Civil and Environmental Research www.iiste.org
ISSN 2224-5790 (Paper) ISSN 2225-0514 (Online)
Vol.10, No.3, 2018

Small Scale Irrigation Development in Upper West Region, Ghana; Challenges, Potentials and Solutions

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Abstract

Agriculture production is largely rain fed in Ghana and West Africa. Meanwhile the rainfall pattern in these arid and semi-arid areas is short and erratic. In the Upper West Region, rainfall starts in May and ends in October. Small-scale irrigation systems have been introduced to ensure food security in the region. Food insecurity and poverty are the major setbacks resulting in migration out of the region in search of other menial jobs during the dry season. The study was carried out in four districts, Wa West, Nadowli, Lambussie-Karni and Nandom with their respective schemes at Siru, Sankana, Karni and Kokoligu. The scope of the study was to assess the state of irrigation structures, identify challenges and potentials and propose ways to improve irrigation development in the region. It was ascertained that irrigation structures in the region are in a very deplorable state leading to inadequate water supply to farms. Although soil nutrient levels in the study area are low, the high clay contents compared to most soils from the region suggest a higher ability to hold available plant nutrients for plant growth. The study also found out that irrigation in the region lacked access to inputs and credit, ready markets, mechanized labor and extension services thus resulting in the poor performance of small-scale irrigation schemes. The study also identifies water and land as major potentials for production if reliable farmer support and the appropriate technologies are available. There is the need for major stakeholders such as farmers, government (MMDAs), policy makers, research institutions and non-governmental organizations to complement efforts to rehabilitate irrigation structures, facilitate input availability, easy access to credit and enhance extension services to boost the development of already existing schemes in the region.

Keywords: small scale irrigation, development, challenges, potentials, solutions

1. Introduction

All over the world developing nations have invested a chunk of their funds in infrastructure for irrigation development in the form of irrigation schemes over the last half century, noticing its importance for food cultivation for the rising population (Gorantiwar and Smout, 2005). This investment, together with modern farming practices such as the use of fertilizers, high yielding varieties and plant protection techniques has led to an increase in yield per acre of irrigated land compared to that obtained from rain-fed agriculture on the same size of land (Shah, 2008). Notwithstanding this achievement, there is still doubt that many irrigation schemes are not performing up to their desire levels or achieve the goals. Irrigation development is seen as a remedy to reducing poverty than any other public development in most dry and semi-dry countries as emphasized by Carruthers *et al*., (1997).

The wide poverty gap between the Southern and Northern Ghana has been attributed to the rainfall pattern of Ghana. The south experiences a bimodal rainfall pattern whiles the north have a unimodal rainfall pattern. Hence, farmers in Northern Ghana cannot engage in all-year-round farming with one rainy season. Having realized the shortcomings of rain-fed agriculture to guarantee food supply and all year round farming especially in Northern Ghana, the Government of Ghana and other development partners have developed some irrigation schemes in the Upper West Region to help enhance agricultural production and reduce poverty (National Development Planning Commission, 2008). However, current Ghana Poverty Mapping report reveals the region is still the poorest in all Ghana's regions with 70.7% as a whole (Ghana Statistical Service, 2015). Therefore, pragmatic steps need to be put in place to address the high poverty incidence in the region and key to this is to improve the development of small scale irrigation schemes considering the fact that the majority of the people are found in rural communities and are the most vulnerable. This paper seeks to assess small scale irrigation development in the Upper West Region, examine the land suitability of selected schemes, identify challenges and potentials and propose ways to improve irrigation development in the region.

2. Brief History of Irrigation Development in Ghana

History trace Ghana's irrigated agriculture to a little over a century ago (Namara *et al*., 2011; Smith, 1969) but the practice on a small-scale started far way back in the early 80s on farm lands that were high above flood level between the lagoon and the sandbar separating it from the sea (Kyei-Baffour and Ofori, 2006). As a result of the natural terrain in certain areas of the country, intensive farming methods by irrigation, manuring and crop rotation had to be employed (Kyei-Baffour and Ofori, 2006; Smith, 1969). The practice of serious irrigation in the 1960s and the year 1980 saw the development of approximately 19,000 ha of irrigated land and by the year 2007 the area under irrigation had increased to 33,800 ha (Namara *et al*., 2011).

In Ghanaian perspective, irrigation systems can be categorized into two different forms: formal systems and informal systems. Officially not much is known about the informal systems, but they are expanding at a faster rate as a result of easy access to relatively affordable pumping technologies and readily available markets for horticultural crops (Namara *et al*., 2011).

