



## Modernized Irrigation Technologies in West Africa

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### ABSTRACT

Crop production in West Africa is mostly dependent upon rainfed agriculture. Irrigation is a vital need due to uneven distribution of rainfall and seasonality of water resources. However, management and sustainability of irrigation are under risk due to notably weak database, excessive cost, unappropriate soil or land use, environmental problems and extreme pessimism in some quarters since rainfed agriculture is seen as potentially able to support the present population. This paper focuses on modernized irrigation technologies and systems that utilize less water. Information about irrigation systems in Ghana and Liberia were gathered through: 1) Irrigation development authorities in both countries, by reviewing past literatures, online publications, reports and files about irrigation in West Africa, specifically Ghana and Liberia; 2) International Food Policy Research Institute (IFPRI); 3) Collation of information, reports and data from Ghana Irrigation Development Authority (GIDA) and 4) International Water Management Institute (IWMI). The result shows that both countries have higher irrigation potential. However, the areas developed for irrigation is still a small portion as compare to the total land available for irrigation. On the other hand, as seen in the result, Liberia as compare to Ghana has even low level of irrigation development.

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## Batı Afrika'da Modernize Sulama Teknolojileri

### MAKALE BİLGİSİ

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### ÖZET

Birçok Batı Afrika ülkesinde ekonominin temel ögesi olan tarım, genellikle doğal yağışlara dayalıdır. Bu ülkelerde sulu tarım son derece kısıtlı olmakla birlikte, doğal yağışların düzensizliği ve mevsimselliği sulamayı zorunlu kılmaktadır. Ancak, yetersiz veri tabanı, yüksek maliyetler, toprakların amaç dışı kullanımı, çevresel problemler ve kuru tarımın nüfusu beslemeye yeteceği algısı gibi nedenlerle sulama sistemlerinin geliştirilmesi, yönetimi ve sürdürülebilirliği tehdit altındadır. Bu çalışmada; Batı Afrika'da daha az su kullanan sulama sistemlerinin geliştirilmesi ve yenilenmesi üzerinde durulacaktır. Ayrıca, sulama projelerinin sosyal, ekonomik ve çevresel etkileri üzerinde de durulacaktır. Çalışmada; sulama projelerine ilişkin bir dizi modernizasyon ve optimizasyon yöntemi tartışılacaktır. Bu çalışma için Batı Afrika'da özelde ise Gana ve Liberya ülkelerinde sulamaya ilişkin geçmişte yapılmış tüm çalışmalar taranacaktır. Gana ve Liberya'da sulama sistemlerine ilişkin bilgiler; 1) Her iki ülkede sulama hizmetlerinden sorumlu kamu kurumları; 2) Uluslararası Gıda Politikası Araştırma Enstitüsü (IFPRI); 3) İlgili tüm literatürün taranması ve 4) Uluslararası Su Yönetimi Enstitüsü (IWMI) ve diğer kaynaklardan elde edilen veri, bilgi ve raporların derlenmesi sonucunda oluşturulacaktır.

## Introduction

The role of irrigation in increasing agricultural production is well recognized. Over 324 million hectares or 21% of the world's croplands are irrigated (FAO, 2016). This land produces one-third of the world's food. At present, almost three-quarters of the world's irrigated area is in developing countries. Increased irrigated area and the technological innovations brought along with the Green Revolution enabled Asia to achieve food self-sufficiency.

Since the 1950s, the total irrigated area in the world expanded rapidly. Between 1961 and 1990, the area under irrigation increased by almost 100 million hectares. The annual growth rate of irrigated area exceeded 2% during the 1960s and 1970s. Today, the growth rate worldwide has slowed down to a moderate 0.8%. Between 1961 and 1990, the irrigated area in Asia expanded by 70 million hectares (FAO, 1992).

