PRINT: ISSN 0970-9274 ONLINE: ISSN 2456-6608
J Hum Ecol, 73(1-3): 102-115 (2021)
DOI: 10.31901/24566608.2021/73.1-3.3306

Irrigation Water Management Practices in Upper West Region of Ghana: Prospects, Challenges and Mitigation Measures

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KEYWORDS Agriculture. Food Security. Irrigation Water Scheduling. Operation and Maintenance. Productivity

ABSTRACT Water is vital for agricultural production especially in arid areas like the Upper West Region (UWR) in Ghana. The management of water resources for irrigation is therefore paramount. Irrigation Water Management (IWM) Practices and their potential for boosting agricultural productivity and food security in UWR are examined in this paper with focus on three purposively sampled irrigation schemes at Sankana, Busa and Yelayiri. Thirty sampled members of Water User Associations (WUAs) and leaders from each of the schemes were interviewed for their views on IWM practices and challenges. Additionally, 10 agricultural experts also provided their views. The quantitative data were analysed with SPSS whiles the qualitative information was subjected to content and discourse analyses. Crosstab correlation helped to determine the relationship between WUAs/farmers' IWM practices and the performance of the schemes whiles pairwise ranking helped to reveal the severity of IWM challenges and appropriate measures recommended for fixing them.

INTRODUCTION

Water is important for the survival of all living organisms. It contributes significantly to the socio-economic development of every country. Water is used for crop production, aquaculture and livestock watering among others. Water thus, plays key roles in providing security for good crop harvests and conservation of biodiversity. However, water has come under serious threats over the years. To avoid a global water crisis, farmers will have to strive to increase productivity to meet growing demands for food, while industry and cities find ways to use water more efficiently.

Successful agriculture is dependent upon farmers having sufficient access to water. However, water scarcity is already a critical constraint to farming in many parts of the world (Siala et al. 2017). According to the United Nations (2018), the world's water resources are being depleted at an alarming rate and this will leave the bulk of the population without access to water for drinking and other uses in 30 years' time. This is likely to affect availability of irrigation water, which is crucial in mitigating the harsh climatic effects and facilitate all-year-round agriculture, especially in the five northern regions of Ghana where seasonal long dry periods are experienced annually. The increasing climate change impacts and the associated water availability and quality challenges, make sustainable management of irrigation water a vital prerequisite for agricultural production.

Despite the fundamental importance of irrigation water, its management in Ghana is constrained by multi-faceted challenges, which are gravely affecting the performance of most irrigation schemes in the Upper West Region (UWR). For instance, vital information which serves as baseline data on irrigation water management (IWM) practices in the region, is disjointed and inaccessible mainly

because of ineffective coordination among key actors. This is a major factor that accounts for poor IWM outcomes, which probably leads to widespread food and nutrition insecurity and abject poverty in rural communities in the 5 northern regions of Ghana.

Objectives

The main objective of this paper therefore, is to explore irrigation water management (IWM) practices in UWR of Ghana with a specific focus on its prospects to support livelihoods, ensure food and nutrition security and reduce poverty. The fundamental challenges confronting IWM practices are identified, discussed and appropriate mitigation measures recommended for solving them. To investigate the feasibility of achieving the objective of the paper, the authors searched for answers to four pertinent questions frequently posed by sustainable development stakeholders in Ghana: a) What are the key IWM practices in UWR?; b) What are the prospects of using IWM to support livelihoods, ensure food and nutrition security and reduce poverty in arid areas like UWR?; c) What challenges affect IWM practices in the region?; d) How can these challenges be effectively mitigated in the region to boost agricultural productivity, food and nutrition security and poverty reduction?

Literature Review

Irrigation Water Management

The need to efficiently manage irrigation water resources is receiving lots of attention globally in recent times. This is due to the increasing incidence of climate change, high demand from population growth, over-exploitation/environmental concerns, water scarcity and increasing production costs. According to Klausmeyer (2012), "Irrigation water management is the act of timing and regulating irrigation water application in a way that will satisfy the water requirement of the crop without wasting water, energy, and plant nutrients or degrading the soil resource". MDM Landscapes (2019) indicated that IWM will be used for more extensive properties that need a system to help manage the volume, rate, and timing of water application in order to match with water holding capacities and soil intake and to promote optimum crop yields, and its especially important to monitor soil moisture without runoff or deep percolation losses.

FAO (2015) observed that although irrigation is regarded as the key to achieving increased agricultural production and attaining food security, most rural communities in Africa do not have enough capacity to reach their irrigation potentials. To ensure sustainability of agriculture, water must be used according to crop-water requirement in volumes that can be retained by the soil and at rates that agree with the intake properties of the soil. It is therefore important to assist irrigators to understand how to conserve water and avoid the negative human activities that lead to water wastage. In addition, the managers and beneficiary farmers of irrigation schemes in Ghana and UWR in particular should be properly trained in the evaluation of IWM practices and in preventing wastage of water by strictly implementing planned irrigation schedules.