2.1 Formal / Modern Irrigation Schemes.

These kinds of schemes are capital intensive and normally undertaken by the Government of Ghana and its development partners from the initial phase of the projects to the end. These schemes ranges from few hectares to tens of hundreds of hectares, hence government developed schemes covers small, medium and large scale. Out of the total irrigated land, it is estimated that a little below 9,000 ha was developed by GoG with the remaining land been developed by the private sector (Namara *et al*., 2011). Several studies conducted in Africa and more especially West Africa reveals that most medium to large irrigation schemes developed by government has failed (Dittoh, 1991; Sarris and Ham, 1991; Musa, 1992; Mariko *et al.,* 2001). Indeed studies conducted on Ghana's twenty-two (22) public irrigation schemes suggest that most of them are not performing up to expectation (Dittoh *et al.,* 2014; Kyei-Baffour and Ofori, 2006). Moreover research shows that formal schemes appear not to favor small poor farmers (Pant, 2004).

2.2 Informal/Traditional Irrigation.

Informal or traditional systems are initiated and developed by private entrepreneurs and farmers. These systems rather seem to be doing well in terms of the area irrigated and yield obtained than the formal systems. In Ghana, it has been estimated that the area under traditional irrigation is five times more than the formal irrigation systems (Dittoh *et al*., 2013). According to Nanes (2011), the area under traditional irrigation is far higher than what has been estimated. These forms of irrigation include groundwater or shallow well irrigation, tube-well irrigation, small pump irrigation and out-growers systems. The use of pumps to irrigate from surface waters is becoming popular among farmers in almost all Ghana's regional capitals (Namara *et al.,* 2011). In fact at the last final deliberation workshop of the AgWM Solutions in Accra, key participants came to a conclusion that 80 to 90 percent of Ghana's irrigation is smallholder based (Dittoh and Akuriba, 2012). Unlike formal irrigation systems, which seem to be primarily designed for rice production, the major crops grown under informal irrigation systems are horticultural. However, some staple crops such as maize, rice and cassava are cultivated either solely or in association with vegetables (Kyei-Baffour and Ofori, 2006).

2. 3 Why Irrigation Development in Northern Ghana

Water is one of the most important ingredients in agricultural production aside labor. The dependence on natural rainfall for agricultural production affects crop yield when the rains fail at the needed time (Kyei-Baffour and Ofori, 2006). The inability to control this natural input makes it difficult for farmers to produce effectively which subsequently result into low yields being obtain by most producers especially those in the northern part of the country of which the study area is not an exception. Therefore, it is necessary to improve upon the development of irrigation schemes more importantly small scale ones to provide all-year-round-farming due to the long dry season and the erratic nature of rains which seriously affect agricultural productivity since it cannot be controlled (Kyei-Baffour, 1994).

Irrigation has the ability to solve these bottlenecks and helps reduce poverty by offering employment especially to rural households, ensuring food security and stabilizing food prices both in the rural and urban markets (Lipton *et al.,* 2003). It is estimated that 40 percent of the total world food crops produced comes from irrigation under only 17 percent of the total arable land in the world (Upton, 1996; International Programme for Technology and Research in Irrigation and Drainage, (IPTRID), 1999). This suggests that 60 percent of food crops produced is through natural rainfall. However, research shows that, crop yield in irrigated farming are far better than those from natural rainfall (Kyei-Baffour, 1994, Swamikannu and Berger 2009). This strengthens the argument that irrigation development is the solution to long lasting agriculture (Shah, 2008). The good thing about irrigation is that, it can control and release water anytime to crops especially at peak demand for its growth and also has the potential to take away unused water, which is difficult or not possible to do with natural rainfall (Rydzewski, 1987). Irrigation is also needed because of the long dry season that pertains in northern Ghana. The timing of rains is another issue that affects agricultural production. For example, the northern part of Ghana experiences a single rainfall pattern of short duration and excessive evapotranspiration rates. The dry season in this areas are long of almost 7-8 months. This means that under rain-fed agriculture, farming is possible for only 4-5 months and production of crops with longer duration is risky further suggesting the development of irrigation schemes in the three northern regions.

