Ghana

GEOGRAPHY, CLIMATE AND POPULATION

Ghana is situated on the west coast of Africa with a total area of 238 540 km². The country has a north-south extent of about 670 km and a maximum east-west extent of about 560 km. It shares borders with Côte d'Ivoire to the west, Burkina Faso to the north, and Togo to the east. To the south are the Gulf of Guinea and the Atlantic Ocean. The country is divided into 10 administrative regions.

The topography is predominantly undulating and of low relief with slopes of less than 1 percent. Despite the gentle slopes, about 70 percent of the country is subject to moderate to severe sheet and gully erosion. The highest elevation in Ghana, Mount Afadjato in the Akwapim-Togo Ranges, rises 880 metres above sea level. There are five distinct geographical regions:

- The low plains, stretching across the southern part of the country.
- The Ashanti Uplands, stretching from the Côte d'Ivoire border in the west to the elevated edge of the Volta Basin in the east.
- The Akwapim-Togo Ranges in the eastern part of the country consist of a generally rugged complex of folded strata, with many prominent heights composed of volcanic rock. The ranges begin west of Accra and continue in a northeasterly direction, finally crossing the border into Togo.
- The Volta Basin occupies the central part of Ghana and covers about 45 percent of the nation's total area. The basin is characterized by poor soil, generally of Voltaian sandstone.
- The high plains in the northern and northwestern part of Ghana, outside the Volta Basin, consist of a dissected plateau. Soils in the high plains are more arable than those in the Volta Basin.

Ghana has a warm, humid climate. Mean annual rainfall of the country is estimated at 1 187 mm. Mean annual temperatures range from 26.1 °C near the coast to 28.9 °C in the extreme north. Annual potential open water evaporation has been estimated as ranging between 1 350 mm in the south to about 2 000 mm in the north. The actual amount of evaporation depends on a number of factors including water availability, vegetation cover and prevailing weather conditions among others.

There are six agro-ecological zones defined on the basis of climate, reflected by the natural vegetation and influenced by the soils (Table 1). Rainfall distribution is bimodal in the forest, transitional and coastal zones, giving rise to a major and a minor growing season. In the remaining two agro-ecological zones, the unimodal rainfall distribution gives rise to only one growing season. Only in some parts of the country is the climate favourable for non-irrigated agriculture. Rainfall exceeds potential evaporation during relatively short periods. Even in the southern forest zone where rainfall is at its highest, irrigation is essential for short season crops during the dry period. The unreliability of rainfall is a cause of concern. Complete crop failures can be expected in most northern

areas in about one in every five years. This risk can rise to one in every three years during low rainfall periods.

The cultivable area is estimated to be 10 million ha, which is 42 percent of the total area of the country and this (the sum of arable land and permanent crops) was about 6.33 million ha in 2002 (Table 2).

The country's population is about 21.4 million (2004), of which 54 percent is rural. The annual population growth rate is 1.7 percent. Population density is 90 inhabitants/km^2 nationwide, with a variation from 26 inhabitants/km^2 in the Northern Region to 896 inhabitants/km^2 in the Greater Accra Region. In 2002, 79 percent of the total population had access to improved drinking water sources; this coverage was 93 percent in urban areas and 68 percent in rural areas.

TABLE 1
Characteristics of agro-ecological zones in Ghana

Zone	Rainfall	Portion of total area	Length of growing season	Dominant land use systems	Main food crops
	(mm/yr)	(%)	(days)		
Rain forest	2 200	3	Major season: 150-160 Minor season: 100	forest, plantations	roots, plantain
Deciduous forest	1 500	3	Major season: 150-160 Minor season: 90	forest, plantations	roots, plantain
Transition zone	1 300	28		annual food and cash crops	maize, roots, plantain
Guinea savannah	1 100	63	180-200	annual food and cash crops, livestock	sorghum, maize
Sudan savannah	1 000	1	150-160	annual food crops, livestock	millet, sorghum, cowpea
Coastal savannah	800	2	Major season: 100-110 Minor season: 50	annual food crops	roots, maize

TABLE 2
Basic statistics and population

Physical area			
Area of the country	2002	23 854 000	ha
Cultivated area (arable land and area under permanent crops)	2002	6 331 000	ha
• as % of the total area of the country	2002	27	%
• arable land (annual crops + temp. fallow + temp. meadows)	2002	4 181 000	ha
• area under permanent crops	2002	2 150 000	ha
Population			
Total population	2004	21 377000	inhabitants
• of which rural	2004	54	%
Population density	2004	90	inhabitants/km^2
Economically active population	2004	10 773 000	inhabitants
• as % of total population	2004	50	%
• female	2004	50	%
• male	2004	50	%
Population economically active in agriculture	2004	6 021 000	inhabitants
• as % of total economically active population	2004	56	%
• female	2004	46	%
• male	2004	54	%
Economy and development			
Gross Domestic Product (GDP) (current US$)	2003	7 700	million US$/yr
• value added in agriculture (% of GDP)	2003	35.2	%
• GDP per capita	2003	368	US$/yr
Human Development Index (highest = 1)	2002	0.568	
Access to improved drinking water sources			
Total population	2002	79	%
Urban population	2002	93	%
Rural population	2002	68	%

