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Alternate Solutions Towards Sustainable Irrigated Agriculture in Ghana: Review of Literature

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Abstract:

Irrigated agriculture management is still not effective in Ghana. The growing recognition of irrigation problems and its impact on the economy and environment have prompted the government of Ghana to implement plans and strategies to encourage new developments and technologies to promote sustainable irrigated agriculture. The study aims at identifying sustainable ways in promoting irrigated agriculture in Ghana. literature search and thematic analysis of the literature were used and the themes identified provide the basis for the study. The results were that sustainability can be achieved if there is effective WUA management, strong irrigation facility, effective farmers training, improving extension capacity to deliver, sustainable irrigation techniques and effective collaboration. In conclusion, irrigation sectors should take full advantage of abundant water resource in Ghana and ensure that irrigation is handled in a way that protects the environment for the present generation without compromising the benefits of the future generations.

Keywords: Irrigation, Sustainability, Agriculture, Policy, Management, Ghana.

1. Introduction

Recently, Irrigated agriculture and the use of water resources in agriculture are facing challenges of sustainable development. Because of the challenges, attention about sustainability development has now centred on developing agricultural technologies and practices that can improve productivity for farmers and at the same time does not cause any undue harm to the environment. Apart from water resources management and irrigated agriculture, sustainable development concept is applied in other fields worldwide. In this study we borrowed the definition of Tilman, Cassman, Matson, Naylor, & Polasky (2002) who defined sustainable agriculture as "practices that meet current and future societal needs for food and fibre, for ecosystem services, and for healthy lives, and that do so by maximizing the net benefit to society when all costs and benefits of the practices are considered".

Irrigated agriculture has made significant contributions to food and economic development in the world (FAO, 2003; Mukherji, 2009; Valipour, 2015). With the contribution of irrigation in the semi-arid and arid areas alongside the emerging issue that affects it, stakeholders are working together to manage irrigation in a sustainable way. In Ghana, unsatisfactory result of irrigated agriculture has often been linked to inefficient water distribution, unsatisfactory operation and maintenance (O&M), uncoordinated irrigation support services, non-conducive agricultural marketing system (Laube, 2007), poor collaboration and weak extension support system (MOFA, 2011; Namara, Horowitz, Nyamadi, Barry, & others, 2011; Ofori, Kyei-Baffour, Mensah, Agyare, & others, 2010). Over the years, Ghana agriculture productivity has been stagnant and has contributed 23% of the National Gross Domestic Product (GDP) in 2012 (DBP, 2012; FAO, 2015). Despite the contributions of government expenditure on agriculture, the expected growth rate of 6 percent in agricultural GDP has not fully been realised (FAO, 2015).

With the abundant water resources for irrigation farming in Ghana, the impact of mismanagement and uncontrolled irrigated farming practices leave much to be desired (Adomako & Ampadu, 2015). The growing recognition of irrigation issues and its impact on the economy and environment have prompted the government to implement development plans and strategies, bye-laws, national irrigation policies to encourage new developments and technologies to boost irrigated agriculture in Ghana (Braimah, King, & Sulemana, 2014; Drechsel, Obuobie, Adam-Bradford, & Cofie, 2014; MOFA, 2011). An institutional framework was developed to promote collaborations and partnerships among irrigation stakeholders in promoting sustainable irrigated agriculture. However, irrigated agriculture is still not effective. For example, the performance of crops has been poor due to limited advance knowledge and inter-organisational collaboration has also been difficult (Kyei-Baffour, Mensah, Agyare, & others, 2010). The paper aims at identifying key strategies and recommendations from current study as alternate solutions to reshape Ghana's irrigated agriculture. The following questions were answered throughout the study: (1) What are the emerging sustainable irrigated agriculture practices? (2) What lessons can Ghana's irrigation learn from these practices?

1.1 Relevant Policies in Irrigated Agriculture and Irrigation Schemes in Ghana

In 2002, Food and Agriculture Sector Development Policy (FASDEP I) was introduced and subsequent to that, FASDEP II came to address the loopholes and inefficiencies (such as focusing primarily on private sector at the expense of poor farmers) in the FASDEP I (Drechsel et al., 2014). Agricultural policy objectives for food and agriculture sector are to enhance food security and preparedness, improve growth in incomes, increase competitiveness and enhance integration into domestic and international markets, manage land and environment in a sustainable manner, apply science and technology in food and agriculture development and, improved institutional Coordination.