2.4 Small-Scale Irrigation in Ghana's Irrigation Policy and Development Plan

The Ghana Shared Growth and Development Agenda (2010-2013) at the national level proposed the development of appropriate irrigation schemes for smallholder famers as a follow-up of an earlier national and sector policies, as well as political debate (Dittoh *et al*., 2014). According to (MOFA 2007), the Food and Agriculture Sector Development Policy (FASDEP II) is the main agricultural policy with the Medium-Term Agricultural Sector Investment Plan (METASIP) 2011-2015 being the country's agricultural development plan carved out from the policy (MOFA, 2010). Both documents clearly listed the importance of irrigated farming and the potential for development. In 2002, FASDEP II estimated 11, 000 hectares of land to be under formal irrigation. However, an estimated 500,000 ha of land including inland valleys could be developed for irrigation as noted by the policy. According to Dittoh *et al*., (2014), in 2000, GIDA identified 32,000 hectares of inland valleys in the country for food production with proper moisture capturing methods which were underutilized. Issues that hinder smallholder irrigation development were outlined in FASDEP II as "formal irrigation development is much dependent on external support and over dependence on the formal system has limited the area under irrigation". Moreover, the informal sector (Small Scale Irrigation) is not supported fully to achieve its potential. Despite these facts, the policy has not made any guideline to actualize small-scale irrigation development.

The value of Small-Scale Irrigation (SSI) have been outlined in the METASIP with priority placed on micro and small-scale irrigation systems in the short- and medium-term as many of them have succeeded to a large extent. The policies equally outline plans in the long term to develop large scale irrigation systems in the near future and a number of valleys in the savanna zones. The METASIP outlines future development plans for SSI systems by 2015 which are yet to be realized.

It is therefore the objective of the country's irrigation policy to address the following four key areas in order to achieve the main goal of Ghana's agriculture sector (MOFA/FAO, 2010). They include:

- Inadequate production and low growth rates
- Constrained land and water resources
- Irrigated agriculture and environmental degradation
- Insufficient support to the irrigation sector.

The role of irrigation in enhancing food production and poverty reduction is categorically stated in the policy. However, the policy states that, the surest way to decrease the poverty level is by developing irrigation schemes. It also identifies different forms of irrigation practices as being part of the solution process. The Ghana irrigation policy does not treat SSI as important over large schemes, but rather explores the possible options in different parts of the country.

Lastly, the procedure for groundwater resources development especially for irrigation has been addressed in the Water Resources Commission Act (No. 522 of 1996) and Legislative Instrument (LI 1827- 2006) as provided in the National Water Policy (2007). The distinction between surface and groundwater resources and the importance of one over the other is clearly spelt out in the NWP (2007). The objectives of the irrigation policy are to:

- Provide good adequate water for crop, livestock and fish production.
- Maintaining the ecosystem so as to provide alternative livelihoods by ensuring good quality water availability.

These objectives can be achieved through the following measures:

- District assemblies should promote small and valley bottom irrigation development.
- Assemblies should support in the utilization and maintenance of small irrigation structures.
- There is need to promote public private partnership in the provision of large irrigation infrastructure.
- Conserve water resources through the efficient fertilizer application methods.

- Improve water application methods and minimize losses in irrigation schemes.
- Prevent the silting up of water bodies by practicing good land use and control land degradation.

Although these policies envisage the importance of irrigation, including SSI to national development, it appears a little has been done so far. In 2014, the Ministry of Food and Agriculture reported that the combined area cropped under both formal and informal irrigation in 2013 was 21,677.9 ha, an increase of 8.1% over 2012. This success was largely through the contributions of small and private irrigation systems.

3. Methodology

In assessing small scale irrigation development in UWR, data was collected from selected small-scale irrigation schemes in four districts (Wa West, Nadowli, Nandom and Lambussie-Karni) for detailed study. They include; Siru, Sankana, Kokoligu and Karni systems. The criteria used in selecting these schemes were based on GIDA-UWR preliminary survey to identify schemes with several challenges that require immediate attention, proximity of the scheme, cost and timing of the research. Figure 3.1 outlines the methods used in carrying out the research.