Overall poverty levels, as defined by the Ghanaian poverty line of a consumption expenditure of 900 000 cedis (about US$100) per adult per year, decreased between 1991/92 and 1998/99 from 52 percent to 40 percent. Export crop farmers and wage employees in private employment enjoyed the greatest increases in their standard of living, while food crop farmers experienced the least improvement. Poverty was greatest within this last group, constituting 59 percent of the poor in Ghana. This has been caused, among other reasons, by the lack of access to markets, high cost of inputs and a low level of economic infrastructure. There are also significant differences in the spatial distribution of poverty. Poverty levels in 1998/99 were highest in the three northern savannah regions, the Upper East, Upper West and Northern Regions, with 88 percent, 84 percent and 69 percent respectively. In contrast, poverty levels were lowest in the Greater Accra and Ashanti Regions with 5 percent and 28 percent respectively.

ECONOMY, AGRICULTURE AND FOOD SECURITY

Ghana's Gross Domestic Product (GDP) in 2003 was US$7.7 billion (current US$). Agriculture contributed 35.2 percent of the GDP in 2003, while about 56 percent of the economically active population was employed in the sector in the same year. The annual per capita income in Ghana was US$390 in 2001. The services sector and the industrial sector, including mining and construction, are also important in terms of contribution to the GDP. The country continues to be an exporter of primary products (cocoa, timber, gold) and an importer of manufactured goods and oils, making its economy vulnerable to external shocks.

Ghana is not self-sufficient in food production, and it has been difficult to ensure food availability in sufficient quantities all year round. During periods of good rains, food abounds but inadequate storage facilities result in losses of perishable crops. Inadequate agro-processing facilities for agricultural products are adding to food insecurity in the country. The rapidly growing population poses another dimension to the question of food security in the country. Protein Energy Malnutrition (PEM) is the most widespread and serious nutritional disorder in Ghana, especially among children. It is manifested in mild to severe stunting, wasting and underweight among children. Food availability varies from season to season and from year to year depending on rainfall amount and its distribution in space and time.

Rainfed agriculture is predominant and average farm size is small (< 1.2 ha), thus smallholder farms dominate the sector, accounting for about 80 percent of total agricultural production. The average food crop farmer has limited contact with the product market and is unlikely to use fertilizers, insecticides or high yielding seed varieties. The use of irrigation technology is not widespread but considered of great importance in view of the seasonal and incidental occurrence of drought.

Traditional farming systems have developed over time as adaptations to the six major agro-ecological zones in Ghana (Table 1). In the two forest zones, tree crops are significant with cocoa, oil-palm, coffee and rubber being of particular importance. Food crop production is important in all the agro-ecological zones. Maize is an important cereal in the south and middle belts, but progressively gives way northwards to sorghum and millet. Yam and grain legumes are important crops in the middle belt and towards the north.

WATER RESOURCES AND USE

Water resources

Three main river systems drain the country:

- The Volta river system consists of the Oti and Daka rivers, the White and Black Volta rivers, and the Pru, Sene and Afram rivers. The basin covers 70 percent of the country area.

- The southwestern river system comprises the Bia, Tano, Ankobra and Pra rivers and covers 22 percent of the country area.
- The coastal river system comprises the Ochi-Nakwa, Ochi Amissah, Ayensu, Densu and the Tordzie rivers, covering 8 percent of the country area.

Groundwater occurs mainly in the following formations:

- The Voltaian formation has little or no primary porosity and thus groundwater occurrence is associated with the development of secondary porosity because of jointing, shearing, fracturing and weathering. In the wet forested southwestern part of the country, the weathered zone has an average thickness of 60 m while it is thinnest in the semi-arid area in the extreme northeast where the mean thickness is about 10 m. Yields rarely exceed 6 m^3/hr.
- The Cenozoic and Mesozoic sediments occur mainly in the extreme southeastern and western part of the country. Three aquifers occur in this formation. The first aquifer is unconfined and occurs in the Recent Sand very close to the coast. It is between 2 and 4 m deep and contains meteoric water. The intermediate aquifer is either semi-confined or confined and occurs mainly in the Red Continental Deposits of sand clay and gravel. The depth of this aquifer varies from 6 m to 120 m. The third aquifer occurs in the limestone and varies in depth between 120 and 300 m. Groundwater in this aquifer occurs under artesian conditions and is fresh. The average yield in this limestone aquifer is about 184 m^3/hr.

