to the intensified effects of hazards in the agriculture sector, expected to result from climate change and to enhance African people s ability to cope with and adapt to climate change.

8. **Developing human resources:** though institutions can make the difference between success and failure in agricultural development, laws, regulations and organizations may be ineffective without well-trained, motivated individuals to enforce and administer them. Thus human resources development plays a crucial role in determining the outcomes of irrigation-related water management programmes.

   Major capacity building programmes are well underway or have been initiated throughout Africa. Water education and capacity-building needs can be fulfilled through training centres established for such reasons, which strengthen the capacity and skills of water professionals in planning, designing, operating and maintaining agricultural, irrigation and drainage systems.

9. **Supporting research and adopting innovative technology:** research and technology play crucial roles in agricultural production. Without research, the multidisciplinary concerns associated with development are unlikely to be addressed. Using information

technology and evidence on economic evolution, water and food production and needs can be projected. Research can also solve various problems and enlighten the public on the implications of adopting technological innovations. Solutions to food production problems in African water-scarce areas include high-yielding, drought tolerant crop varieties and improvements in crop genetics. Research is responsible for envisaging the role of water relative to future agricultural demands, suggesting structural adjustments to secure funds and attracting investments in agriculture, and working out the transition costs of such adjustments.

10. **Increasing investments in agriculture:** investments in agriculture may appear to produce low yields and slow returns. However, viewed from an African perspective, they can be enormously productive. Agriculture accounts for about 30 percent of sub-Saharan Africa s GDP, at least 40 percent of export value and approximately 70 percent of employment. Furthermore, two-thirds of manufacturing added value in most African countries is based on agricultural raw materials. In a number of smaller countries, agriculture plays an even more dominant role, representing 80 percent or more of export earnings.

    Yet, the overwhelming majority of public irrigation agencies in Africa recover only a minor share of recurrent costs, with no contributions to capital outlays. Most African farmers still receive irrigation water at no or at a nominal cost. The agriculture sector is accordingly dependent on subsidies and international agencies. Such an environment makes raising private funds for expanding and modernizing systems more difficult, because lenders and investors look to future cash flow for repayment.

    African governments are, therefore, responding to the above-described unfavourable environment by translating political decisions into adequate allocations of resources to water, taking advantage of the aid community s increasingly encouraging attitude towards funding water-related activities. This financing effort is supported by an increasingly consistent strategy to recover costs from users and to establish incentives to ensure more efficient use of water. The Millennium Development Goal of reducing poverty and hunger by half by 2015 are achieved only if the current levels of spending for water and food production are increased, through tapping all available sources of finance; not only public funding and users contributions, but also private finance (domestic or international) and development funds.

11. **Formulating regional and continental initiatives to counteract crises:** for example, the recent increase in costs of producing fertilizers, which are of strategic importance to the achievement of an African green revolution that will roll back hunger and disease in many parts of the continent, has been addressed by establishment of the African Fertilizer Financing Mechanism Special Fund, through an initiative by the African Development Bank with a view to mobilizing resources from donors to finance, in particular, fertilizer production, distribution, procurement and use in Africa.

Forming partnerships across Africa

Forming productive partnerships is central to tackling the problems hindering agricultural development in Africa, with regard to the major role agriculture plays in the economy and society of most African countries. Since increased productivity in the sector is considered to be the very basis for the continent s economic and social development, partnerships have been formed between African governments and the international community to create an enabling environment through which agricultural productivity in Africa can be further developed.

The New Partnership for Africa s Development

The New Partnership for Africa s Development (NEPAD), initiated by the five Heads of State (Algeria, Egypt, Nigeria, Senegal and South Africa), to provide a vision and strategic framework for Africa s renewal, through facing the current challenges hindering the continent s progress and development (poverty, underdevelopment, marginalization, etc.). NEPAD is an African Union designed programme that aims to achieve the following objectives:

a) Establish the conditions for sustainable development by ensuring:
- peace and security;
- democracy and good, political, economic and corporate governance;
- regional cooperation and integration; and
- capacity building.

b) Policy reforms and increased investment in the following priority sectors:
- agriculture;
- human development with a focus on health, education, science and technology and skills development;
- building and improving infrastructure, including information and communication technology (ICT), energy, transport, water and sanitation;
- promoting diversification of production and exports, particularly with respect to agro-industries, manufacturing, mining, mineral beneficiation and tourism;
- accelerating intra-African trade and improving access to markets of developed countries; and
- the environment.

c) Mobilizing resources by:
- increasing domestic savings and investments;
- improving management of public revenue and expenditure;
- improving Africa s share in global trade;
- attracting foreign direct investment; and
- increasing capital flows through further debt reduction and increasing ODA flows.