The national irrigation policy was approved in 2010 by the cabinet and it was implemented in 2011 (MOFA, 2011). The goal of the policy is to enhance sustainable growth and performance in irrigation. This policy addresses the constraints and opportunities for all the irrigation sub-sectors which include informal, formal and commercial irrigation. Figure 1 depicts the proposed institutional framework for national irrigation policy implementation. The framework means that Ministry of Food and Agriculture (MoFA) and Ghana Irrigation Development Authority (GIDA) cannot work in isolation given that the management of agricultural water is complex and cannot be handled by one institution. Therefore, GIDA encourages institutions and organisations such as regulatory bodies, local government, NGOs to partner or collaborate with them for the effective management of irrigation. GIDA is a sub-sector of MoFA that is responsible for irrigation management in Ghana. It oversees the promotion of both public and private irrigation.

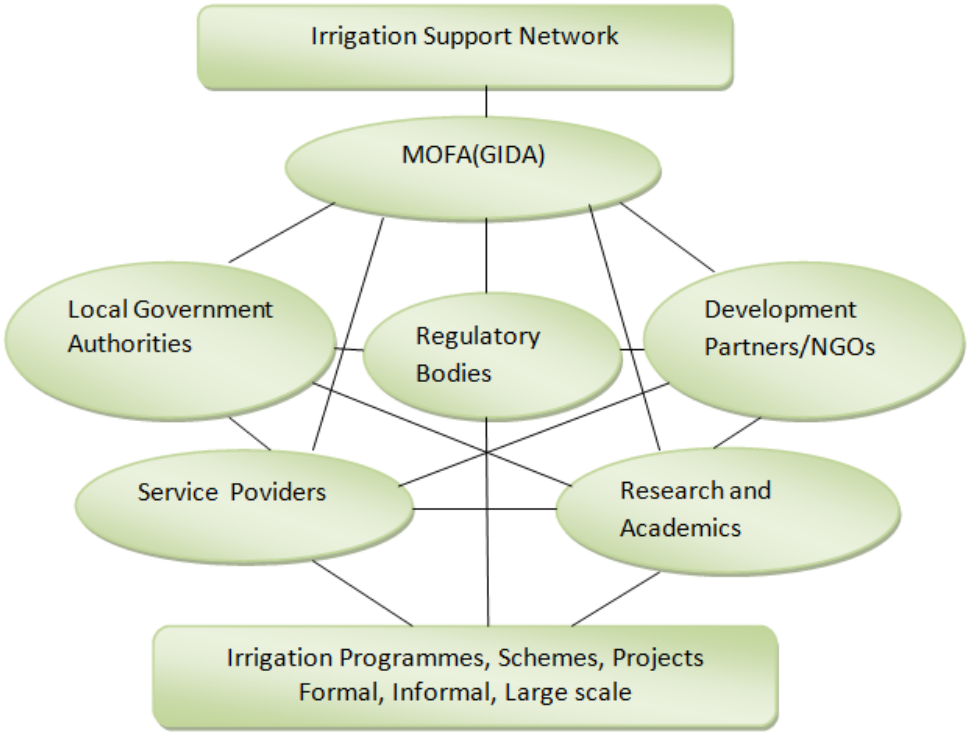

Figure 1: A Proposed institutional framework for the policy implementation.

Source: (Adopted from (MOFA, 2011))

The national water policy has implications for the development of irrigation (GoG, 2007). The government of Ghana through the new policy, ensure that water is available to farmers in a sufficient quantity and quality for the cultivation of crops (Drechsel et al., 2014). Also, the national land policy was developed in 1999 by the Government of Ghana with the aim of sustainable use of national land and its natural resources in the Ghanaian society (RoG, 1999). The policy supports the socio-economic activities undertaken in accordance with sustainable resource management principles and the ecosystem. The policy expects both large scale and small scale irrigation projects to comply with the provisions of the State Lands Act (RoG, 1999).