Sustainable Irrigation Water Management

IFPRI (2001) indicated that sustainable IWM should simultaneously achieve two objectives: a) sustaining irrigated agriculture for food security and b) preserving the associated natural environment and also a stable relationship should be maintained now and in the future between irrigated agriculture and natural environment by mitigating conflicts through appropriate practices. Nkrumah et al. (2014) observed that the complex spatial climate variability in Ghana makes the implementation of climate change mitigation and adaptation strategies difficult. In addition, climate change will continue to exert pressure on freshwater resources through rising temperatures, changing rainfall patterns and increasing rates of floods and droughts (European Environment Agency 2017). Hammond Murray-Rust and Fakhruddin (2014) observed that population growth rate of about 3 percent per annum in rural areas in West Africa implies that twice as much drinking water would be required in 25 years. These challenges have catalysed stakeholders to craft plans for harnessing runoffs during the rainy season so that farmers would not have to wait for 8 months before engaging in farming activities. Effective IWM practices would ensure that water for irrigation is well sustained for crop production. Sustainable IWM is aimed at sustaining irrigation to ensure food and

nutrition security while at the same time preserving the natural environment, United Nations General Assembly (2015). These two objectives cannot be mutually exclusive; they must be attained together.

According to Twerefou (2013), the sustainability of water resources in Ghana and most West African countries is quite precarious. Surface water bodies such as rivers and lakes that were hitherto perennial are drying up at an alarming rate due to negative human activities such as uncoordinated and over-extraction of groundwater, pollution of water sources and deforestation, which are fuelling intense competition and conflicts over scarce freshwater resources (Steward et al. 2012). These activities are significantly altering the flow regimes of surface water systems, which serve as source of recharge of irrigation dams and groundwater flow systems. Cosgrove and Loucks (2015) observed that poor water distribution and usage during the past decades have largely been attributed to the perception that water is a free good from nature. Most people in local communities in Ghana regard water projects as social interventions provided by the government and non-governmental organisations (NGOs) to alleviate poverty. The prevailing mentality is that provision of water is the responsibility of governments and NGOs and they clearly have no sense of ownership of water projects in local communities. To ensure sustainability of water resources requires the commitment of all stakeholders and implementation of resilient adaptation measures by all concerned. Brandshaug (2019) stressed that the key stakeholders and the population in general need to change their perceptions about water being a free commodity and put value to it. In line with this, significant progress in water resources management, pragmatic policies ranging from water abstraction to disposal and more efficient use and management systems need to be adapted. This requires effective sensitization and awareness creation programmes to educate the farming population and other users on best water management practices, including appropriate conflict resolution mechanisms to reconcile the needs of upstream and downstream water users. In addition, it is important to find effective ways to make water accessible at reduced cost for farmers working on irrigation schemes and to strengthen the management and technical capacity of water providers and users.

Factors Affecting Sustainable Irrigation Water Management in Ghana

For IWM in UWR to be sustainable, a number of important factors require effective management. The key factors are briefly discussed in the following sub-sections.

i. Irrigation Water Management Policy Issues

Ghana receives a considerable amount of rainfall annually, but its frequency, intensity and distribution are unreliable. Though a number of small dams are being constructed, no long-term plans have been instituted to developed large-scale project to store excess rainwater for irrigation and other purposes, especially in arid regions like UWR in northern Ghana. These huge volumes from runoffs are allowed to go waste, and cause flooding and destruction of farmlands and other properties. In line with this, Ghana Irrigation Development Authority (GIDA) was established to play a leading role in the irrigation water development and management (MoFA 2011). Namara et al. (2011) indicated that GIDA is the only public organisation linked directly to irrigation development, management and dissemination of improved technology among farmers. However, the performance of the irrigation sub-sector over the years, has seriously been hampered by problems such as a) inadequate maintenance of irrigation infrastructure; b) high O and M costs mainly due to high electricity tariff for pump irrigation schemes; c) poor access roads to markets and farms; d) encroachment on farmlands; and e) illegal mining activities on a number of irrigation sites.

In order to address the irrigation sub-sector challenges in Ghana, the National Irrigation Policy, Strategies and Regulatory Measures document was developed in 2010 and promulgated in 2011 (MoFA 2011). The policy is to regulate the development and management of irrigation in Ghana. In 2012, *the Ghana Agricultural Water Management Pre-Investment Reform Action Framework,* a diagnostic study of the irrigation sub-sector by Nyamadi et al. (2012), identified additional challenges including low recovery of Irrigation Service Charge (ISC) from farmers and inadequate government budgetary allocation among others. These challenges stifled investments in the irrigation subsector and to effectively address them, the study

recommended implementation of Restructuring and Modernization Programme (RMP) of GIDA and the irrigation sub-sector which started in 2015.