The African Ministerial Council of Water

The African Ministers responsible for water, having noted the establishment of the African Union, the launch of the New Partnership for Africa s Development (NEPAD) with the overall objective of encouraging new approaches to Africa s sustainable development challenges, and being aware of the challenges posed by the Millennium Declaration and the regional intergovernmental responses essential for translating the MDGs on water and sanitation into reality in Africa, established the African Ministerial Council on Water (AMCOW). AMCOW was formally launched in Abuja, Nigeria on 30 April 2002.

AMCOW s mission is to provide political leadership, policy direction and advocacy in the provision, use and management of water resources for sustainable social and economic development and maintenance of African ecosystems, and to strengthen intergovernmental cooperation to address water and sanitation issues in Africa.

AMCOW s major functions are to facilitate regional and international cooperation through the coordination of policies and actions amongst African countries regarding water resources issues, and to review and mobilize additional financing for the water sector in Africa, and to provide a mechanism for monitoring the progress of implementation of major regional and global water resources and water supply and sanitation initiatives. AMCOW aims to develop mechanisms that will promote best practices for water policy reforms, integrated water resources management, food security, water supply and sanitation. AMCOW will also enhance and consolidate intergovernmental and regional cooperation in the management of shared waters, including surface and groundwater.

AMCOW also provides a forum for dialogue with UN agencies and other partners on water issues, and promotes participation in regional studies regarding climate change, development of observation networks, facilitates information exchange and aims to develop policies and strategies to address water issues in Africa.

AMCOW engages in dialogue and consultations with UN agencies, regional economic groupings and with regional and global financial institutions on financing and other issues relevant to the water and sanitation sector in Africa.

The African Water Facility

The African Water Facility (AWF) is an initiative launched in 2004 by the African Ministers Council on Water as a result of the implementation of the objectives of the African Water Vision and Framework for Action for 2025, adopted at the 2000 World Water Forum in The Hague. The AWF s main objective is to expand Africa s access to financial resources for the water and sanitation sector, and create an enabling environment for water management to generate and attract more investment for the development and management of sustainable water resources. The AWF mobilized € 500 million to finance its 2005-2009 operational programme from: (i) Development partners (financial contribution, secondment of staff, co-funding); (ii) African Governments (financial contribution); and (iii) Beneficiary contribution (co-funding; provision of facilities, services and equipment).

Opportunities for sustainable agriculture

Food supply concerns are usually addressed in light of current water availability, taking into account social, economic, environmental and cultural factors that could affect the future of water. It is estimated that increasing water productivity, combined with better water management, could meet about half of the demand of agricultural water. However, the other half cannot be covered unless new water resources are developed. The following courses of action constitute promising alternatives for the development of water resources for agriculture in Africa.

1. **Increasing water productivity:** efforts to improve food security and rural livelihoods must focus on raising water productivity in both rainfed and irrigated agriculture and on increasing the availability of affordable, environmentally acceptable water that generates maximum socio-economic returns. Better agronomic practices and crop selection can save water and reduce waste. Biotechnology can provide seeds with higher yields, better resistance to pests and diseases, and higher tolerance to inundation, drought and saline water. Yield-increasing, water-saving technology can also raise water productivity. In addition, better communication systems can provide market, weather and other information that enhance production decisions. All these technologies will improve the management abilities of irrigation and drainage agencies, leading to better and cheaper services.

2. **Harnessing new water supplies:** whatever agricultural advances are made, the fact remains that growing more food requires more water, both for rainfed and irrigated agriculture. Even under favourable assumptions about improvements in irrigation efficiency and agronomic potential, water supplies for agriculture will have to significantly increase to meet Africa s growing food requirements. Some of this additional water can come from harvesting rainwater in arid and semi-arid regions and from developing small-scale water sources such as shallow aquifers. These are preferred solutions because they can be used in areas with extensive poverty, little water and rapid population growth. Reducing waste in return flows from agricultural users, can improve water supplies. It is obvious that where demands for both agricultural and environmental requirements exceed the amount available, choices and compromises have to be made. The enormous pressure on freshwater resources makes it increasingly necessary to improve communication between farmers and environmentalists. Despite the recent increase in food prices worldwide, importing food would reduce stress on water systems, but its impact on local poverty, socio-economic, cultural and environmental situations has to be better understood.