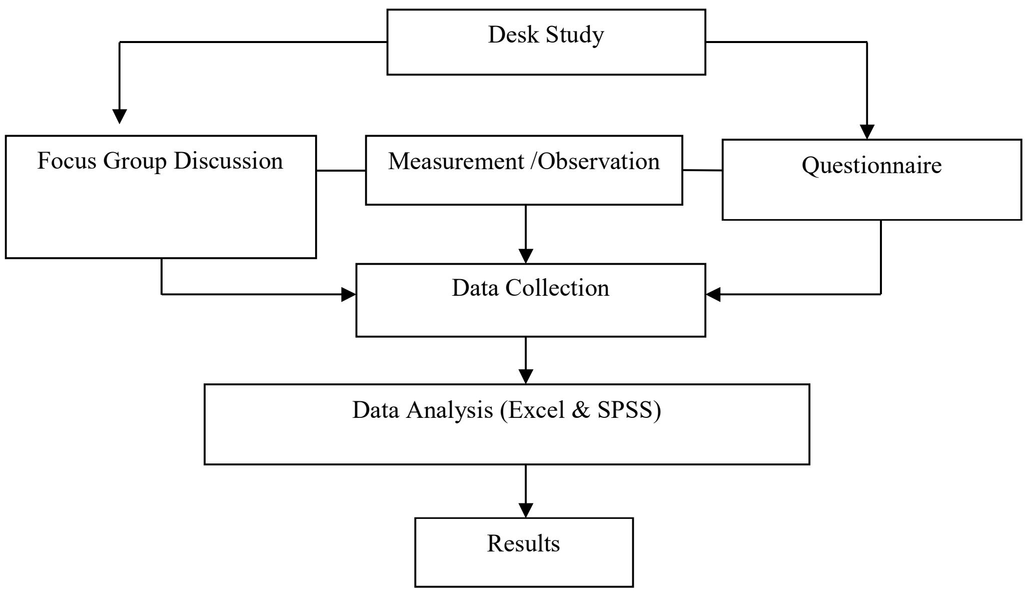

Figure 3.1 outlined the methodology in carrying out the research

3.2 Desk study

Secondary data was collected from GIDA for study. They include reports, journals, and articles. Official records were obtained from GIDA which gave some information on small scale irrigation schemes in the region. The data provided information on the various schemes in the region, their date of construction and rehabilitation, technical state, water use, potential irrigable land and developed area.

3.3 Focus group discussions (FGD's)

Departmental heads of GIDA and MOFA at both the regional and district levels were interviewed on their own assessment of small scale irrigation development in the region. The Water Users Association (WUA) executives and other opinion leaders were also interviewed on the challenges facing the schemes and the way forward to improve the development of these schemes.

3.4 Administration of questionnaire

Questionnaires were administered to a total of 231 farmers at the selected schemes to obtain detailed information on small scale irrigation development in the region. Data on the challenges and potentials of these schemes was also collected. The data was then analyzed using Excel and SPSS.

3.5 Field work

3.5.1 Assessment of irrigation structures

Field visits were carried out at the selected schemes to assess the state of existing irrigation structures on the ground, how they are utilized by farmers and constraints on their performance. This was done through measurement of some structures (canals, laterals and bunds), observation and interviews.

3.5.2 Land suitability analysis

The study mainly involved the sampling of two dam sites and examination of the soils (Wa West-Siru and Nadowli-Sankana). In each dam site, an area to be cultivated under irrigation was identified and soil samples taken. Composite soil samples from depths of 0-20 cm were collected randomly from each dam site and analyzed for initial physical and chemical properties of the soil. In addition, auger bores were made at each scheme to examine the soil for depth, drainage, texture and coarse fragment content. Standard laboratory procedures were followed in soil sample preparation. Soil samples were mixed, homogenized, air dried in shade, ground and passed through a 2 mm sieve, and analyzed for total N, available P, pH, organic carbon, exchangeable cations (K+, $Ca^{2+,}$ Mg^{2+}), exchangeable acidity (Al+H) and soil texture. Accordingly, soil pH was measured using a soil to water ratio of 1:1 (w/v). Organic carbon was determined following the Walkley and Black wet oxidation method. Total nitrogen was determined by the micro-Kjeldahl digestion, distillation and titration method. The available phosphorus was extracted by Bray-1 procedures and was determined calorimetrically. Exchangeable potassium was determined by the ammonium acetate method. Soil texture was determined using Bouyoucos hydrometer method.

4. Results and Discussions

4.1 State of Irrigation Structures in the Region

The state of irrigation structures in the four selected schemes comprising Siru, Sankana, Karni and Kokoligu was done based on physical assessment, measurement and observation. Detail description on the technical state of structures at the various schemes is provided below.

- At Siru, the ongoing irrigation practice is basically private, led by farmers. The system has no major infrastructure in place aside a notch as shown in figure 4.2. Thus conveyance of water is done along the river course within irrigable area using pumps of varying capacities which have been acquired by farmers. The farmers who are not able to purchase pumping machines resort to the digging of shallow wells near their plots for water to irrigate and others also flood their fields with water from the reservoir through the notch.