Falling groundwater levels have been observed in the Upper Regions where over 2 000 boreholes have been drilled since the mid-1970s in the rural areas to provide potable water to communities.

Wetlands constitute about 10 percent of Ghana's total land area. The three main types of wetlands are: i) marine/coastal wetlands; iii) inland wetlands; iii) human-made wetlands. Wetlands in Ghana are very productive and their resources have been traditionally used by local populations as a source of the basic necessities of life, ranging from building materials, hunting and fishing areas, to sources of water for humans and livestock. Local populations have developed traditional knowledge systems and practices which govern the management of wetlands. Ghana is a signatory to the Ramsar Convention and there are five Ramsar sites of international importance in the country: i) Densu Delta; ii) Songor; iii) Keta Complex; iv) Muni-Pomadze; v) Sakumo Lagoons. All these are protected areas and they have been gazetted as such. Other wetlands located in the forest and wildlife reserves of the Mole National Park, Black Volta, Sene, Bia and Owabi Wildlife Sanctuaries are protected too. Some wetlands, which fall outside the conserved wetland areas, are subject to traditional conservation practices such as the rivers Ankobra and Pra. The two most important lakes in the country are Lake Volta and Lake Bosomtwi in the Ashanti region..

Ghana's total actual renewable water resources are estimated to be 53.2 km^3/yr, of which 30.3 km^3/yr are internally produced (Table 3). Internally produced surface water amounts to 29 km^3/yr, while groundwater is estimated at 26.3 km^3/yr. The overlap between surface water and groundwater is estimated at 25 km^3/yr. About 22.9 km^3 of surface water enter the country annually, of which 8.7 km^3 come from Burkina Faso, 6.2 km^3 from Côte d'Ivoire and 8 km^3 from Togo.

The Akosombo Dam was completed in the mid-1960s and impounds the Volta River to form Lake Volta, one of the largest artificial lakes. The hydropower capacity of the dam is 912 MW. Lake Volta has a surface area of 8 502 km^2, a maximum depth of 91 m and a capacity of 147.96 km^3. The total dam capacity of the country is 148.5 km^3.

Water use

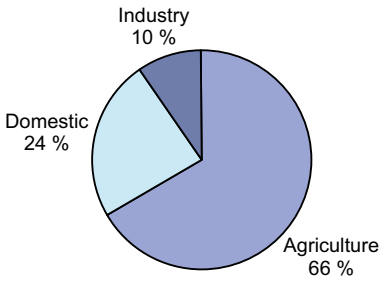
The main consumptive water uses in Ghana are for domestic, industrial and irrigation purposes. In 2000, about 652 million m^3 were withdrawn for irrigation (66 percent),

TABLE 3
Water: sources and use

Renewable water resources			
Average precipitation		1 187	mm/yr
		283.1	10^9 m³/yr
Internal renewable water resources		30.3	10^9 m³/yr
Total actual renewable water resources		53.2	10^9 m³/yr
Dependency ratio		43.1	%
Total actual renewable water resources per inhabitant	2004	2 489	m³/yr
Total dam capacity	1995	148 500	10^6 m³
Water withdrawal			
Total water withdrawal	2000	982	10^6 m³/yr
- irrigation + livestock	2000	652	10^6 m³/yr
- domestic	2000	235	10^6 m³/yr
- industry	2000	95	10^6 m³/yr
• per inhabitant	2000	50	m³/yr
• as % of total actual renewable water resources	2000	1.8	%
Non-conventional sources of water			
Produced wastewater		-	10^6 m³/yr
Treated wastewater		-	10^6 m³/yr
Reused treated wastewater		-	10^6 m³/yr
Desalinated water produced		-	10^6 m³/yr
Reused agricultural drainage water		-	10^6 m³/yr

235 million m³ for domestic purposes (24 percent) and 95 million m³ for the industry (10 percent), giving a total water withdrawal of 982 million m³ (Table 3 and Figure 1). The combined withdrawal for domestic and industry is 95 million m³ for rural and 235 million m³ for urban areas. Current water use for hydroelectricity generation (only at the Akosombo Dam), which is non-consumptive water use, is 37.843 km³/yr.

FIGURE 1
Water withdrawal
Total: 0.982 km³ in 2000



The sources of water supply in the country are surface water and groundwater. Groundwater is usually abstracted from boreholes for most rural areas. Some borehole supplies are also tapped to supplement urban water supplies. In 2000, 95 percent of the withdrawal for urban supply was from surface water and the remaining 5 percent from groundwater.