Ghana is located in West Africa with the closest landmark in the centre of the earth. It is located between latitudes 4 – 11.5° north and longitude 3.11° west and 1.11° east. Accra, which is the capital of Ghana, lies in the Greenwich meridian. Ghana shares boundaries with Burkina Faso to the north, to the west by La cote d'Ivoire, to the east by Togo and to the south by the Gulf of Guinea (La Pierre, 2004). Ghana has total land coverage of 238,537 km^2 with a total population of approximately 27 million[1] as of 2014. Ghana has several natural resources such as agriculture, minerals and human resource. Agriculture is the main key sector of the economy, which employs 60 percent of the Ghanaian workforce and contributes 29.9% to GDP (OBG, 2012)

In Ghana, GIDA has constructed 22 public irrigation schemes as indicated in (fig 2), covering about 14,700 ha, of which 60% were developed in 2003 (MOFA, 2011). Currently, there are 56 irrigation schemes managed by GIDA and farmers. Most of the schemes were originally managed by GIDA and in the northern region of Ghana by Irrigation Company of Upper East Region (ICOUR). Table 1 shows the method of irrigation practice among 22 public irrigation scheme in Ghana. Apart from public

[1] Population projection by sex, 2010 to 2014, Nation Ghana Statistical Service. (Retrieved on August 3, 2014).

irrigation schemes, other small-scale irrigation is practised across the length and breadth of the country. Private small-scale irrigated area is estimated to be about 1,850,000 ha of which about 500,000 farmers are actively involved (Giordano, de Fraiture, Weight, & van der Bliek, 2012). Private small-scale Farmers operate in a small size farm and use simple tools such as cutlass, bucket, knife and hoe.

Table 1: Methods of Irrigation from 22 Public Irrigation Scheme

Mode of irrigation	Name of schemes
• Run-off-river diversion and gravity-fed systems	• Sata, Annum Valley
• River pumping-based and gravity-fed systems	• Aveyime, Kikam
• Reservoir-based gravity-fed systems	• Libga, Afife, Bontanga, Gollinga, Tono, Vea, Ashaiman, Kpong, Okyereko
• Reservoir pumping-based gravity-fed systems	• Dawhenya
• Lake pumping-based sprinkler irrigation systems	• Weija, Kpando-Trokor, Amate, Dedeso
• River pumping-based sprinkler irrigation systems	• Subinja, Tanoso, Akumadan
• Reservoir pumping-based sprinkler irrigation systems	• Mankessim

Source: (Namara et al., 2011)

2 Method

The study was conducted using internet and literature search method with particular focus on selected keywords that were relevant to the study (Buchanan, Cunningham, Blandford, Rimmer, & Warwick, 2005; Palmer, Teffeau, & Pirmann, 2009). Results were limited to peer-reviewed papers between 2005 to 2016 on irrigation, collaboration, capacity building, irrigation stakeholders, collective management, modern irrigation practices and integrated water management. Articles were searched through peer-reviewed journals and databases such as Google scholar, Wiley online library, Science direct, and Springer. Additionally, MoFA, GIDA, Food and Agriculture Organisation of the United Nations (FAO), The International Commission on Irrigation and Drainage (ICID), The United Nations Development Programme (UNDP), UN Sustainable Development Solutions Network (UNSDSN), Integrated Water Resource, Inc. (IWRI) and integrated water resources management (IWMI) website were visited to solicit for useful information (Thatje, Laudien, Heilmayer, & Nauen, 2007). In the analyses part, the study identified themes with Computer Aided Qualitative Data Analysis Software (CAQDAS) called NVivo 7. It is a software that enables the researcher to track and organise data sources (Baugh, Hallcom, & Harris, 2010). The data were categorised according to themes in order to examine emerging issues, concepts, and pattern from the literature. Below are the steps on how the analyses were undertaken:

1. Import articles into the NVivo software in text format;
2. Identify and summarise the main ideas, issues, and themes from each article;
3. Code and store the emerging ideas and themes;
4. Develop a node index system by organising into hierarchies to represent the organisation of themes into categories.