3. **Expanding storage capacity:** new storage capacity will be required to replace capacity lost to sedimentation and to save water lost during times of scarcity. Water storage can be surface storage in reservoirs or groundwater storage. New techniques and institutional mechanisms are urgently needed to enhance, recharge and improve management of groundwater aquifers. New surface reservoirs are a subject of considerable controversy because of their potential effects on local communities and the environment, including inundation of land, resettlement of people, and disturbance of river ecosystems and fish migrations. In addition, such reservoirs are subject to sedimentation and evaporation. Reservoirs, however, perform functions that are hard to replace by other means and so will remain a necessary option in water resources development.

4. **Empowering communities and water user groups:** individuals and groups must be empowered to make decisions so that local populations can control a share of development resources. New roles for civil society organizations have to be created and enhanced through expanding the formation of water user associations to run irrigation systems. New multi-stakeholder catchment committees should be empowered to influence water allocations and management practices. Such organizations can protect the interests of poor farmers and engage them in other collective actions that improve their livelihoods. The central role of female farmers in many of these activities must be better recognized, and their rights and representation redefined.

5. **Ensuring access to food:** at the individual, local and continental levels should be ensured. Infrastructure for storing and distributing food should be developed, as should the ability to generate foreign exchange to pay for food imports. Domestic development policies (including subsidies and implicit taxes), international assistance programmes and international trade agreements should acknowledge and support the centrality of agriculture-based development in these circumstances.

6. **Reforming water management institutions:** reforms should reorient water management institutions towards people, making them more service-oriented, user-controlled and self-financed, with transparent decision-making and accountability. These institutions should be embedded in a system of integrated water management with empowered multi-stakeholder basin organizations managing surface and groundwater. This approach should enhance water access for poor people and disadvantaged groups, and allow minimum flows for basic needs and the environment.

   Qualified, skilled people are needed to develop and run these institutions. Moreover, the envisaged shift to a service orientation may require changes in attitudes, skills, and management practices. The motivation, knowledge and skills of staff have to be developed through education, training and human resources management. These processes require increasing the capacity of local professionals and researchers to provide education and training on water and food production, facilitating the exchange of knowledge between local users, technicians and professional water managers; and establishing or strengthening links between water users, water managers, education institutions and water research organizations.

7. **Making needed investments:** to meet the demand for food, to increase the productivity and development of water, and to improve the livelihoods of rural people. Investment programmes should respond to the key principles of participation, accountability and transparency and should foster representative institutions in an integrated water resources development and management context.

   Investments should develop water resources to enable community-based irrigation, modernize existing irrigation and drainage systems, and replace and augment storage capacity in reservoirs and groundwater basins particularly in water scarce countries. Groundwater recharge programmes should be initiated to help restore groundwater tables. Moreover, investments are needed in drainage and reclamation of degraded irrigated land,

restoration of eroded lands and provision of flood protection and drainage in frequently inundated areas. Also, environmental regulations and parallel investments in municipal and industrial waste treatment are needed to improve the quality of river water, reduce dilution requirements and increase supplies.

Both funding for investment and for operations are to be the result of a negotiation process between the authorities, the service provider and the users on the level of services and the associated costs of service provision. All costs must be recovered, partly through contribution from users and partly from the government representing the interests of the society.

The way ahead

For agriculture to feed the at least 1.8 billion people in Africa in 2050, water allocated to agriculture must be used more efficiently and new water resources developed. Many organizations and institutes will have to choose water use and development priorities, and carefully consider the difficult tradeoffs between water for agriculture and water for the environment.

Shared understanding of the problems and their consequences, solutions and the interconnections and tradeoffs among these groups is crucial if actions are to achieve common objectives. The starting point must be the development of a common awareness and understanding among current and future decision-makers in Africa. This must be done in schools, in the media, and in workshops, meetings and conferences, allowing those concerned to make decisions. Appropriate actions must then be taken on economic policy and trade, investment, infrastructure, institutional reform, research and capacity building, as follows:

1. **Developing consistent, comprehensive water and food policies:** African governments need to intensify efforts to prepare medium and long-term water and food policies at the local, national and regional levels. National dialogues on such policy-making should be initiated and strengthened among those responsible for and affected by the development and use of water resources. Associated reforms and capacity building in irrigated and rainfed agriculture should be deepened, allowing the main stakeholders to determine their future.