International water issues

Ghana shares three international rivers:

- The Volta River is shared by six countries: Ghana, Côte d'Ivoire, Togo, Burkina Faso, Benin and Mali. There is no mechanism to develop the Volta River together, but a permanent joint commission has been set up to discuss ways of sharing benefits and increasing cooperation for better management of the Volta river basin. Developments in the White Volta Basin by Burkina Faso affect Ghana since it is downstream. This is creating insecurity and conflict, as it is perceived to be the cause of the drop in water level in Lake Volta below the minimum operating level of the Akosombo hydropower plant. Ghana shares hydropower created at Akosombo and Kpong hydropower plants with all the riparian countries except Burkina Faso and Mali.

- The Bia River originates in the Ashanti Uplands and flows into Côte d'Ivoire.
- The Tano River, flowing parallel with the Bia River to the southeast of the latter, also has its headwaters in the Ashanti Uplands and enters the Atlantic Ocean through the Tano lagoon located in Côte d'Ivoire.

IRRIGATION AND DRAINAGE DEVELOPMENT

Evolution of irrigation development

Total irrigation potential has been estimated at 1.9 million ha. Another estimate of potential gives 0.7 million ha for small-scale irrigated sawah rice farming (bunding, levelling and puddling fields for irrigated rice cultivation) in inland valley watersheds and by including the floodplains this potential may reach 1 million ha.

The development of formal irrigation is comparatively recent in Ghana. The first scheme was initiated in the early 1960s and 22 public irrigation schemes existed in the country by 2003 (Table 4). The construction of most of the schemes was supply-driven and often emphasis was on developing exclusively smallholder plots regardless of whether interested smallholder farmers and with irrigation experience were available and willing to cultivate them. In other instances, the sources where supply purchases should be made were fixed by the donor country without the choice of buying from the cheapest source. Informal urban and peri-urban irrigation is practised in and around the big cities of the country, where the urban population provides a ready market for their produce. Informal irrigation is not new in Ghana; for example in the Kumasi area it was found that it has been practised in at least part of the currently irrigated area for more than 30 years.

In 2000, the total water-managed area in Ghana was estimated to be 30 900 ha (Table 5). In fact, this corresponds to the area under full and partial control, as no data are available for wetlands and inland valley bottoms. Nonetheless, there are reports that seasonally flooded flat valley bottoms are coming under increasing use. It is believed that overall about 27 900 ha of the total of 30 900 ha equipped, or 90 percent, were actually irrigated in 2000, while in the 22 public irrigation schemes, only 5 600 ha of the 8 587 ha equipped, or 65 percent, were actually irrigated. This is due to deterioration of the infrastructure because of lack of sufficient funds for maintenance. The bad state of the infrastructure leads to a decline in productivity which is worse in pumped schemes than in gravity-fed schemes. The cost of electricity is one reason for this. Attempts to rehabilitate the schemes are being made. It is estimated that 24 600 ha are equipped for surface irrigation, of which 8 007 ha public schemes, 4 693 ha private schemes and 11 900 ha informal peri-urban irrigation, and 6 300 ha for sprinkler irrigation, of which 580 ha public schemes and 5 720 ha private schemes (Figure 2). Surface water is primarily used to irrigate the developed areas through gravity, pumping or a combination of the two. For most of the irrigation projects in the country, dams have been constructed to store water to be used for irrigating the lands. In a few cases, weirs are built on perennial rivers for irrigation water abstraction. In most of the

TABLE 4
Public irrigation schemes in Ghana in 2000

Name of irrigation Scheme	Region	Equipped area (ha)
Ashaiman	Greater Accra Region	155
Weija	Greater Accra Region	200
Dawhenya	Greater Accra Region	400
Kpong (Right bank)	Greater Accra Region	2 700
Aveyime	Volta Region	280
Afife	Volta Region	880
Kpando Torkor	Volta Region	80
Amate	Eastern Region	60
Dedeso	Eastern Region	40
Okyereko	Central Region	40
Mankessim	Central Region	40
Kikam	Western Region	27
Akomadan	Ashanti Region	60
Anum valley	Ashanti Region	100
Tanoso	Ashanti Region	60
Sata	Ashanti Region	40
Subinja	Brong-Ahafo Region	60
Bontanga	Northern Region	450
Golinga	Northern Region	45
Ligba	Northern Region	40
Tono	Upper East Region	2 430
Vea	Upper East Region	400
TOTAL		**8 587**