ii. Participation in Irrigation Water Management

Sustainability of irrigation water provision needs a participatory and holistic approach by policy-makers, planners and managers of the governance of water resources at all levels; local, regional, national and international. Buuren et al. (2019) indicated that effective participation only takes place when the stakeholders are part of the decision-making process. To take this a step further, Zugravu and Rahoveanu (2010) stressed that effective participation occurs if democratically elected or accountable agencies or spokespersons represent various stakeholder groups. Participation in decision-making can also take place through market processes such as when appropriate pricing systems are in place and local governments, community organisations and irrigation managers at the regional level signal their demands for bulk water services. An integrated approach to irrigation water management that promotes active participatory planning and implementation processes requires bringing all stakeholders on board. This will equip them with ideas to determine how to meet society's long-term needs for water resources and maintain essential ecological services and socio-economic benefits. The establishment of Water Users' Associations (WUAs) for irrigation schemes gives greater responsibility to farmers to manage and maintain smallholder irrigation schemes in Ghana. The integrated approach to Integrated Water Management (IWM) is informed by the principles of integrated water resources management (IWRM) of a river, lake or basin, which is known as integrated river basin management (IRBM). Evers (2016) observed that the IRBM approach advocates managing a river and its entire catchment as a single system and coordinating the activities of all stakeholders in the basin and along the river.

iii. Infrastructure and Irrigation Water Management

Irrigation infrastructure such as head works, conveyance and drainage play important roles in irrigation water management and sustainability of irrigation schemes. Namara et al. (2011) indicated that irrigation infrastructure is used for multiple purposes including livestock watering, crop production and fishing. Therefore, infrastructure that is robust and can stand the test of time are important for farming activities in the UWR. International Water Management Institute (2010) indicated that GIDA together with the Ministry of Food and Agriculture (MoFA) from inventory surveys conducted on existing dams identified 360 small dams and 560 dugouts in the northern regions. Out of these, 84 small dams and 54 dugouts are located in the UWR. These small dams include Busa, Yaleyiri, and Sankana irrigation dams, which are in the study area. In recent times, a number of dams have been constructed in UWR under projects such as Small-Scale Irrigation Development Project (SSIDP) and Ghana Social Opportunities Project (GSOP) under the supervision of GIDA. The dams include Tono and Vea in the Upper East Region (UER) and Bontanga in the Northern Region (NR) irrigate 2,450ha, 500ha and 390ha respectively (Namara et al. 2011). These irrigation infrastructures are associated with a lot of benefits such as all-year-round farming and other indirect job opportunities in the rural communities. These benefits motivated the government to introduce the construction of more dams and irrigation infrastructure in northern Ghana under the One-Village-One-Dam (1V1D) Programme for dry season farming. In addition, development of fifteen (15) dams made up of 6 new and 9 existing as well as solar powered water extraction from borehole and the Black Volta River in UWR and some parts of Northern Region with financial assistance from the 11th European Development Fund (EDF) of the European Union and the German Agency for Technical Cooperation (GIZ). These 15 irrigation schemes make up an area of 1,007 ha of irrigable land area (SOFRECO 2017).

Irrigation Water Management Practices in Ghana

According to GIDA and JICA (2004), IWM is an integrated process, which involves diversion, conveyance, regulation and measurements, distribution and drainage up to the discharge point. IWM practices in Ghana cannot be carried out in isolation or by just focusing on the infrastructure alone; all the elements must be considered. IWM involves the deployment of multi-disciplinary knowledge and expertise from the fields of devel-

opment policy-making, water resources management, engineering, agronomy, economics, and sociology as well as active participation of the end-users at the local community level. In the area of agronomy and water management, IWM comprises irrigation water scheduling, in-field water distribution guided by land development, distribution channels, the types of crops grown, and an auditing system that permits the measuring of water released on the basis of crop=water requirements, and a drainage system comprising in-field, secondary and main drains. IWM is affected by a number of factors such as pollution resulting in poor irrigation water quality, soil degradation and water logging from poor drainage systems. In Ghana, IWM practices have not been effective because of the non-involvement of all key actors in tackling the challenges in a holistic and well-coordinated manner. Principal IWM practices are discussed in the next sub-sections.

Irrigation System Audit

Water delivered to irrigated farms needs to be properly accounted for. Proper accounting measures are the best way to reduce wastage of water in all the stages of water delivery to the fields (from source to the discharge point). The recent installation of automation systems in some medium-scale irrigation schemes such as Tono, Kpong Left Bank and Kpong irrigation schemes will help to account for water supplied, water usage and transparent billing systems (CGAP 2019). These systems comprise instrumentation and automation devices driven by SCADA and solar powered automated gates to facilitate supply of constant volumes of irrigation water through a network of canals.

A proper audit of water usage will improve water management on schemes and increase the ISC recovery rate, which has been low on small-scale irrigation schemes in Ghana. Irrigation Water System Audit (IWSA) involves inspection and measurement of the effectiveness of irrigation systems in relation to their application of water to plants (Petro 2011). EarthKind (2010) indicates that IWSA involves three major activities; a) site inspection, b) performance testing and c) irrigation scheduling, with each activity resulting in significant savings of cost and water. IWSA processes also involve recording various site characteristics and then conducting a test to ascertain the uniformity of the irrigation system water delivery. This is essential for boosting irrigation water use efficiency and providing insight into water usage and wastage.