Farmers construct bunds and gullies of various sizes for efficient water use and control. Bunds cross-sectional height ranges between 0.5m and 0.4 m. The lack of technical expertise or advice in constructing bunds normally leads to failure of most of these bunds due to the continuous flooding of fields and sometimes due to rain. Therefore, there is an urgent need to provide a facelift at Siru by constructing conveyance system, which will reduce wastage of water and also increase yield with good water management structures and provision of farmers' technical extension services.

Figure 4.2 State of Notch and Bunds at Siru

- The Sankana irrigation scheme has a gravity system of irrigation. The conveyance canals are two, being the right and left bank canals of which both are in a bad state making it difficult for farmers to get enough water to irrigate crops. From field assessment and observation, both canals are trapezoidal in shape and lined. The extent of deterioration of the canals and laterals as shown in figure 4.3 will require complete reconstruction with proper water management structures like check gates, turn outs, division boxes, and canal crossings.

The right and left bank canals are 1.03km and 1.17km respectively. The bottom width of the right bank canal is 0.3m and the top width is 1.9m. The depth of the canal is 0.9m.The left bank canal measures 0.2m, 0.5m and 0.3m accordingly. A section of the left bank canal consists of 2Nr. 300 mm diameter Asbestos pipe aqueducts in parallel across an 18m spillway channel. There are 26 laterals constructed under UWADEP of which 9 are on the right bank canal and 17 on the left bank canal (GIDA-UWR, 2014). The total length of the laterals is estimated to be about 3.9km. They are lined with slabs and trapezoidal in shape. The average length of the laterals is about 150m, with spacing of 75-100m. The right bank laterals irrigate 40% (24ha) of the developed area and left bank 60% (36ha). The drainage system consists of the main Bulipielaa and tertiary drains. The main drain is 1.1km long. The tertiary drains are from plot to plot and discharge into the main drain from the last plot. There are no secondary drains on the scheme. The dilapidated state of canals in this scheme makes it difficult if not impossible to deliver the right amount of water to the fields. Siltation and non control gates results in a lot of water seepage from both canals.

Figure 4.3 State of Right and Left Bank canals at Sankana

- At Karni, the scheme consists of one (1) main canal and seven (7) laterals. The main canal is in a very deplorable state as presented in figure 4.4. The laterals are fairly good but due to the bad nature of the main canal, farmers find it difficult to get enough water to irrigate their crops as a result of water seepage into the bare ground. Moreover, farmers upstream breached through the main canal to tap water into their fields. Hence, instead of water flowing through the already dilapidated canal downstream, it is diverted into shallow wells upstream leading to inadequate water supply downstream. The main canal is about 845m (0.845km) long, with a section (300m) completely silted with sand. The bottom width is 0.3m and top width of 0.6m. The depth of the canal is 0.5m. The average length of each lateral is about 343m and with spacing of 70-100m. The bottom and top width is 0.3m and 0.4m respectively. Lateral depth is 0.3m. There are no gates to control water into the fields. Farmers in this scheme rely greatly on groundwater/shallow wells for irrigation. Management of this scheme is done basically by farmers themselves.

Figure 4.4 State of Main Canal and Lateral at Karni

- At Kokoligu, the scheme is made of pipes which serve as canals and discharges water into chambers dotted across the entire field for farmers to irrigate their crops as shown in figure 4.5. As a result of animals grazing on the fields, most of these pipes are broken and cannot deliver the right amount of water for irrigation. This leads to water wastage and thus affect crop production.

Figure 4.5 State of Pipes and Chambers at Kokoligu

Land Suitability of Cropping Area

Land suitability examination of two schemes (Siru and Sankana) was performed and various soil chemical and physical properties analyzed to determine the suitability of the cropping area. Table 1 presents the soil chemical properties (Mineral Content) at Siru and Sankana.

Soil Reaction (pH):

The top soil (0 – 20cm) from Siru and Sankana dam sites is moderately acidic (5.6 – 6.0). Maintaining soil pH between 5.5 and 7.0 will enhance the availability of nutrients such as nitrogen (N) and phosphorus (P) as well as microbial breakdown of crop residue as stated by the Savannah Agricultural Research Institute (SARI) Wa-Station.

Organic Matter and Nitrogen status (OM and N):

Topsoil organic matter for Siru dam site is low OM (<1.5%) and moderate OM (1.6 - 3.0%) for Sankana. Nitrogen however for both sites is low (<0.1%). On the whole, the organic matter status of all the sites can be improved. Soil nutrient depletion is a principal concern. Moreover, most of the cultivated soils are inherently low in natural fertility and even the relatively better soils are increasingly being depleted through many years of continuous cropping without adequate nutrient additions. It is worthy of note that soil organic matter is critical in both nutrient and water retention. It is also a nutrient reservoir for holding and releasing nutrients during mineralization.