Within the context of national agricultural and water policies, that reflect a wide range of economic, political and environmental considerations and stakeholder interests, many irrigation schemes worldwide suffer from poor management, both in its technical and social dimensions. This often leads to unsustainable practices with decaying infrastructure and a reluctance of users to contribute to their maintenance. Many irrigation schemes are caught in downward cycles of poor maintenance, poor water delivery performance and dwindling agricultural productivity and profits.

The traditional agricultural systems based on the cultivation of crops, mainly for home consumption, have to be transformed into a more diversified system with higher agricultural inputs and to be market oriented. To feed growing population and support farmers' welfare and rural development, these objectives should be more encouraged and supported.

Considering the constraints regarding the availability of cultivable lands, there is no other way than to make water use more efficient in already irrigated areas, shifting its pattern from seasonal to year-round supply.

It is not only irrigation that needs more water. Due to the rapid urbanization and industrialization, the competition of water use between irrigation and other water users will become a focal point because they have to share limited water resources.

One major task of the irrigation sector will, therefore, be to reduce water losses and to achieve equitable water delivery. Modernization of irrigation schemes will, therefore, be an essential part of the solution. Modernization aims at improving a system so that farmers are able to control water at minimized losses. However, modernization is not only a physical improvement of the system but also includes institutional reforms to sustain their performance.

It has meanwhile been recognized that human capacity building is a key prerequisite for better operation and maintenance. As far as controlling water in open canal systems is concerned, this is not always the case. When water scarcity occurs, intensive management takes place. Good operation usually requires a lot of labor. The poorer the irrigation system is functioning, the more labor will be required. However, when enough water is available, farmers don't care much of controlling water and

withdraw their labor input from the operation. That is because they have no direct benefit from saving water. In other words, the farmer who can take enough water has no real incentive to save it. Therefore, physical improvement of the system through modernization has to go along with transferring management responsibilities to the farmers in order to change this attitude.

Nevertheless, many countries, except Japan and Korea, are still reluctant to modernize old systems saying that it is very costly and that expansion of irrigation is more important than modernization. However, water availability is getting tighter in many basins. Competition with water users is mounting, which might threaten water use for irrigation. Therefore, effective water use achieved by modernization has the same effect as the development of new water resources. If comparing the costs for new water resources development such as the construction of dams and reservoirs, modernization will often be more favorable.

As already mentioned before, modernization has to go along with institutional reforms. For raising funds, integrated development with municipal water suppliers is recommendable. Water Users Associations should be strengthened so that they will be accountable for the management of the irrigation system. Modernization will make it possible to introduce adequate water fees for not only O&M but also for some parts of capital cost recovery because modernization of irrigation systems results in remarkable returns to farmers including equitable and rational water delivery, water security and labor saving for operation (FAO, 1992).

Many governments, donors, and investors rallying around the New Partnership for Africa's Development (NEPAD) share the basic premises that rapid growth in agriculture is required in sub-Saharan Africa (SSA) to meet the ambitious Millennium Development Goals (MDGs) and other agreed targets for poverty alleviation and food security. Many, but not all, also agree with the premise of NEPAD's Comprehensive Africa Agriculture Development Programme (CAADP) that since irrigation and other forms of water management for agriculture are prerequisites for agricultural intensification, much of the required growth will depend on new investment in this sector, and that if SSA is to meet its poverty reduction and food security targets, investment must be increased substantially, and innovative approaches to agricultural water development that enhance prospects for sustainable returns on investment must be found (Brüntrup, 2011).

High irrigation investment costs together with declining world food prices and the perceived failures of many past irrigation projects are believed to be the main reasons for reluctance of international financial and development agencies and SSA governments to invest more resources in irrigation. There is no doubt that water is one of the most important inputs in agricultural production in both Ghana and Liberia apart from labour. More importantly, almost all agricultural production depends on natural rainfall. Because of this situation, crop yields are invariably poor when the rains fail, come too early or too late since there can literally be no control over this important input.

This paper discusses concepts of modernization of irrigation systems. Modernization is understood as a process of change from supply oriented to service oriented irrigation. The process involves institutional, organizational and technological changes. Modernization in that sense is a response to current trends from protective to productive irrigation. The paper discusses strategic choices with an emphasis on technological options and presents an outline for a plan of action on modernization.