3 The Summary of the Literature Reviewed

To understand some of the pertinent issues in Ghana and some other part of the world in relation to irrigated agriculture and sustainability, national literature on irrigation

challenges and International literature contributions towards sustainable irrigated agriculture are examined in this section.

3.1 National literature on irrigation challenges

The major challenges facing Ghana to achieve sustained irrigated agriculture have already been well documented in many studies and several recommendations are already established. Although irrigation farming are in every part of Ghana, it is highly concentrated in the northern regions with crippling challenges (Dinye & Ayitio, 2013; Månsson, 2011; Obuobie, Drechsel, Danso, Raschid-Sally, & others, 2004). Also, the two largest irrigation schemes are located in northern Ghana, namely Tono and Vea irrigation schemes which provide a lot of farmers with the needed water for agriculture farming and increases their socio-economic livelihood activities.

Namara et al. (2011) explored irrigation development in Ghana, past experiences, emerging opportunities, and future directions. They found out that the emerged problems confronting irrigation in Ghana were financial incapabilities, institutional issues, access to inputs and services, marketing and post-harvest handling, poor collaboration and conflict among government and landowners over compensation[2]. Namara et al. findings were also supported by key findings in the FAO/IFC "Africa Irrigation Diagnostic Report" on Ghana, indicating the overall constrained by a lack of financing which has is exacerbated by the above issues (IFC, 2014).

Appiah-Nkansah (2009) examined the irrigation systems in the Upper West. He found out that, Ghana irrigation is beset with problems ranging from poorly maintained canals, weeds and mud surrounded by canal networks. In a similar study, Owusu, Nyantakyi, & Borkloe (2013) attributed poor maintenance structures by the government,

[2] Government pays compensation to landowners after using their Land for development of public (Namara et tal., 2011)

in that government unwillingness to actively participate in the maintenance and provision of machinery service has resulted in miserable consequences. Principally, the government provides headwork, conveyance and distribute infrastructure for irrigation development in the country, therefore when maintenance is left in the hands of farmers alone, it will be difficult given the current problems faced by farmers such as low farm income and production (MOFA, 2011). This has led to a total neglect of some of the schemes leading to a complete breakdown.

Cornish & Lawrence (2001) discovered that, in many cases, farmers lack basic information on areas such as land preparation, water management, crop development as well as sustainable methods of irrigation and this claim was also buttressed by IFC, 2014; Schraven (2010). Consequently, this situation can lead to a detrimental effect on crop total output and food consumption (Drechsel & Keraita, 2014). Besides, information management and sharing are also essential components of sustainable irrigated agriculture, however, the information and knowledge needed for effective management of irrigated agriculture are still struggling to develop (Asante, 2013; IFC, 2014). Computers needed to store important information on the farms are missing and the available ones are either broken or uneasy to use. By so doing, the information such as farm data, reports and documentations are likely to be written on paper and saved in the shelves. They are sometimes lost from the shelves or almost torn apart due to old age.

Photo 1

It shows a section of an open conveyor canal of about 7.5 km constructed between Weija lake and pumping station reservoir for the transportation of water. Due to poor management practices, the canal is filled with weeds and sand and it is now a dumping place for neighbours staying around the area.

Photo 2

It shows a cow intruding into farmers okra farm. Due to no measures to protect farmlands against encroachments, farmers are going to suffer after losing their investment.

Photo 3

It shows a section of an open conveyor canal being filled with debris from highlands. During the raining season, a flood occurs which renders the area volatile.

Photo 4

It shows farm food crops harvested and collected in a basket whiles other are lying on the ground. The environment in which food crops are prepared for the market are unhygienic and has health implications.