Available phosphorus (P):

The soils in Siru and Sankana have low phosphorus content (<10mg/kg). The availability of P is low in most Ghanaian soils with a high P-fixation capacity and the problem becomes more serious when the organic matter status of the soil is low. P deficiency reduces the efficiency of biological nitrogen fixation.

Exchangeable Potassium (K):

Exchangeable K levels for the sites are moderate (50–100mg/kg). Potassium for most northern soils is high due to burning for land preparation.

Effective Cation Exchange Capacity (ECEC):

ECEC, the exchangeable cations (Ca, Mg, K, Na) contents for Siru and Sankana are low (<10cmol/kg). The availability of these bases depends largely on a higher organic matter in the soil.

Soil Physical Properties

The texture for soils from Siru dam site is Sandyloam and that of Sankana is Sandyclayloam. They both have significant clay percentages of 14.32% and 28.2% respectively. The high clay contents compared to most soils from the region suggest a higher ability to hold plant available nutrients for plant growth. Water holding capacity will be high and less susceptible to erosion.

Summary of Soil Analysis

In general, the two sites sampled had low chemical properties than reported values for productive soils. Thus soil fertility is generally low. The levels of organic matter, total nitrogen and available phosphorus are generally low. The low organic carbon and total N contents may be attributed to the low biomass production and a high rate of decomposition. Potassium is mostly abundant in the soils of Northern Ghana, including UWR.

Though the nutrients levels are low, the high clay contents compared to most soils from the region suggest a higher ability to hold plant available nutrients for plant growth. Water holding capacity will be high and less susceptible to erosion. An increasingly erratic rainfall pattern is without doubt the most limiting factor to crop production in the UWR. Thus measures to mitigate water deficit created by the low rainfall are indispensable.

Table 1: Soil chemical Properties (Mineral Content) at Siru and Sankana

Properties	Siru Dam Site	Sankana Dam Site
$_PH$ (1:1H_2O)	5.86	5.71
Organic C (%)	0.780	1.250
Organic M (%)	1.345	2.155
Total N (%)	0.056	0.099
Bray-1 available P (mg/kg)	6.452	5.687
Potassium K (mg/kg)	64.95	78.59
Exchangeable bases: (cmol/kg)		
• Ca	1.94	2.57
• Mg	0.49	0.61
• K	0.57	0.78
• Na	0.05	0.07
Exchangeable acidity (cmol/kg)	0.08	0.09
ECEC (cmol/kg)	3.13	4.12
Particle Size: (%)		
• Sand	82.72	64.84
• Silt	2.96	6.96
• Clay	14.32	28.2
• Texture	Sandy loam	Sandyclayloam

Challenges Identified

Farmers in the selected schemes identify the following water structures, labor, inputs, extension services, energy (fuel) and market as the key constraints to their production.

❖ Water: access to reliable source of water is vital to irrigation farming. In ensuring that farmers get adequate water for their production, it is important to put the right structures in place for water capturing and delivering to fields. From the field survey, it was realized that structures such as canals and laterals were in a very bad state making it almost impossible to send the right volumes of water to fields. Moreover, there are no gates or proper drains for controlling, regulating and draining off water in all the schemes. This situation has compelled the majority of farmers to resort to groundwater or shallow wells for irrigation which requires a lot of labor.

- ❖ Availability of Labor: Labor is one of the major ingredients that affect production greatly in the study area. In most instances on these small farms, the farmers and their families provide the labor force operating the irrigation system and no direct cash payment is made for outside help. In this case, the cost of labor may not be included in the operating cost calculations. In some cases, the farmer and some members of family may hire labor for ploughing. In this case, the cost of the labor would need to be included. This can be a significant cost and may have an influence on the values and choice of system, particularly as some systems are more labor intensive than others. A particular case is where farmers spend a chunk of their time to irrigate their fields since most of them depend on wells. Lifting water from wells to irrigate once or twice daily can be labor intensive. Instead of farmers using part of their time into other equally important activities on their fields if irrigation structures were functioning properly, they rather spend much time to irrigate their crops. This accounts for the smaller cultivation of fields.

- ❖ Inputs and Credit: the cost of inputs such as fertilizer, seeds, insecticides, herbicides and equipment especially pumping machines comes at a high cost. Most of the farmers do not have collateral to secure loans from the banks. This constraints expansion of activities and limits most farmers to subsistence farming.