## Materials and Methods

### *Choice of Technology and Maintenance of Infrastructure*

Experience in many parts of sub saharan Africa has shown that with adequate community involvement in planning, design and management, small irrigation schemes can be more viable and sustainable than conventional large-scale schemes (Merrey et al., 2002). Top-down implementation process mostly leads to non-acceptance of irrigation schemes by farmers. A classic example is the Meki-Ziway Scheme in Oromia, Ethiopia, which failed largely because farmers could neither get spare parts for the imported pumps nor afford the electricity fee to run the pumps. For sustainable schemes, irrigation technologies must match the capacity of the users (Awulachew et al., 2005). In addition, designs must fit other user conditions such as climate, soil types, crops to be cultivated and method of management of irrigation infrastructure. One of the biggest constraints is that there are few experts who can fine-tune all these elements in a design to actually work in practice.

The reason for poor maintenance as identified by Sijbrandij and van der Zaag (1993) are; (1) restriction on cost of maintenance of irrigation schemes; (2) neglect of duty by maintenance sections; (3) lack of accountability; (4) lack of channels for expressing water users opinion on canal maintenance problems; (5) informal participation of farmers in maintenance and (6) apathy from water users due to the perception that they are not responsible for care of the facility.

### *The Structure of the Irrigation Sector in Ghana*

The policy in a Ghana recognizes three principal categories of irrigation and with their specific opportunities and constraints (Ghana Irrigation Development Authority, 2011):

- (a) Informal [smallholder] irrigation,
- (b) Formal irrigation, and
- (c) Large Scale Commercial Irrigation.

*Informal irrigation:* This may be defined as irrigation practiced by individual who cultivates an area of up to about 0.5 ha or more by using simple structures and equipment for water storage, conveyance and distribution. This includes: Watering cans, Flooding, Motorized pumps with hose, etc.

*Formal irrigation:* Formal irrigation may be defined as one that is reliant on some form of permanent irrigation infrastructure funded by the public sector.

*Large scale or commercial irrigation:* This category of irrigation falls actually under both formal and informal subsectors. Large scale commercial irrigation is formal

when Government provides the water supply, conveyance, and primary distribution infrastructure, while the private investor provides secondary distribution and water application machinery and equipment.

### *Typology of Irrigation Systems*

The irrigation system typologies observed Sub saharan Africa, especially Ghana and Liberia may be broadly classified into two groups based on their current level of formalization. These are (1) the conventional systems, which are mainly initiated and developed by the Government of Ghana or various non governmental organizations (NGOs); and (2) the emerging systems (Obuobie et al., 2006).

Ghana's irrigation systems may be classified into four major typologies based on such criteria as ownership/management, source of water, type of infrastructure or technology involved, and source of power for abstracting, conveying, and distributing water (Namara et al., 2010, Namara et al, 2011). These are:

- Public systems,
- Small reservoirs and dugouts,
- River/lake lift private systems,
- Groundwater systems.

These four typologies can be subdivided:

- Public-owned surface irrigation systems;
- Public-private partnership commercial systems;
- Small reservoir- and dugout- based systems;
- Private- or group-based river-lift systems;
- Groundwater-based irrigation systems; and
- Lowland/inland valley rice water capture systems.

## Results and Discussion

Although irrigation in Africa has the potential to boost agricultural productivities by at least 50 percent, food production on the continent is almost entirely rainfed. The area equipped for irrigation, currently slightly more than 13 million hectares, makes up just 6 percent of the total cultivated area (Figure 1). The study shows irrigation technologies mostly used in Sub-Saharan Africa, especially Ghana includes watering can, which was about 55.1% followed by motorized pump with hose which was 29.0% and finally flooding system which was also 15.9% as it was given in Table 1. In Liberia, the main water user was agriculture with 60 million m<sup>3</sup> /year (57%), followed by the domestic sector with 30.4 million m<sup>3</sup> /year (28%) and industry with 16.4 million m<sup>3</sup> /year (15%) (Figure 2). In 1987, the total water managed area was 20 100 ha, comprising 100 ha equipped for full or partial control irrigation, consisting mainly of small development projects supported through international or bilateral cooperation; 2 000 ha of equipped wetlands and inland valley bottoms, mainly cropped with rice; and 18 000 ha of non-equipped cultivated wetlands, swamps and inland valley bottoms (Figure 3).