TABLE 5
Irrigation and drainage

Irrigation potential		**1 900 000**	**ha**
Water management			
1. Full or partial control irrigation: equipped area	2000	30 900	ha
- surface irrigation	2000	24 600	ha
- sprinkler irrigation	2000	6 300	ha
- localized irrigation		-	ha
• % of area irrigated from groundwater	1994	0	%
• % of area irrigated from surface water	1994	100	%
2. Equipped lowlands (wetland, ivb, flood plains, mangroves)		-	ha
3. Spate irrigation		-	ha
Total area equipped for irrigation (1+2+3)	**2000**	**30 900**	**ha**
• as % of cultivated area	2000	0.5	%
• average increase per year over the last .... years		-	%
• power irrigated area as % of total area equipped		-	%
• % of total area equipped actually irrigated	2000	90	%
4. Non-equipped cultivated wetlands and inland valley bottoms		-	
5. Non-equipped flood recession cropping area		-	ha
Total water-managed area (1+2+3+4+5)	**2000**	**30 900**	**ha**
• as % of cultivated area	2000	0.5	%
Full or partial control irrigation schemes **Criteria**			
Small-scale schemes < ha		-	ha
Medium-scale schemes		-	ha
Large-scale schemes > ha		-	ha
Total number of households in irrigation		-	
Irrigated crops in full or partial control irrigation schemes			
Total irrigated grain production		-	tonnes
• as % of total grain production		-	%
Total harvested irrigated cropped area		-	ha
• Annual crops: total		-	ha
- rice	2002	5 238	ha
- vegetables		-	ha
• Permanent crops: total		-	ha
Irrigated cropping intensity		-	%
Drainage - Environment			
Total drained area		-	ha
- part of the area equipped for irrigation drained		-	ha
- other drained area (non-irrigated)		-	ha
• drained area as % of cultivated area		-	%
Flood-protected areas		-	ha
Area salinized by irrigation		-	ha
Population affected by water-related diseases		-	inhabitants

irrigation schemes in Ghana, supplementary irrigation is practised because during the wet season, it is only at some times that irrigation is required.

The water-managed area in Ghana can be categorized as follows (Figure 3):

- Public schemes: 8 587 ha. Large schemes (> 500 ha) cover 6 010 ha, small schemes (< 100 ha) 592 ha and medium schemes 1 985 ha.
- Private schemes: 10 413 ha.
- Informal peri-urban irrigation: 11 900 ha. This area refers to peri-urban irrigation in the Kumasi area only. It is believed that

FIGURE 2
Irrigation techniques
Total: 30 900 ha in 2000

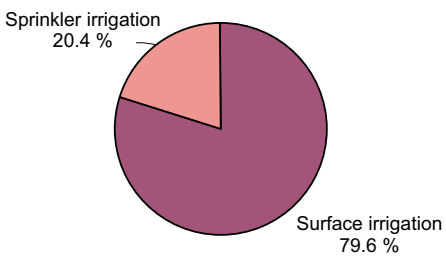
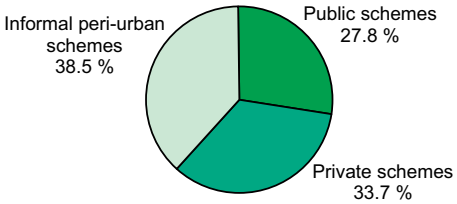


FIGURE 3
Irrigation structure - equipped area
Total: 30 900 ha in 2000



similar, extensive areas exist around Accra and Takoradi. As some of the informal irrigators use treated water illegally and others use poor quality wastewater, they tend to avoid government agencies and efforts to register them have been met with stiff resistance.

Role of irrigation in agricultural production, the economy and society

The major irrigated crop is rice, with a harvested area of 5 238 ha in 2002. Other frequently produced crops include tomatoes, okra, peppers, aubergine, sugar cane, cucumber, cowpea and maize. In peri-urban schemes, mostly vegetables are grown. Irrigated rice yields vary from 3.5 to 7 tonnes/ha. Nevertheless, the 4.6 tonnes/ha average irrigated rice yield sharply contrasts with the 1.0–1.5 tonnes/ha under uncontrolled water conditions. The mean yield of sawah rice without fertilizer application is estimated between 2 and 2.5 tonnes/ha. Farmers who grow high-value crops such as vegetables with gravity-fed irrigation usually enjoy an increase in income due to irrigation, while farmers who grow rice with pumping schemes tend to be worse off. In informal peri-urban irrigation schemes, gross income for different crop types varies widely but the average is about US$1 200/ha. In general, women are involved in sowing and harvesting whereas men control the water and weeding.

The data situation on irrigation costs is poor and only a few figures are available. The Kpong Scheme in the Greater Accra Region had a development cost of US$2 200/ha (year 2000 cost). In contrast, the Tono Scheme in the Upper East region had a development cost of US$40 000–50 000/ha. These figures may however not be representative because included in the cost are three townships that were built, a club house, a swimming pool, a tarred road network, streetlights and the cost of extending power from the nearest town to the project site. The cost of rehabilitation was found to be between US$400 and 5 000/ha. At the Dawhenya Irrigation Project the farmers are levied about US$110/ha per year as an irrigation service charge. In the specific schemes a lot of pumping is necessary, hence the high cost of the service charge, which includes the cost of power, water and minor maintenance of the system. For the Afife and Ashaiman gravity-fed schemes, the irrigation service charge is US$22/ha per year.