- ❖ Marketing: Crops are sold either directly by farmers to consumers in local markets or through middlemen. Market information is not readily available to farmers; hence farmers who transport their produce to distant towns may find the market flooded with the same produce. Middlemen and women take advantage of the situation and lure farmers into selling their produce at a much cheaper price. Clearly, farmers need some protection, may be in the form of better market information.

- ❖ Extension Service: farmers complain of crop failure as a result of diseases. This has not only affected yield but also demoralized them from cultivating certain crops. Agricultural Extension Agents (AEAs) hardly visit farmers to identify their challenges in order to provide them with appropriate solutions. Farmers therefore rely on their own 'try and error methods' to solve their challenges and this affects their output and income. Extension service is a medium by which information and technologies are delivered to farmers (Moris, 1985). According to the World Bank definition of extension service, it is the process by which farmers are aware of improved technologies and adopt them in order to improve their efficiency, income and welfare (Purcell and Anderson 1997: and Pedon, 2006). In the four selected schemes, statistics show that most of the farmers can neither read nor write. Therefore in order to ensure that farmers get the right agricultural information, it must be done through extension agents and field facilitators of NGOs. At the moment farmers in the study area are practicing irrigation without much knowledge on agronomy, proper water application techniques and crop protection. A clear example is the case of Siru, where farmers construct bunds and gullies for efficient water use and control, but due to lack of proper technical advice they are failing as a result of the continuous flooding of fields. Also, in all the four selected schemes, vegetable farmers were not using the right amount and method of fertilizer application, they apply as and when there is money to buy fertilizer.

- ❖ Energy and Pumps breakdown: farmers acquire these pumps based on their ability to afford instead of technical knowledge. Farmers are not trained to maintain their pumps and generally do not carry spare parts. The cost of fuel is also becoming increasingly high and this increases their cost of production. Moreover, spare parts for these pumps are normally difficult to acquire as stated by Namara *et al.,* (2011).

Potentials Identified

The potentials identified in these schemes include:

- ❖ Land: The region has abundant land for production. Out of a total command area of 164 ha in the four selected schemes, only 44 ha is under cultivation. The remaining 120 ha is not cultivated implying there is available land for production in the region. Agricultural land was last measured in 2011 at 69.88 % according to the World Bank. The Ministry of Food and Agriculture (MOFA) statistical results indicate vast arable land availability for both irrigation and rain-fed production (Obeng, 2000). Of the total land area of 23.9 million hectares, 13.6 million hectares (57.1 %) was classified as agricultural land area with only 5.3 million (22.2 % of all agricultural land area) under cultivation with just 4 percent under irrigation during the last count in 1995 as reported by MOFA. It is therefore not out of place when people make the assertion that land is abundant in Ghana for that matter the study area.

- Water Availability: The research shows that there are available water resources all year round for agricultural production in the region. The capacities of the four schemes (Siru, Sankana, Kokoligu and Karni) were 0.73, 1.6, 0.320 and 0.365 million m^3 respectively from the field survey and capable of storing and supplying enough water for irrigation. A study by IFPRI reveals that there is enough water for irrigation increment in Ghana (Dittoh *et al*., 2014). The estimated renewable water resource of Ghana is 53.2 km^3 of which 0.25 km^3 is used for agriculture production (Alexandratos *et al., 2006*). Ghana has a cultivable land area of about 42 % which covers the entire country with a little of 4.25 % under intensive cultivation. This means that, water and land utilization in Ghana is very low for irrigation and rain-fed production (Venot *et al.,* 2012). Despite challenges to supply water to certain deprived areas, substantial amounts of water are lost due to evaporation, runoff, leakage and seepage. Water "lost" through these processes are likely to return to aquifers or streams which can be re-extracted for use if only the appropriate structures are available and the water quality has not gone beyond acceptable limits (Wallace, 2000).
- District Assemblies (DAs): All the four schemes are under the jurisdiction of a particular district. The first point of call as far as development is concerned in the districts is the DA. Moreover, the 1992 Constitution of the Republic of Ghana, in Article 240, tasks the local government authorities (Metropolitan, Municipal, and District Assemblies- MMDAs) to plan, initiate, co-ordinate, manage and execute policies in respect to all matters affecting the people within their areas. In view of that mandate, the Local Government Act, 1993 Act 462 defines some functions for the MMDAs such as to:
    - Formulate and execute plans, programmes and strategies for the effective mobilization of the resources necessary for the overall development of the district.
    - Promote and support productive activity and social development in the district and remove any obstacles to initiative development.
    - Initiate programmes for the development of basic infrastructure and provide municipal works and services in the district.
- District Agricultural Development Units (DADUs): Another potential that was found to be present in all the selected schemes is the DADUs. Their objectives are to:
    - Manage and co-ordinate the District Department of Food and Agriculture within the District Assembly.
    - Ensure the development and effective implementation of the district agricultural programmes.