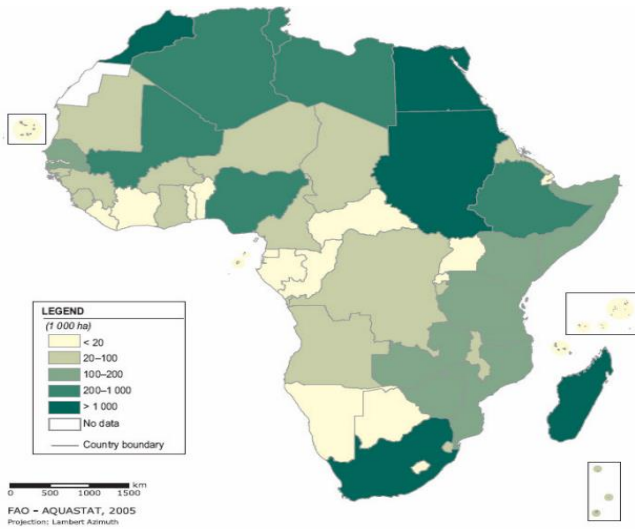


Figure 1 Irrigation in Africa (FAO, 2005)

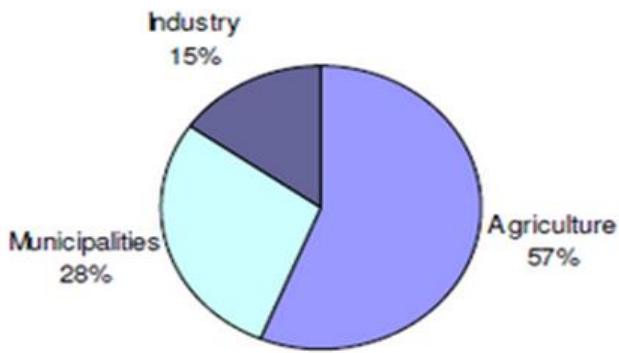


Figure 2 Water withdrawal (Liberia), (FAO, 2016)

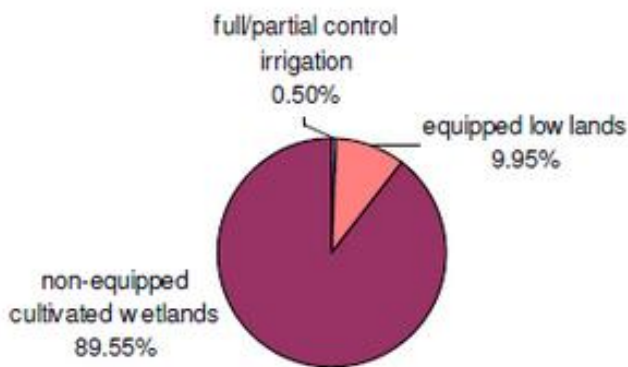


Figure 3 Distribution of the water managed areas (Liberia) in 1987 (FAO, 2016)

Table 1 Irrigation technologies used and mostly used by respondents (Ghana)\*

Irrigation technology	Used		Mostly used	
	F	P	F	P
Watering can	90	84.1	51	55.1
Flooding	17	16.8	17	15.9
Motorized pump with hose	34	31.8	31	29.0

\*(Akuffo and Irene, 2013), F: Frequency, P: Percent,

The study also showed that both Ghana and Liberia have higher irrigation potential, as shown in Table 2, but less is done when it comes to irrigation development. Ghana has a total land area of irrigation area of 23.854.000 ha and cultivable area of 10.000.000 ha, but at the year 2002 the cultivated area was 6 331 000 ha with an irrigation potential area of 1 900 000 and irrigation potential in percentage of cultivable area as 19%. As compared to Liberia with an area of 11.137.000 ha, and an irrigation potential area of 600.000 ha, and irrigation potential in percentage of cultivable area as 12%.