The operators of peri-urban schemes are usually given extension services to improve on their produce. Apart from that, however, they are unsupported and largely overlooked by policy makers. Government Authorities do not interact with them, for example:

- The Water Resources Commission (WRC) is concerned with major users of raw water using machines to lift the water, while peri-urban irrigators usually use manual means to abstract water.
- The Ghana Irrigation Development Authority (GIDA) does not interact with peri-urban irrigation operators because the schemes for which GIDA has overseeing responsibilities are the 22 formal public irrigation schemes only.

Because most of the public irrigation schemes have deteriorated and need some form of rehabilitation, they are operating at low levels of overall efficiency. Water use efficiency at conveyance and field levels is low since no concerted efforts have been made to address the problem of water losses.

Status and evolution of drainage systems

Drainage and irrigation go hand in hand in every irrigation project. However, as a result of persistent poor maintenance, the drainage system sometimes deteriorates with time. Subsurface drains are virtually absent from irrigation schemes in Ghana.

WATER MANAGEMENT, POLICIES AND LEGISLATION RELATED TO WATER USE IN AGRICULTURE

Institutions

The ministries dealing with water and irrigation include the Ministry of Food and Agriculture, the Ministry of Works and Housing, and the Ministry of Environment, Science and Technology.

In the Ministry of Food and Agriculture (MoFA), the Ghana Irrigation Development Authority (GIDA) is the main institution in charge of irrigation. It started in the early 1960s as a Land Planning Unit of MoFA, was upgraded in 1964 to become the Irrigation, Reclamation and Drainage Department (IRDD) and became the Irrigation Department in 1974. Finally, in 1977, GIDA was established by the SMC (Supreme Military Council) Decree No. 85. It is entrusted with irrigation development, provides all agricultural inputs and extension services, delivers water to the farmers and secures the repayment of credits. It is also expected to exercise management control over its irrigation dams, the associated catchment areas and over the drainage of irrigated areas and general water quality, especially within its project areas. Due to its vast terms of reference together with scarce available resources, GIDA offers poor services and its irrigation projects are often unsuccessful because of the lack of technical support.

Institutions involved in water management within the Ministry of Works and Housing (MWH) are:

- The Water Resources Commission (WRC), which is the leading institution involved in water resources management in the country. This new institution came into being in 1996 following the execution of the Water Resources Management (WARM) studies supported by CIDA, DANIDA, DFID, CfD, GTZ, UNDP and the World Bank. Prior to this date, the management of the country's water resources was fragmented among various institutions with no clear policy on who is in control.
- The Ghana Water Company Limited (GWCL), which exercises management functions over water sources that it abstracts for treatment and subsequent distribution to consumers. In some cases, it builds dams on which water supply schemes for big cities are based. It has the mandate to manage such water sources, including the relevant catchment areas for the benefit of the Ghanaian public.
- The Community Water and Sanitation Agency (CWSA), which is responsible for water supply to rural communities, including small towns. It also deals with household sanitation and hygiene promotion and has offices in all regions of Ghana.

Within the Ministry of Environment, Science and Technology (MEST), the following institutions are involved in water management:

- The Environmental Protection Agency (EPA) by virtue of its mandate and functions is one of the institutions that are involved in some aspects of water resources management. It maintains and enforces standards for wastewater discharge into water bodies. It also ensures, through the concept of Environmental Impact Assessments (EIA), that the negative impact of development projects are reduced through the monitoring of the companies' mitigation plans.
- The Water Research Institute (WRI) was formed in 1996 from the merger of the Institute of Aquatic Biology and the Water Resources Research Institute, all part of the Council for Scientific and Industrial Research (CSIR). It has a mandate to conduct research into water and related resources. In pursuance of this mandate, it generates and provides scientific information, strategies and services towards the rational development, utilization and management of Ghana's water resources in support of the socio-economic advancement of the

country, especially in the agriculture, health, industry, energy, transportation, education and tourism sectors. It engages, amongst other things, in research on groundwater resources (availability, quality, quantity), on hydrometeorological and hydrological data for planning and research, on irrigation technology, rainwater harvesting, sawah eco-technology for rice production, water management in valley bottoms for rice production and production of bio-insecticides for the control of malaria and bilharzia vectors.