Irrigation Water Scheduling

FAO (2007) indicates that irrigation scheduling involves the application of irrigation water according to predetermined schedules based on monitoring of soil water status and crop-water requirements. Since different types of crops have different water requirements, scheduling of water will ensure accurate and timely supply of water and thereby minimize waste. The method of scheduling irrigation water depends on soil or plant monitoring or soil water estimates (Raveendra et al. 2017). Inappropriate water management of irrigation schemes may lead to water wastage, crop withering, poor yields and loss of revenue to farmers. Klausmeyer (2012) indicated that irrigation scheduling is the part of proper irrigation water management that involves the decision of when to irrigate and how much water to and that scheduling tools provide information, which irrigation decision makers can use to develop irrigation strategies for each field on the farm. To prevent these problems, it is necessary to introduce water delivery schedules so that the crops of all farmers are irrigated in blocks at the same time and harvesting is done at the same time. At the beginning of the cropping year, irrigation water schedules are prepared by the schemes managers and farmers based on crop-water requirements, soil types and period of the year. In the wet season (May to July and September to October), where soil moisture are optimum, supplementary irrigation schedules are adapted. This enables conservation of water, which could be used for other purposes such as aquaculture and livestock watering. On the other hand, during the dry season (November-April), when temperatures are very high and plants' water requirements surge, full-scale comprehensive schedules are used to prevent the crops from withering.

In-field Water Distribution

Water distribution systems are conveyance systems consisting of the laterals, gates and furrows, which convey water to the crops in a timely manner (Salman et al. 2019). The type of in-field water distribution system depends on the type of

crops, water demand and the quantity of available water. For instance, because rice requires a lot of water, the flooding method of in-field water distribution is preferred and bunds are used to serve as controls and checks on water wastage. For smallholder irrigation schemes, the land is normally divided into plots and levelled to facilitate water distribution to crops and to avoid waterlogging and destruction of bunds that sub-divide the plots. In the case of vegetables, water is sprayed directly onto the crops because micro sprinklers do not require the levelling of fields. Likewise, drip irrigation system supplies water directly to the roots of the plants. According to Mati (2012), most formal irrigation schemes are divided into smaller units (laterals or blocks) each with its own farmers' leaders. In-field water distribution ensures equitable distribution of water to each plot or farm so as to avoid over irrigation or under irrigation of crops. The leaders of each unit are responsible for ensuring group discipline at all times. They are expected to stick to water distribution schedules and regulations of farmer-based organizations (FBOs). Water Users' Associations (WUAs) play a significant role in ensuring water distribution to the plots at both the sectional and sub-sectional levels.

Irrigation Water Drainage System

Drainage is the removal of excess water on the surface or sub-surface of the soil, including removal of dissolved salts, in order to facilitate crop growth and development. The drainage system is also part of the integrated water resources management because the quality of irrigation water depends on the drainage system of a given area (Gooch and Stalnache 2010). In poorly drained areas where inadequate or no drains exist to convey excess water, water and soil quality are most likely to be contaminated, leading to high salinity and sodicity values and in effect affect the water quality and often does meet the FAO irrigation water quality standards. Namara et al. (2011) indicated that poor drainage system affects crop yields, reduce cultivated areas, impedes irrigation water delivery, and field levelling. The drainage system helps to restore water balance and prevent ponding, waterlogging and soil salinization (Ritzema 2009). Irrigation and drainage improvements are not necessarily mutually exclusive. Often both may be required together to assure sustained, high-level production of crops.

Irrigation Infrastructure Maintenance

Namara et al. (2011) indicated that actual irrigation areas have been decreasing year after year from problems such as decline in capacity to convey and distribute water due to aging facilities, collapse of facilities, high cost of operation and maintenance. Irrigation infrastructure is developed based on civil engineering standards such as floods return periods, materials and construction standards and they are expected to deteriorate over time and therefore need to be maintained regularly to ensure efficiency and sustainability. This is a vital IWM practice, which is often relegated to the background (Blank et al. 2002). The process starts with drawing up a maintenance plan and routinely inspecting the hydraulic structures and the irrigation system to identify defects such as broken and leaking canals and repairing them to allow free flow of water to areas where it is required. According L.I. 2230 (2016), farmers must be included in the operation and maintenance (O and M) of irrigation schemes to ensure allocation of roles and responsibilities from the inception stage. Due to inadequate financial resources, in most cases the infrastructure is left to deteriorate and eventually becomes dysfunctional. IWMI (2010) indicated that 27,900ha of the total 30,000ha were equipped for irrigation and actually irrigated in the year 2000 and attributed it to deterioration of irrigation infrastructure and lack of sufficient funds for maintenance. To prevent this challenge, farmers must be trained in the development of maintenance schedules, O and M of irrigation systems and scheduling of irrigation water delivery (Mati 2012).

