

*Full Length Research Paper*

# Private initiatives in rural irrigated agriculture towards sustainable livelihoods in Nadowli-Kaleo District, Ghana

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At the dawn of the 21st Century, the goal of achieving poverty reduction became a global concern. Diverse livelihood public interventions such as the provision of community dams since then have been implemented in rural settings including Nadowli-Kaleo District of the Upper West Region, Ghana to promote food security through dry-season farming. However, the objectives of these interventions have not been realized. Rather, rural farmers engaged in irrigation farming have resorted to the initiation and utilization of private water systems prompting the examination of factors accounting for the choice of irrigation operations. A case research design was adapted in the conduct of the investigation. Five communities were selected as cases based on a set of criteria namely, the presence of an open-access dam and on-going private irrigation schemes. Factors accruing to the preference for private water systems to that of open-access community dams for irrigation included contamination of dam water by other users such as funeral undertakers, water vendors and fishermen, as well as drying up of dam water. Although irrigation engagement tremendously benefits irrigation operators and consumers through provision of fresh vegetables for household consumptions and income generation, irrigation operations are however saddled with the destruction of irrigation crops by animals, financial inadequacies and limited knowledge of farmers in irrigation agronomy. Measures proposed to propel the productive capacity of rural irrigation farmers comprise: creation of irrigation fund for farmers, entrepreneurship training in basic agronomic techniques in irrigation farming, giving awards to irrigation farmers on Farmers' Day Celebrations, establishment of block irrigation systems, and proper management of existing community dams.

**Key words:** Agriculture, rural irrigation, private initiatives, sustainable livelihoods, irrigation systems.

## INTRODUCTION

Irrigated agriculture has a track record of making giant gains in livelihoods empowerment globally. Whereas only

20% of the global agricultural land is irrigated, about 40% of the world food supply is generated from irrigation

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(Mandri-Perrot and Bisbey, 2016). Irrigation promotes farm cultivation throughout the year and also has an advantage of regulating water supplied to the crop since the water is synthetically managed. When irrigation is efficiently combined with other farm inputs such as adequate and appropriate crop fertilizer, and enhanced varieties of seed, the produce per acre of irrigated land outstrip what is generated from rain-fed agricultural land of the same size (Inkoom and Nanguo, 2011; Namara et al., 2011). Irrigated agriculture therefore creates room for an all year round intensified and diversified agriculture through increased farm produce and earnings, agricultural wage employment and reduction in poverty either directly or indirectly (ADB et al., 2007).

The scale of irrigation development can range from millions of hectares such as that found on the Indo-Gangetic Plain to that of a farmer operating on a couple of hectares using water from a well. The motivation for undertaking irrigation also ranges from inspiration of international politics to an individual's desire for a better life (Rydzewski, 1990). The benefits accruing to irrigation and its utilization especially in the area of food supply however varies on continental, regional and country basis. For instance, while 60% of food output in Asia emanates from irrigated agriculture, only 9% of Sub-Saharan Africa's total food supply is based on non-rain fed agriculture. As much as 98% of the total food output of Egypt thrived on irrigation (Lipton et al., 2003).

The global annual water withdrawal for irrigation is estimated at 2672 km<sup>3</sup>. On continental basis, Asia leads with 76% of total irrigation water abstraction (2026 km<sup>3</sup>/year), followed by Americas 15% (397 km<sup>3</sup>/year), Africa with 6.5% (171 km<sup>3</sup>/year) and Oceania 0.3% (9 km<sup>3</sup>/year). Also, irrigation water use per unit of surface area (density) is largest in arid regions with high cropping intensity such as Pakistan, Egypt, India, and Mexico which have relatively high drought risks (Podimata and Yannopoulos, 2015).

The Continent of Africa especially Sub-Saharan Africa is lagging behind in terms of investment and development of the irrigation sector. In 1961, the total irrigated land in Africa was approximately 7.4 million ha. This increased to 13.6 million in 2008 representing 6% of cultivable land (World Food Programme (WFP) and FAO, 2010). Moreover Madagascar, South Africa and Sudan make up two-thirds of the irrigated area in Sub-Saharan Africa. The performance of the sub-Continent is by far the least compared to any other region in the world. Whereas China and India expanded their irrigated area by 25 million ha and 32 million ha, respectively over a forty year period, that of the Sub-Saharan region of Africa was only 4 million ha within the same period (ADB et al., 2007).

The rate of increase of land under irrigation in Africa reached its peak in the mid-1970s with an annual growth rate of 2.3%, but has however slowed down since then (Miyoshi and Nagayo, 2006). Irrigation development in developing countries especially Sub-Sahara Africa has

therefore been dwindling due to a continual decline in the flow of investment fund to the sector by the World Bank, development partners and other external donor agencies. For instance, the allocation of Official Development Assistance (ODA) to the agricultural sector including irrigated agriculture in Sub-Saharan Africa dropped from 17% in 1980 to 6% in 2008 (Sakaki and Koga, 2013). Such changing modalities by external donors have been nurtured by the realization that irrigation programmes and investment in developing countries have not realized the expected impact of improving agricultural production. This reduction in irrigation investment was possible by means of a structural adjustment policy to address poor investments by anti-agricultural policies (World Bank, 2007).