Their responsibilities include:

- Oversee the preparation of the District Agricultural Development Plan and its incorporation into overall District Assembly Plan.
- Prepare District Annual Agricultural Work Programs and Budget for submission to the District Assembly.
- Ensure that scheduled training programmes are implemented and technical backstopping provided.
- Liaise between Department of Food and Agriculture and stakeholders on programmes related to the development of agriculture in the District.
- Ensure effective monitoring and evaluation of agricultural programmes in the districts.
- Establish relevant demonstrations, field days, and farmer fora in the districts.

- Advise the District Assembly on matters related to agriculture in the district and
- Ensure food safety in the district.

- Financial institutions and NGOs

In 1976, the Ghanaian government, through the Bank of Ghana, established Rural Banks to channel credit to productive rural ventures and promote rural development. This strategy was intended to improve the economic and social life of the rural poor. It is expected that, in the long term, credit will enable the poor to invest in agricultural and non-agricultural productive assets, as well as adopt new technologies and farming methods among others. Therefore, it is envisaged that financial institutions operating in these districts will assist rural farmers with loans to enable them finance their agriculture activities. At Sankana and Karni farmers attested to fact that they have gotten some support from MOFA, Plan Ghana and Catholic Relief Service in the form of credit, inputs and technology some years ago. Although for some time now they have not received such aid, the presence of these NGOs in the districts implies that farmers still stand the chance of benefiting from these benevolent organizations.

5. Conclusion

There are many factors that affect the performance of irrigation schemes in the region. These include poor irrigation structures, soil infertility, lack of access to credit, mechanized labor, poor extension services, lack of markets and high cost of inputs. The Upper West Region is in the savannah ecological zone and is prone to prolonged drought. Access to irrigation increases the opportunity for crop intensity and diversification, which has the potential of increasing farmer income. Irrigation is becoming a practice to increase total annual income for many household in the study area. In addition to their normal rain-fed cultivation, farmers cultivate vegetable crops during the dry season using small-scale irrigation. The main irrigated vegetables are tomato, pepper, onion, garden eggs and leafy vegetables. With the introduction of cereal crops such as rice and maize, using irrigation, farmers stand the chance of stabilizing production and making more profit.

The use of small diesel pump for water delivery and application during the dry season vegetable production is far better than the use of watering can, bucket and calabash form of water application which is labour intensive. Farmers who use pumps to irrigate reduce the time and energy used in irrigation as compared to those lifting from shallow wells.

The four reservoirs namely Siru, Sankana Karni and Kokoligu of which studies were conducted are capable of storing enough water for irrigation farming in the dry season.

6. Recommendations

The quest to search for measures and solutions to alleviate poverty and food insecurity in the region has been on the fore for many years which requires various interventions. In doing that, it is important to give attention to the different social class of the rural community in the region which consists of groups of poor people with unequal level of assets and endowment. With this at the fore, the following possible solutions are recommended for the improvement of present and future small-scale irrigation development in the region.

They include;

- Government through district assemblies should rehabilitate and prioritize capacity utilization of existing irrigation systems before starting new developments in order to learn from the weakness and plan for new ones in the region.
- Farmers must be encouraged to use more organic manure as compared to chemical fertilizer in order to improve their soil fertility.
- There is the need to form vibrant farmer groups and Water Users Association to enable them access credit, plan and take decision that will improve productivity and scheme performance such as fee fixing for irrigation water use.
- MOFA through Agricultural Extension Agents (AEAs) need to organize regular in-service training for farmers in order to keep them abreast with new skills, technologies and especially on the use of inputs.
- Farmers need to focus and diversify from current crop production to other highly profitable cereal crops considering the high cost of irrigation development.

- Government and other developmental agencies should facilitate groundwater or shallow wells development in order to further improve access to irrigation water at existing schemes.

- A Regional Maintenance Unit should be created and attached to GIDA to do regular monitoring and prompt repairs of facilities instead of allowing the WUAs to contract their own masons to do repairs. This would ensure quality of work and prolong the lifespan of facilities.

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