METHODOLOGY

Study Area and Research Methods

This paper presents the findings of a research conducted on three irrigation schemes at Sankana, Busa and Yelayiri in the Upper West Region (UWR) as found in Figure 1. The total land area of the region is 1.85 million hectares, representing 7.75 percent of Ghana's landmass. The region has a huge potential for irrigation because of the presence of many rivers and streams. UWR lies within

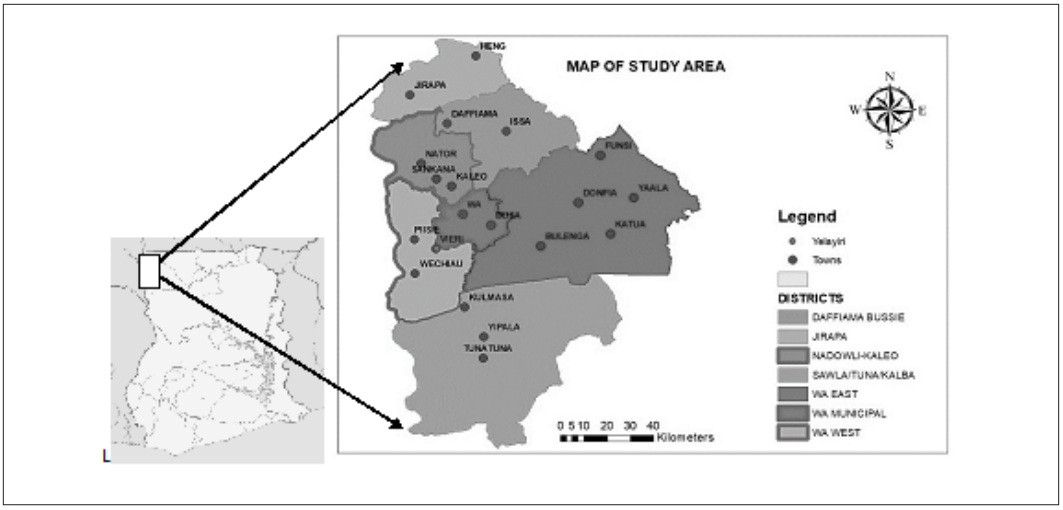

Fig. 1. Study area
Source: Authors' construct, 2019

the Guinea Savannah ecological zone in Ghana. It experiences a uni-modal rainfall regime of 1,000mm from mid-June to October and a long dry season between November and mid-June (8 months). The region's temperature varies between a minimum of 15°C and a maximum of 40°C. The amount, intensity, distribution and frequency of rainfall are usually unreliable and this makes irrigation a vital instrument for ensuring all-year-round agricultural production.

Sampling Procedure, Data Collection and Analyses

Both primary and secondary data were used for preparing this paper. Secondary data were obtained through a comprehensive review of existing literature on the subject. Quantitative and qualitative research methods were employed in collecting primary data from smallholder farmers and experts in the field of irrigated agriculture and sustainable development. Multi-stage sampling procedure was used to select 90 smallholder farmers. At the first stage, purposive sampling technique was used to select three schemes-Sankana, Busa and Yelayiri. At the second stage, simple random sampling technique was used to select 30 farmers each from the three selected schemes. At the third stage, 30 Water Users Associations (WUAs) members and leaders were sampled from each of the three schemes and interviewed to elicit their views on IWM practices and the challenges affecting their performance on the schemes. The views of 10 development policy-makers and experts in agriculture, rural development and water resources management were solicited and SPSS version 20 was used to analyse the quantitative data. The identified IWM challenges were prioritized with the help of pairwise ranking. According to Russell (1997), pairwise ranking is used to prioritize lists such as problems, projects or commodities. The method enables development stakeholders to determine which problems in local communities should be prioritized for redress. Crosstab correlation was used to determine the influence of WUAs/farmers on IWM practices and the performance of the three schemes. Aprameya (2016) posited that crosstabs point out correlation between different groups of variables. The qualitative information collected was subjected to thematic, content and discourse analysis.

RESULTS AND DISCUSSION

This paper investigated IWM practices in UWR of Ghana with the aim of promoting food and nutrition security, poverty reduction and improved livelihoods in rural communities. Principal IWM chal-

lenges confronting the three irrigation schemes at Sankana, Busa and Yelayiri communities were identified, analysed, prioritised and appropriate mitigation measures proposed for redressing them. The results of the data analyses are presented in this section of the paper. Tables 1, 2 and 3 which are constructed from field data respectively reveal pairwise ranking of IWM challenges at the Sankana, Busa and Yelayiri irrigation schemes.

Irrigation Water Management Practices in UWR

The IWM practices deployed at the three case-studied irrigation schemes included irrigation system audit, irrigation water scheduling, in-filed water distribution and maintenance of infrastructure. A crosstab test was ran to determine the relationship between the WUAs/farmers' IWM practices and the productivity of the schemes. The results revealed strong evidence of WUAs/farmers' influence on irrigation system audit across the three schemes (Chi-square = 6.259, df 2, $p<0.05$). In other words, majority of the WUAs/farmers are responsible for carrying out irrigation system audit on the schemes. This practice promotes participatory irrigation management and facilitates equitable distribution of water to irrigated fields. This finding agrees with the observation by Kosanlawit et al.