The study further shows area under irrigation and full/partial irrigation control techniques used between 2000 in Ghana and 1987 in Liberia (Table 3 and Table 4). According to the FAO Aquastat survey (2005), the area under full/partial control in Ghana was 30 900 ha in 2000 while in Liberia it was estimated at 100 ha. It is also noted that in Ghana area used for surface irrigation was 24 600 ha, for sprinkler irrigation 6 300 ha while the data on localized irrigation was not complete. However, data on irrigation techniques for Liberia were not provided due to civil war in the country. Therefore, no up-to-date information on irrigated areas in Liberia is available.

### Conclusion and Recommendations

It is efficiently proven that modernized, well designed irrigation technologies improves crop yield. However, in West Africa especially Ghana and Liberia, there is still a lot that needs to be done in terms of improving infrastructure for water to meet modernized standard for irrigation. Additionally, organizing Water Users Association (WUA) for management, operation and maintenance of these projects at the county or district level will improve functionality if the systems are to be established. As to further promote water management, legislation, law reinforcement, research and establishment of education centers, tariff policy and stakeholder's capacity building are factors for improvement. If the end users' problems are addressed in the development and rehabilitation of the irrigation project, this will increase their interest for careful monitoring of their systems. Capacity building for farmers through training will improve their knowledge on selection, management, operation and maintenance of the irrigational structure thereby enhancing their functionality. Education and training of staffs, that are able to design those systems while taking into account the project management issues and capabilities of farmers will meet project goals and natural, cultural and economic condition of the end users. Finally, the absence of recent data on irrigation activities is one of the major drawdown in determining the extent of how much has been achieved in term of modernizing irrigation technology especially in Liberia. Therefore updating data on irrigation will improve debate on irrigation. Based on the above mentioned, the following have been recommended:

- Farmers need to be educated to desist from old farming methods, and employ modern farming strategies that will help to improve agricultural productivity.

- Most irrigation systems in Ghana and Liberia belong to government not individual due to the high cost of irrigation equipment in both countries. Governmental or non-government organizations can support individuals or cooperatives financially, so that after harvest they pay back their money.
- Research institutions should improve research in the area of irrigation, especially in Liberia, which will include studies on how much has been achieved and how much needs to be done in achieving modernized technologies in both countries so as to boost food production.

Table 2 Land use and irrigation potential\*

Area	A	Country	
		Ghana	Liberia
Total Area	AR	23.854	11.137
	PC	1.12	3.19
Cultivable Area	AR	10.000	-
	PC	0.47	-
Cultivated Area (2002)	AR	6.331	600
	PC	0.30	0.17
Irrigation potential	AR	1.900	600
	PC	19	12

\*(FAO, 2005), A: Area, AR: Area (x10<sup>3</sup>ha), PC: Per capita (ha/person)

Table 3 Area under irrigation\*

Area	Country	
	Ghana	Liberia
Year	2000	1987
Full/partial control irrigation (ha)	30.900	100
Spate Irrigation (ha)	-	-
Equipped Lowlands (ha)	-	2.000
Total Irrigation (ha)	30.900	2.100
Cultivated Area (%)	0.5	0.3
Part of equipped area irrigated (%)	90	-
Annual increase Rate (%)	30.1	-

\*FAO, 2005

Table 4 Full/partial control irrigation techniques\*

Full/partial control irrigation equipped area (ha)	Country	
	Ghana	Liberia
Year	2000	1987
Surface irrigation	24 600	-
Sprinkler irrigation	6 300	-
Localized irrigation	-	-

\*(FAO, 2005)

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