   Trade in virtual water (water embedded in key water-intensive crops) offers potential for making water allocations more efficient. It can help integrate water and food policies in Africa, especially at the regional level.

2. **Promoting equitable trade:** trade arrangements in Africa should encourage water-scarce regions to produce and export high-value crops and import water-intensive staple crops from water-abundant regions. Trade regimes must also make special provisions for African countries not yet able to compete in the market for their food supplies. The economic implications of long-term food imports in food-deficit countries and regions should be evaluated. The impacts of national agricultural subsidies on African countries should be assessed and wisely governed. Trade regimes in African regions should also be adjusted to promote

socially equitable food production and distribution, and to support agriculture-based rural development initiatives.

3. **Expanding water storage and improving water quality:** more water storage at or below the surface is essential to achieving the water volumes required for food production and other purposes. Water storage and harvesting techniques should be further developed to enhance productivity in rainfed agriculture. Work to contain agricultural pollution is urgently needed because the effects take years to materialize in groundwater. Such efforts should be consistent with other pollution control policies, and policies that provide incentives to pollute should be eliminated, especially subsidies that encourage high-yield practices, which often result in highly polluting agriculture. Improving the quality of agricultural return flows requires the development of affordable and effective technologies, such as lower impact pesticides and herbicides (including biological agents) and livestock feed. Strategies are needed to phase out more persistent agricultural chemicals throughout Africa.

4. **Shifting the focus of irrigation development:** many large projects have been implemented, but resources should be devoted to small irrigation systems that provide supplemental irrigation and to rainfed agriculture. Small-scale technologies can provide many benefits in poor rural areas; developing them should be a top priority in the least developed African countries. Innovative technology that enhances affordable small plot irrigation can be one of the most effective ways of raising incomes, increasing land productivity, and achieving household food security, liberating the continent s poorest and hungriest people from poverty and hunger.

5. **Increasing the productivity of irrigated agriculture:** is essential given that growing competition for water will undoubtedly increase tensions between riparian countries. The main challenge is determining how much water should be used to preserve downstream water quality as well as the aquatic ecosystems needed to guarantee that quality. Methods are available to make such determinations and should be widely implemented. In addition, increasing the productivity of irrigated systems requires improving the efficiency of hydraulic systems and enhancing agronomic performance through decent cropping practices and appropriate crop choices.

   Because pumping water is a common way to increase the flexibility of irrigated systems, surface and groundwater management need to be better integrated. Such efforts should rely on individual farmers and irrigation agencies, which must work hand in hand.

6. **Reform of irrigation and drainage institutions:** should shift these agencies towards service-oriented management based on the principle of charging for services, to secure funding for sustainable service provision. Cost recovery mechanisms should be improved significantly to cover costs of operation and maintenance. This approach is feasible only if appropriate, effective accountability mechanisms are in place, if decision-making is transparent and participatory, and if the services provided are sufficient.

7. **Developing information systems and knowledge networks:** Internet-based information systems and knowledge networks are needed to update users on the latest innovations in agriculture, to increase awareness of the potential of updated designs and modern

technologies, and to provide examples of good and bad practices. Such information helps raise people s awareness of the consequences of harmful practices and about coping with the risks associated with climate change and its possible effects on water availability.

8. **Improving water education and building capacity:** water education and capacity building for individuals and staff at all levels should be considered integral elements of all programmes that aim to improve agricultural management and development. These elements include knowledge about water in a framework that responds to sectorial and societal needs. Human resources development can be carried out in different ways, including incorporating training into agriculture projects, establishing specialized training centers and developing relevant education programmes.

9. **Increasing research:** more research is required to develop new and situation-adapted technologies that maximize water productivity and poverty alleviation in irrigated and rainfed areas. This should be accompanied by research on developing institutions for management, operation, and maintenance. Biotechnology research is required to increase crop yields. Private genetic research supports growth in the yields of tradeable cereal and horticultural crops. Public funding is required for research on locally important crops that are unlikely to attract private investment, and on better drought resistance and salinity tolerance of major cereals. Research should also investigate the effects of developing and using genetically modified crops.

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