Figure 3 Poor Farm Management Practice

Author's Photos

More to the point, obsolete irrigation equipment and mechanisation were reported by Atiim (2011) as inhibiting factors to sustainable irrigated agriculture in Ghana especially, the Northern regions of Ghana. Traditional irrigation method of farming does not practice in such a way that the soil and water are protected. For example, unauthorised dug-out in most part in the northern Ghana (irrigation water from unauthorised dug-out might contain toxins which are not good for plant growth) as shown in (fig 4) has serious health and environmental risk (Obuobie et al., 2004). Schraven, (2010) reported that farmers rely on the river along the farms as their irrigation water source and dug wells on river beds. Figure 3 identifies some of the major problems arises from to unsustainable irrigation management. These practices reduce the water level during the dry season and seriously contaminate underground water due to deep infiltration of fertilisers and pesticides into the soil. Meanwhile, Ghana has institution responsible for environmental protection such as Environmental Protection Agency (EPA), water and sanitation and local authorities that makes sure that the environment is protected. Other similar studies support Schraven's contention about the implication of poor management of water for irrigation purposes (Afrane & Ntiamoah, 2011; Anim-Gyampo, Zango, & Ampadu, 2014; Ansah-Asare & Asante, 2008).

Figure 4: Dug-Out System in Upper West, Ghana.
Source: (Appiah-Nkansah, 2009; Schraven, 2010)

3.2 International literature contributions to irrigation development

In the context of international literature, the significance of their contribution towards sustainable irrigated agriculture is highlighted. The shift from old agriculture practices, considered as unsustainable to improved irrigation methods, water efficiency, economic incentives, on-farm irrigation technologies, capacity building of all stakeholder groups in irrigation and among other related sustainable practices promote sustainable development (FAO, 2015; Franks, Garcés-Restrepo, & Putuhena, 2008; IICA, 2015; Levidow et al., 2014; Mwendera & Chilonda, 2013; Omid, Akbari, Zarafshani, Eskandari, & Fami, 2011; Reynolds et al., 2011; SDSN, 2013; Sheahan & Barrett, 2014; UNDP, 2015). Furthermore, Increased attention on the active participation of stakeholders, an institutional structure in association with physical, managerial, environmental, technical, financial and operational component to address sustainability in irrigated agriculture

practice was also reinforced by FAO, IWRI, ICID and UNEP.

Connor (2015) reported that the best practice for managing water demand is to increase water use efficiency and reduce water losses to increase agriculture production. For example, it was evident in Pakistan that deficit irrigation had increased the performance of wheat and cotton and he concluded that maintaining leaching is very important because it maintains the nutrient loss and soil fertility. A similar case in India suggested that transient soil moisture deficit stress has resulted in an effective water use in groundnut production (Connor, 2015; Pareek, Sopory, & Bohnert, 2010).

Global Water Partnership (GWP, 2012) pointed out that it is necessary to link adapted management approach to local conditions on the basis of awareness creation, participation, strong locally based organisation, suitable regulation as well as macro policy intervention that can improve sustainability.

A review conducted by Billib, Bardowicks, & Arumí (2009) admitted that improvement in farmers' capacities and awareness creation to improve water use has a high potential of minimising the negative environmental impacts of irrigation, decreasing the production costs and contributing to the sustainability of irrigated agriculture. In effect, irrigation support services especially extension service is necessary for making it a reality (cited in Ortega et al. 2005).

Waste water is a useful resource that provides benefits in several ways. In agriculture, waste water reuse provides the necessary water to enable plant growth. Apart from agricultural benefits of waste water, it provides various benefits for farmers all over the world include conserving fresh water bodies, improving soil productivity, preventing surface and groundwater waters discharge, and improving economic development (Corcoran, 2010). Thus, FAO has developed guidelines for the use of wastewater reuse in agriculture (WHO, 2006). The guidelines provide standards and options for evaluating the suitability of water for irrigated agriculture.

4 Discussion and alternative Practice

As claimed by Hamidov, Thiel, & Zikos (2015) that no single condition is sufficient to achieve high levels of canal maintenance and irrigation performance. The irrigation management problems in these case countries are similar to those in Ghana. Again, these approaches that have been used in these case countries have ultimate replication potential in shaping agriculture in Ghana.