Water management

Since irrigated agriculture is relatively new in Ghana, the management of the schemes had hitherto been entrusted to the staff of GIDA, and the relatively larger projects to reputable consultancy firms during the first few years after completion. A few irrigation projects in the country are operated by private companies. In the case of the Tono and Vea Schemes, they were initially fully funded by the government. In an attempt to stop continuous public funding of the schemes, the Irrigation Company of the Upper East Region (ICOUR) was established as a commercial entity. The idea was to start reducing the funding to ICOUR until it can stand on its own. Currently there is only a loose connection between ICOUR and GIDA, and ICOUR does not report to GIDA. However, it is reported that ICOUR still relies on the Central Government to provide it with funds to meet some of its recurrent expenditure, like maintenance of infrastructure, including housing. Another such company is Weija Irrigation Company (WEICO), which also operates as a commercial entity with a loose connection with GIDA. The Government intended to make WEICO operate on its own but there are financial problems. Apart from the abovementioned schemes, some other private irrigation schemes exist that have been financed by private companies.

Farmer participation in the management of irrigation projects commenced in 1987 with the passing of a legislative instrument, LI 1350, which legalized and streamlined the GIDA staff management role and incorporated farmer participation in project management.

Finances

GIDA, as the main institution in charge of irrigation in the country, has no autonomy in financial matters. Staff salaries and all other recurrent expenditures associated with GIDA are paid by the government, and the cost of services rendered by the Authority to farmers is paid to the Government. Revenue includes charges/levies for irrigation water and the cost of other inputs, such as land preparation and supply of fertilizers and pesticides. The fees charged are generally not enough to cover the full cost of irrigation water delivery, including all the management and the infrastructure that is in place. Subsidies on agricultural inputs have been withdrawn as part of IMF conditions for financial assistance to the country. This applies to both rainfed and irrigated agriculture. Generally, lack of capital has been one of the major problems hampering irrigation development in the country. Impounding water for irrigation through large dams has proved too expensive.

Policies and legislation

Ghana's agricultural policy is driven by five key objectives: i) ensuring food security and adequate nutrition for the population; ii) promoting the supply of raw materials for other sectors of the economy; iii) contributing to export earnings; iv) increasing the employment opportunities and incomes of the rural population; v) generating resources for general economic development. The importance of water in the realization of these objectives is well known. The key issue in the development and utilization of the water resources of the country is to ensure sustainability while giving preference to domestic water requirements if there are competing uses of the resource.

The policy reform strategy within the irrigation sub-sector is to increase agricultural production through the development of water resources for irrigation. This is being done by: i) limiting the cost of irrigation projects to not more than US$600/ha; ii) recovery of at least operation and maintenance costs; iii) handing over the management of projects to farmers' associations; iv) involving farmers from the inception and selection of technologies through to the decision-making stages of irrigation projects; and v) a contribution of between 10 and 25 percent of project costs by beneficiary communities or associations for small-scale projects.

The Draft Water Policy identifies the availability and ease of access to water in sufficient quantities for cultivation of food crops, watering of livestock and sustainable freshwater fisheries as a major precondition for the achievement of food security and self-sufficiency in food production to meet the nutritional needs of the population. Towards achieving this, the Government promises to:

- Support the establishment of micro-irrigation and valley bottom irrigation schemes among rural communities.
- Strengthen district assemblies to assume a central role in supporting community operation and maintenance of small-scale irrigation and other food production facilities.
- Promote partnerships between the public and private sector in the provision of large commercial irrigation infrastructure.
- Encourage the efficient use of fertilizers to reduce pollution of water bodies, as well as high–yielding crop species and agricultural extension services to ensure conservation of water.
- Promote and encourage water use efficiency techniques in agriculture and reduce transmission losses of irrigation water in irrigation schemes.
- Manage land use and control land degradation, including bush fires, to reduce soil loss and siltation of water bodies.
- Develop a pricing system and a mechanism for delivering irrigation water that is affordable for farmers and also ensure cost recovery on investments made in infrastructure.
- Utilize data and information on water cycles, land cover/use, soils and socio-economic elements for the planning, design and development of agricultural schemes.

From the above it is clear that the current irrigation policy of the country emphasizes small-scale irrigation schemes. Farmers are expected to form cooperatives and they are to be involved at the inception stage of projects and to be trained and assisted to operate and manage the systems themselves, unlike in past years when management was largely in the hands of GIDA.

ENVIRONMENT AND HEALTH

Water quality in the country is generally good, especially for irrigation purposes, and the impact of irrigation on water quality is not significant, probably because of the limited extent of irrigation. However, there are isolated problems associated with pollution not necessarily related to irrigation directly but from general agricultural practice. In the Akomadan area, where irrigated tomato farming is practised, there are reports of pesticides in the water and in the soil in the vicinity of the irrigation site because of the application of pesticides. Many of the water sources used for peri-urban irrigation, at least in the Kumasi area, are heavily polluted. Use of water with levels of microbiological pollution well above WHO guidelines for irrigation is commonplace and therefore both growers and consumers are at risk from bacterial and helminth infections. The increasing use of seasonally flooded flat valley bottoms poses problems of water pollution for domestic use downstream.