Table 1: Pairwise ranking of irrigation water management challenges at Sankana Irrigation Scheme

Problems	*High O&M cost*	*Low ISC recovery rate*	*Scheme mgt. know-how*	*Maintenance culture*	*Encroachment of catchments*	*High O&M cost*	*Siltation and poor drainage*	*Dilapidated structures*	*Score*	*Rank*
High O&M cost		0	0	1	0	0	0	0	**1**	**7**
Low ISC recovery rates	1		1	1	0	0	1	1	**5**	**3**
Inadequate WUA know-how in scheme management	1	0		0	0	0	0	0	**1**	**7**
Poor maintenance culture of facilities	0	0	1		0	0	1	1	**3**	5
Encroachment of catchments	1	1	1	1		0	1	1	**6**	**2**
Declining soil fertility	1	1	1	1	1		1	1	**7**	**1**
Siltation and poor drainage	1	0	1	0	0	0		0	**2**	**6**
Dilapidated structures	1	0	1	0	0	0	1		**4**	**4**

Source: Field data, 2019

Table 2: Pairwise ranking of irrigation water management challenges at Busa Irrigation Scheme

	High O&M cost	*Low ISC recovery rate*		*Maintenance culture*	*Encroachment of catchments*	*High O&M cost*	*Siltation and poor drainage*	*Dilapidated structures*	*Score*	*Rank*
Low ISC recovery rates	1		1	1	1	0	1	1	**6**	**1**
Inadequate WUA know-how in scheme management	1	0		0	0	0	0	0	**1**	**7**
Poor maintenance culture of facilities	1	0	1		0	0	1	1	**4**	**4**
Encroachment of catchments	1	0	1	1		1	0	1	**5**	**3**
Declining soil fertility	1	1	1	1	0		1	1	**6**	**1**
Siltation and poor drainage	0	0	1	0	1	0		1	**3**	**5**
Dilapidated structures	0	0	1	0	0	0	0		**1**	**7**

Source: Field data, 2019

Table 3: Pairwise ranking of irrigation water management challenges at Yelayiri Irrigation Scheme

	High O&M cost	*Low ISC recovery rate*	*Scheme mgt. know-how*	*Maintenance culture*	*Encroachment of catchments*	*High O&M cost*	*Siltation and poor drainage*	*Dilapidated structures*	*Score*	*Rank*
High O&M Cost		0	1	0	1	0	1	0	3	5
Low ISC recovery rates	1		1	1	1	0	1	0	5	3
Inadequate WUA know-how in scheme management	0	0		0	1	0	1	0	2	6
Poor Maintenance culture of facilities	1	0	1		1	0	1	0	4	4
Encroachment of catchments	0	0	0	0		0	1	0	1	7
Declining soil fertility	1	1	1	1	1		1	0	6	2
Siltation & poor drainage	0	0	0	0	0	0		0	0	8
Dilapidated structures	1	1	1	1	1	1	1		7	1

Source: Field data, 2019

(2017) that participatory IWM promotes equitable and sustainable water use, increased farm productivity and farmers' incomes. This finding is also in agreement with Özerol's (2013) who suggested that the benefits of farmers' participation in IWM to include promotion of collective action through learning and building a sense of ownership among local community members.

The crosstab analysis further indicates that irrigation scheduling is not dependent on the WUAs/farmers (Chi-square = 1.491, df 2, p=0.475). About 77 percent of the interviewees across the three schemes indicated that irrigation scheduling is carried out by the WUAs/farmers but this is not significant. El Afendi et al. (2010) asserted that irrigation scheduling is used to increase crop productivity but crop yields of the three irrigation schemes are low probably because irrigators do not adhere to agreed irrigation schedules. The crosstab analysis further revealed that in-field water distribution and maintenance of irrigation infrastructure are not determined by the WUAs/farmers (Chi-square = 1.118, df 2, p=0.572) and (Chi-square = 5.417, df 2 p = 0.067) respectively. These results suggest that in-field water distribution and maintenance of irrigation infrastructure are not determined by the WUAs. Also, between 76.6 percent and 80 percent of the WUAs across the three irrigation schemes stressed that in-field water distribution and maintenance are carried out by the WUAs/farmers but the correlation is insignificant. In-field water distribution by farmers promotes judicious use of water and thus facilitates the cultivation of larger areas with the same quantity of water. The International Finance Corporation (2014) observed that in-field water management by farmers as one of the best ways of ensuring efficient use of irrigation water. The results of the of the data analysis however revealed that irrigation infrastructures at the three schemes are poorly maintained leading to silt deposition, weed infestation and malfunctioning of structures, making it very difficult to control water flow in canals as is confirmed by GIDA and JICA (2004).

Prospects of Irrigation Water Management in UWR

The analysis of the secondary data and information provided by the experts of irrigated agriculture revealed that a Restructuring and Modernisation Programme (RMP) currently being implemented by GIDA is a significant strategy for improving IWM efficiency in Ghana. The RMP includes provision of technical support for the implementation of irrigation projects in collaboration with the private sector under Public Private Partnership (PPP) arrangements, (Glitse et al. 2017). The RMP also seeks to undertake institutional and policy reforms and to shift GIDA's mandate from direct involvement in the implementation and management of irrigation schemes. The programme therefore aims to transfer these responsibilities to Water Users

Associations (WUAs) per L.I. 2230 in 2016. Greater farmer participation in the management of irrigation schemes is expected to promote food and nutrition security, poverty reduction and improved livelihoods in rural communities. This view is corroborated by Salman et al. (2019) who attested to direct relationships among farmers' participation in irrigation management, scheme productivity and sustainability.