Omid et al. (2011) specifically stated that the smooth running of Water User's Associations (WUAs) will depend on the health of the irrigation infrastructure. In this respect, the farmers begin to participate actively when they find out that the condition of the irrigation facility is good and can provide their needs. The Japan International Cooperation Agency, JICA (2009) also confirmed that the state of irrigation facility determines whether the beneficiary farmers will participate in irrigation management or not and the farmers unwillingness to participate had led to the abandonment of several irrigated farming. In Ghana, the water distribution network including canals conveyance, pipes and sprinkler in the case of sprinkler irrigation are weak which leads to clogging and water leakage. Depeweg, Paudel, & Méndez (2014) suggested how to improve the performance of irrigation network through the removal of sediments from canals regularly to avoid heavy accumulation of sand. This method is one of the best ways of maintaining canals and reducing high maintenance and rehabilitation cost. In the context of water efficiency, irrigation water can be enhanced by installing more efficient irrigation systems. For example, drip irrigation system is easy to maintain when maintenance practise is followed. Drip irrigation is more efficient than dug-out irrigation method where water is less managed (Giordano et al., 2012). In addition, the provision of irrigation services and materials are facilitated through financial institutions who lend money to farmers who activities leave up to the expectation of sustainable principles (Sally & Abernethy, 2011). With the training and education given to farmers by extension officers and other irrigation officials, farmers become aware of new skills and knowledge

and can adapt to emerging problems in the farming activities.

There are several irrigation methods existing globally of which some have been used during the ancient time. There are many irrigation methods including but not limited to drip, sprinkler and gravity-fed irrigation. Some of these methods remain unsustainable as they waste a lot of water. In this regard Goyal (2014) supported the idea that drip irrigation or pressurised irrigation saves water and efficiently distribute fertiliser for plant growth. IICA (2015) reported that drip irrigation is an excellent alternative to produce corn and has the advantage of lower production costs per kilo of corn, greater productivity per hectare and, more importantly, higher water productivity. For example, the use of drip irrigation method in Mexico has sustained water bodies tremendously (IICA, 2015; OECD, 2010). In as much as we are supporting the idea of drip irrigation system, it also discourages theft of the equipment. Since sprinkler type exposes and can be seen by everyone, stealing it become easier. FAO (2015) reported also that solar-powered water technologies are increasingly in demand in developing countries and it has the benefit of a cost-effective solution to increase agricultural productivity and sustainability. The development of solar irrigation in Ghana has not generated a lot of governments and farmers attention due to the high cost of operation (Levidow et al., 2014). Though solar-powered irrigation pumps are being constructed at Tamalgu in the Karaga District to make sustainable energy accessible to farmers, the initiative is not widespread in the country. There is a problem of water shortage in most public irrigation schemes that uses pressurised system due to shortage of electricity. It implies that, during the dry season, resistance crops will begin to wither and the non-resistance crops will be destroyed.

In an attempt to manage irrigation water, adoption of suitable technology and the active role of extension agents will be highly desirable. The capacity of the extension agents has become an effective tool to support farmers in irrigation development and management (Taye, 2013). Tollefson, El Atfy, Facon, & Kerc (2014) maintained that many

on-farm water management programs had failed due to the failure of support service to farmers. Good-quality extension and advisory services provided by the public sector, private companies or consultants, NGOs, or farmer organisations is critical toward effective irrigation management (Levidow et al., 2014; Pereira, Feddes, Gilley, & Lesaffre, 2013; Stevens & Ntai, 2011). In Ghana, the capacity of extension officers is generally low, making them not to function properly. The extension-farmer ratio of 1:1500 farmers are too much for a single extension agent to handle, especially when there is no proper incentive or motivation. Drechsel, Scott, Raschid-Sally, Redwood, & Bahri (2010) also stressed that extension workers often lack professional training and skills to execute their responsibilities, however, irrigation extension officers should acquire current agricultural knowledge such as practical knowledge, technical, and innovative skills, professional certification, continued education and limited the extension-farmer ratio (for example 1:500) by employing more extension agents. The contributions made by ICID focuses on a new e-Learning service that is proposed to provide the most viable option in training a large number of irrigation officials and professionals and provision of scholarship to study (ICID, 2014). It is proven that irrigation stakeholders perform adequately when frequent capacity building initiated with needed incentives, technical and water information to boost their efforts. (Mukherji, Facon, De Fraiture, Molden, & Chartres, 2012; Ounvichit, Ishii, Kono, Thampratankul, & Satoh, 2008; Ritzema, Wolters, & Van Scheltinga, 2008; Sheahan & Barrett, 2014). Government conduct farm forums in various part of the country where irrigation is practised but little attention is given to the training of irrigation officials in computer literacy, records keeping and new technologies. Important information is lost at irrigation scheme office making it difficult to evaluate the progress of the schemes. A success story in China shows that incentive to irrigation farmers can improve water management. In China the farmers are rewarded in monetary terms based on the amount of water they have saved at a particular time (Huang, Wang, Easter, & Rozelle, 2010). Additionally, the incentive to farmers is supported by