Groundwater pollution is not widespread and is limited to some agricultural sites which are not necessarily irrigation sites. However, cases of high levels of nitrate and phosphate concentrations have been reported, especially near agricultural sites. In some areas, the occurrence of salt in groundwater is a major problem and this limits its utilization for irrigation purposes.

Mining is predominant in the southwestern river system and in this area pollution of surface water and groundwater has been observed because of the use of cyanide and other poisonous chemicals.

Siltation is a cause for concern in most dams and reservoirs. However, very few studies have been carried out to establish what percentages of the various dams have been silted up. In the case of Lake Volta it is not known how much of the dead storage has been lost to siltation. The siltation volume in Weija Reservoir is not known either, but initial studies carried out prior to its construction concluded that after 50 years of operation less than 1 percent of the volume of the dam would be lost to siltation.

The positive impact of irrigation includes improved access to food and hence better nutrition to some extent, though this effect is limited since irrigation contributes less than 3 percent of the country's food production. Some families have higher incomes because of the use of irrigation facilities. On the other hand, the incidence of waterborne, water-based and water-related diseases increases in areas where irrigation projects are sited. No specific studies have been conducted to establish the percentage of the population affected.

PERSPECTIVES FOR AGRICULTURAL WATER MANAGEMENT

Irrigation development in Ghana started relatively late, in the 1960s. In those days big irrigation schemes were the order of the day. However, heavy investments in irrigation in some of the few big schemes that exist have failed to live up to expectations, as these schemes did not do well after some time due to problems of maintenance and improper management and operation, which resulted in the rapid deterioration of most of the schemes and a large sum of money is now needed to rehabilitate them.

Emphasis has shifted away from big schemes towards small schemes that could be farmer-managed. However, an approach that recognizes that irrigation requires a new production culture is needed. A deliberate effort must be made to re-introduce irrigation to the Ghanaian farmer in a user-friendly manner. In each case, hands-on training in irrigation must be first delivered to farmers for a minimum of a year's production cycle or at least two harvests before they are allowed to continue on their own.

The Ghana Poverty Reduction Strategy 2003-2005 (GPRS) mentions irrigation development and rehabilitation of existing viable facilities to attract private sector management as part of its package of infrastructure enhancement. Financial support within the GPRS (total budget for modernizing agriculture: US$84.1 million) will be directed to vigorous promotion of mainly small-scale irrigation, which communities and districts can easily construct and maintain. Other priority activities are mechanization and promotion of fishing hatcheries. The GPRS approach to the irrigation sub-sector development can be viewed in two categories, i.e. with regard to micro- and small-scale irrigation and with regard to medium- and large-scale schemes.

With regard to micro- and small-scale irrigation, the GPRS will focus on:

- Development of valley bottoms in order to utilize waterlogged river valleys for cultivation of food and other crops by using wet season soil water;
- Provision of small dugouts, boreholes, tube–wells and other simple structures especially in the three northern regions and the Afram Plains;
- Rehabilitation of all viable irrigation facilities;
- Use of a minimum of machinery and more labour to generate employment in construction works;

- Introduction of some non-traditional exports such as mangoes, pawpaws, cashew nuts, and ginger.

Regarding medium- and large-scale irrigation, the GPRS foresees the construction of major dams, pumping stations, diversion structures, canals and long distance conveyance pressure pipe systems. These facilities are to be provided purposely for commercial operators and investors.

Agricultural water use is expected to increase significantly in the future once the funding required for new scheme developments has been mobilized. But because of the high cost of investment in irrigation schemes, the cost of water delivered to farmers would be high.

The water demand for the year 2020 was estimated by population projection and projected areas to be irrigated by then, also assuming the following:

- Covering 100 percent of the rural population with potable water by 2020.
- Rehabilitating existing small- and medium-scale irrigation projects with a total area of 3 500 ha.
- Rehabilitating 44 and 20 dams in the Upper East and Upper West regions respectively.
- Developing 20 stock watering points in the Upper West and Northern regions to support the livestock development projects.
- Surveying, designing and developing 1 000 ha of small-scale irrigation projects in the northern and southern parts of the country where rainfall is deficient, provision of potable water and irrigation water supply for selected agricultural sector investment projects.
- Developing 3 000 ha of large-scale irrigation downstream of Kpong hydropower project.

Based on these assumptions, the projected future annual water demand by 2020 is 617 million m^3 for irrigation, 32 million m^3 for livestock and 463 million m^3 for rural and urban water supply (domestic and industrial). This represents about a 130 percent increase in present water use. Groundwater abstraction is projected to increase by 69 percent in order to meet the water demand in 2020.

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