A key driver of the RMP is the passage of the Legislative Instrument 'Irrigation Water Users Association Regulation' (IWUAR), L.I. 2230 of 2016, which mandates GIDA to establish WUAs to effectively participate in the management of all irrigation schemes in Ghana. The WUAs are responsible for the day-to-day management, operation, and maintenance of the schemes as well as administrative functions such as collection and disbursement of Irrigation Service Charges (ISC). Sensitisation, formation and capacity building programmes should be organized for WUAs to make them effective and efficient in the usage of irrigation water. Piedra-Muñoz et al. (2017) emphasized that the lack of awareness and training of farmers may lead to misuse of irrigation water. The RMP's capacity building programme also focuses on good agricultural practices, group dynamics, water management, marketing, financial management as well as operations and maintenance of the schemes. Training of farmers, especially in irrigation water management, is expected to improve water use efficiency and productivity, which are critical in arid regions like UWR. Svendsen et al. (1997) similarly observed that building the capacity of WUAs will help to increase participation in irrigation schemes' management and enhance their productivity and long-term sustainability.

Irrigation Water Management Challenges and Mitigation Measures

Irrigation Water Management Challenges

The 90 sampled members of the WUAs who participated in the field survey identified a number of fundamental challenges that are constraining IWM practices in UWR (Tables 1, 2, 3). These challenges cut across the three case-studied irrigation schemes but they reveal varying degrees of severity. The challenges include dilapidated infrastructural facilities, poor maintenance culture, high operations and maintenance (O and M) costs, low ISC recovery rates, inadequate know-how by WUAs in scheme management, encroachment of catchment areas, declining soil fertility, siltation and poor drainage management.

Declining soil fertility topped the identified IWM challenges at Sankana and Busa whiles it was ranked as the second most important challenge by farmers of Yelayiri Irrigation Scheme. This challenge accounts for the declining agricultural productivity of the scheme. Gubbels (2019) also observed that declining soil fertility in combination with other factors do not encourage long-term yield increases. Dilapidated structures were identified as the topmost IWM challenge at Yelayiri whiles it was ranked fourth and seventh respectively by Sankan and Busa farmers. Broken down structures like damaged canals do not permit smooth irrigation and may lead to water wastage and high O and M costs (Adongo et al. 2015).

Low recovery of Irrigation Service Charge (ISC) is the most important IWM challenge at Busa but was ranked third by Sankana and Yelayiri farmers. Low ISC recovery rates translate into low accrual of revenue for financing O and M activities of the schemes. This situation seriously undermines the financial sustainability of the schemes. This is in consonance with the observation by Cornish et al. (2004) that ISC is a rightful means of achieving financial sustainability of irrigation schemes. According to farmers in Sankana, encroachment of catchment areas is their second most important challenge. However, the same challenge is respectively ranked third and seventh by Busa and Yelayiri farmers. Sand winning, the main source of encroachment, is rife on the Sankana and Busa schemes and poses a threat to their sustainability. This finding is in harmony with those of Glitse et al. (2018) and Allen et al. (2014) who made similar observations on irrigation schemes in Ghana.

Poor maintenance culture is ranked the fourth most important challenge at Busa and Yelayiri whiles it placed fifth at Sankana. Namara et al. (2011) indicated that due to deterioration of infrastructure, many public irrigation schemes are relegated to the status of rain-fed systems. According to Ziba (2015), this challenge seriously undermines the performance of the schemes in addition to other factors that have caused the collapse of many irrigation schemes in Ghana. The siltation of dams and poor drainage also affect the performance of

the irrigation schemes, in most cases reducing storage capacities of dams and limiting cropping areas. Adongo et al. (2014) concluded in their study on "Siltation of Reservoir of Vea Dam" that siltation reduces storage capacity and the lifespan of reservoirs. The respondents at Yelayiri, Busa and Sankana Irrigation Schemes respectively ranked high O and M costs as the fifth, sixth and seventh most important IWM challenges. This may be partly due to poor maintenance of the schemes. Beyene (2012) rightly recommended that WUAs should take collective actions and provide communal labour to reduce O and M costs. Dhakal et al. (2018) also observed that collective actions come with additional benefits if both costs and benefits are shared proportionately among all members of the WUAs.

Siltation and poor drainage were ranked fifth at Busa, sixth at Sankana and eighth at Yelayiri Irrigation Schemes. This may be due to exposure of top soil to erosion, caused by intensive agricultural activities in unauthorized areas. Adongo et al. (2014) suggested that WUAs' inadequate knowledge of irrigation schemes management negatively affects the general performance sustainability of irrigation schemes. This finding is also in conformity with FAO's (1993) observation that the overall poor performance of irrigation projects leads to non-achievement of full planned benefits. Inadequate capacity of the WUAs to manage the schemes is ranked sixth by Yelayiri and seventh by Sankana and Busa farmers. This reasoning is supported by Fanadzo and Ncube (2018) who identified inadequate capacity of famers as one of the main reasons that accounted for the many failures of smallholder irrigation schemes in South Africa.