Oberkircher & Hornidge (2011), introducing volumetric pricing to create an economic incentive for farmers. This idea can provide farmers to be efficient in using water thus reducing water scarcity. In the case of Ghana since the distribution of water is controlled from a central point that determines the quantity of water supply, farmers can be motivated to report any fault which can jeopardise the efficient flow and distribution of irrigation water. A study conducted in Sudan revealed that legislation and regulation were not effective until local board with enforcement power was set up (Setta, 2012). The Sudan initiative shows that laws need enforcement for it to work and it activates stakeholders to work productively. There are windows of opportunities in shaping irrigated agriculture in Ghana through strong institution backed by government law. This implies that forming a task force under the umbrella of GIDA in collaboration with EPA can detect bad practices and enforce irrigation policy. JICA had prepared a legal arrangement of farmers' participation in irrigation facility management and relevant bye-laws, strategies and policies to help local farmers in Ghana. Drechsel et al. (2014) commented on the importance of such initiatives aiming at reducing the risk of poor irrigation practice and promoting irrigation performance. Unfortunately, the problem of policy enforcement has been a major setback in many contexts in Ghana. This is because the main enforcement bodies lack adequate organisational and human capacities to perform ((Nanedo, Prior, de Bruyn, & Marshall, 2014).

Vanni (2014) observed that in addressing the relevant challenges in collective activities, it is very important to know the type of organisation involves to increase the level of coordination. Organization or institution involvement in collaboration activities differs base on the benefit each will derive. It can be assumed that the effective participation of the farmers will be high since they are the end beneficiaries of every project at the farming sector. Unfortunately, despite the existence of national irrigation policy, its strategies and actions, it has not translated into the expected success of irrigated agriculture in Ghana. For example, some of the institutions exist only on paper while

others collaborate. The consequences are that it increases farmers dissatisfaction and distrust towards stakeholders due to the failure of promises. Since every project at the sector is participatory, the necessary institution can inform the farmers about the progress of any project through meetings. Therefore, Ghana irrigation requires the contributions from relevant stakeholders as partner preferably for a long-term basis with regular interaction, particularly with beneficiary farmers to build up trust and confidence. In furtherance, private sectors that supply equipment and services should actively work together with stakeholders in managing and protecting common water resources (Reynolds et al., 2011). The impact of sustainability at the farm level can be felt when farmers' plights are resolved. Irrigation institutions must be forthcoming and respond to the needs of farmers by ensuring that constant interaction is upheld, building trust as well as integrating transparency in the management of irrigation at all levels. On the whole, collective activities is very crucial and can address most of the problems at the farm-level (Vandersypen, Verbist, Keita, Raes, & Jamin, 2009).

5 Conclusion

The study identified key strategies and recommendations from current studies as alternate solutions to reshape Ghana's irrigated agriculture. The study leads to the conclusion that there is no single solution for irrigated agriculture but the body of literature provided strong stimuli for improvement. Several options have been mentioned in the current study such as sustainable operation and maintenance, improve irrigation system methods, sustainable farming practices, irrigation extension service, collective responsibility and action, institutional frameworks and capacity building. Although some of these strategies and recommendations demand additional costs, they can lead to higher benefits to the farmer, project manager and government. Alternatively, irrigation sector should take full advantage of abundant water resource in Ghana and ensure that irrigation is handled in a way that protects the environment for the present generation without compromising the benefits of the future generations.

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