Mitigation Measures

In order to effectively address the IWM challenges in UWR, the sampled smallholder farmers and WUA leaders of the three case-studied irrigation schemes as well as the development policymakers and agricultural experts provided recommendations for improving IWM practices and the sustainability irrigation schemes that are captured in Table 4.

CONCLUSION

The main Irrigation Water Management (IWM) practices deployed at the Sankana, Busa and Yelayiri irrigation schemes are a) irrigation system audit, b) irrigation water scheduling, c) in-field water distribution, and d) maintenance of infrastructure. The three schemes are beset by a number of challenges that adversely impact crop yields and the sustainability of the schemes. The challenges include the following: dilapidated infrastructure; poor maintenance culture; high O and M costs; WUAs' insufficient know-how in irrigation schemes management; low ISC recovery rates; catchment areas encroachment; declining soil fertility; and siltation and poor drainage. These challenges cut across the three case-studied irrigation schemes however, they have varying degrees of severity and impacts. Despite these challenges, the prospects of the sub-sector present a bright outlook for the contribution of the irrigation schemes for the sustainable development of UWR. Most relevant is the RMP's provision in the RMP that mandates GIDA to establish WUAs and train the farmers to actively engage in the management of the schemes and to improve their productivity and sustainability.

RECOMMENDATIONS

To improve the sustainability of irrigation schemes in Ghana and UWR in particular, appropriate strategies and recommendations are provided for effective implementation. First of all, GIDA should speed up the establishment of WUAs for every irrigation scheme in the country. This will facilitate capacity building of farmers, increase crop production, local ownership and the sustainability of the schemes. Secondly, efficient automated water level control gates and flow metres should be installed on every irrigation scheme so as to improve the recovery of ISC from beneficiary farmers. In addition, automation and instrumentation system being installed on some irrigation schemes such as Tono, KIS and KLBIP should be piloted on other irrigation schemes to make billing for ISC transparent and prevent wastage of water. In addition, well-coordinated routine and planned maintenance schedules should be prepared for every irrigation scheme in UWR and effectively implemented to guarantee sustainability. It is also vital that relevant meta-data and information should be continuously collected, documented and readily made available for decision-making. Finally, public organisations, private sector enterprises and NGOs should contribute to improve the performance of

Table 4: Irrigation water management and mitigation measures

S. No.	*Sankana*	*Busa*	*Yelayiri*	*Mitigation measure*
1.	High O&M cost	High O&M cost	High O&M Cost	Take collective action including communal labour in carrying out O&M activities such as desilting of the canals, weeding, and fixing of eroded sections of irrigation structures. .
2.	Low ISC recovery rates	Low ISC recovery rates	Low ISC recovery rates	One of the requirements that make farmers eligible for land reallocation is full payment of their ISC. Land re-allocation should therefore be carried out on time.Form WUAs on all irrigation schemes which will empower the WUAs to make farmers have peer pressure on others to pay more. Engage in continuous education of farmers to change their mindset to pay. ISC collection must be monitored regularly to increase collection rates.
3.	Inadequate know-how in scheme management	Inadequate know -how in scheme management	Inadequate know-how in scheme management	Capacity of WUA leaders should be built in scheme management covering the relevant areas: O&M of the irrigation system, budgeting, recovery, utilization accounting for ISC, agronomic issues, water management and social management.
4.	Poor Maintenance culture of facilities	Poor maintenance culture of facilities	Poor maintenance culture of facilities	Irrigation schemes management and maintenance culture should be drastically improved through continuous training and regular monitoring and evaluation of the scheme by GIDA.
5.	Encroachment of catchment areas	Encroachment of catchment areas	Encroachment of catchment areas	To root out encroachment on the schemes, surveillance committees should be formed on every irrigation scheme while each farmer should act as a watchdog so that encroachers caught can be reported to the appropriate quarters for corrective action to be taken against them.
6.	Declining soil fertility	Declining soil fertility	Declining soil fertility	The soil fertility status of the irrigation schemes should be determined by GIDA and the farmers trained in soil fertility improvement methods and crop management strategies to ensure higher productivity on the schemes.
7.	Siltation and poor drainage	Siltation and poor drainage	Siltation and poor drainage	Regular monitoring and desilting of the canals and drains should be carried out by the WUAs.
8.	Dilapidated structures	Dilapidated structures	Dilapidated structures	Regular rehabilitation and modernisation of the irrigation schemes are essential to make them fully operational, profitable and sustainable.

Source: Authors' construct, 2020

irrigation schemes by expanding the basket of incentives, inputs and services provided farmers and the other stakeholders of agricultural value chains.

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Paper received for publication in October, 2020
Paper accepted for publication in December, 2020