In Ghana, there is huge potential of land and water resource available for intensification of agriculture under irrigation. Ministry of Food and Agriculture (MOFA) and Ghana Irrigation Development Authority (GIDA) (2012) estimated the irrigation potential of the country to be between 500,000 ha and 2.3 million ha. However, there is apparently low scale of overall development in the sector (Miyoshi and Nagayo, 2006). For instance land under actual irrigation stands at 206,868 ha, out of which 10,668 ha is formally developed and 186,000 ha are developed by individuals engaged in private micro and small scale irrigation farming while 10,200 ha are utilized for commercial purposes. The total land under irrigation represents only 2.8% of the 7.5 million ha of agricultural land under cultivation in Ghana. Water drawn from the renewable water resource is less than 2%, and less than two-thirds of the drawn water is actually developed for irrigation (MOFA and GIDA, 2012).

Irrigation in Ghana is often synonymous to public or communal irrigation systems and schemes mostly managed by Ghana Irrigation Development Authority (GIDA) and Irrigation Company of Upper Regions-ICOUR (Namara et al., 2010). Several research archives with regards to irrigation abounds, and mostly such literature connoting to irrigation operations especially in Ghana are either focused on urban and waste water irrigation activities, or geared towards formal (government and development partners led) irrigation schemes in rural areas. However, local governments and development partners have not reaped the expected benefits of encouraging dry-season farming by way of communal irrigation systems (small dams) establishment. Even though informal (private initiatives) irrigated agriculture dominates the irrigation sector in Ghana (Drechsel et al., 2006) constituting about 89.9% of the irrigated land (MOFA and GIDA 2012; MOFA, 2011), little has been achieved to augment and sustain the efforts of rural farmers engaged in dry-season informal irrigation.

### **Problem statement**

The economy of the Upper West Region is dominantly

agrarian. About 77.1% of households' livelihoods in the region are dependent on agriculture whereas as much as 91.4% of the populace engaged in agriculture are households in rural communities. In the study area (Nadowli-Kaleo district), which is entirely a rural district, 83.4% of households' livelihoods are dependent on farming (Ghana Statistical Service, 2013). These agricultural activities especially crop farming are highly dependent on rainfall. However, the seasonal nature of rains in the study district, thus short rainy season (mostly from June to September) and extended dry seasons (mostly from October to May) coupled with harsh dry-winds render the farmers jobless during the off-rainy seasons (Inkoom and Nanguo, 2011). This has become a perennial problem resulting in food shortages, malnutrition, and inadequate income for basic needs and services among others (Namara et al., 2011). For instance, the sixth round report of the Ghana Living Standard Survey depicted the Upper West Region as the poorest region in the country with 70.7% of its population being poor and the region with the highest extreme poverty of 45.1%. In its findings, poverty was more pronounced in rural savannah and predominantly among farmers (Ghana Statistical Service, 2014a).

Though most farmers realize bumper harvest during the rainy season, such farm produce quickly dissipate as the dry season prolongs due to the high dependence on such harvested produce as sole source of livelihood. In a move to sustain themselves during the dry seasons, these farmers engage in intra-regional rural-urban migration for greener pastures, while others migrate to southern parts of the country where there is prolonged and double maxima rainfall for all year round farming activities (Inkoom and Nanguo, 2011; Kpieta et al., 2013). Others especially the aged with no aim of movement stay back idle in the rural communities during the dry seasons.

In ameliorating the issue of perennial seasonality of rainfall, local governments in partnership with Non-Governmental Organisations and other development partners such as World Bank and International Fund for Agricultural Development (IFAD) responded through the establishment of communal surface irrigation systems in the form of small reservoirs (dams and dugouts) for crop irrigation in farming communities during dry seasons (Dinye and Ayitio, 2013; Inkoom and Nanguo, 2011; Kpieta et al., 2013; Namara et al., 2011). Preliminary survey in the study district (Nadowli-Kaleo) revealed that these communal water systems provided by the local government in the form of dugouts and dams are not utilized for the intended purpose of irrigated agriculture. Rather, rural farmers who are engaged in irrigated agriculture in sustaining their livelihoods during the dry season have resorted to the initiation and utilization of private water systems for crop irrigation.

In undertaking the study and bearing in mind the research problem, the researchers therefore sought to provide answers to the following questions: (i) what

factors influence the choice of irrigation operations?; (ii) how does irrigation engagement affect rural livelihoods?; and (iii) what factors hinder private irrigation development in the study district?

Resultantly, there was the need to examine appropriate irrigation systems and practices that are relevant in improving and sustaining rural livelihoods in Nadowli-Kaleo district of the Upper West Region. Specific objectives in achieving the main objective included: (i) to uncover the factors influencing the choice of irrigation operations in the study district; (ii) to assess the effects of rural irrigated agriculture to livelihoods; and (iii) to examine hindrances to private irrigation development in the study district.

A research on private irrigation operations and reasons for the preference of private water systems to that of community dams in rural irrigated agriculture in Nadowli-Kaleo district is therefore relevant in identifying the lapses that mar the maximization of irrigation potentials in rural areas. Since irrigated agriculture is eminently glued to the achievement of the Sustainable Development Goals (SDGs) especially SDG 1: "End Poverty in all its Forms Everywhere"; and SDG 2: "End Hunger, Achieve Food Security and Improved Nutrition, and Promote Sustainable Agriculture" (ICSU and ISSC, 2015), a paradigm shift in the traditional approaches to development within the irrigation arena will tremendously accelerate the minimization of poverty and its other forms if not totally annihilate them. It will heighten the achievement of food security and improved nutrition as well as the promotion of sustainable agriculture. For instance, the World Food Programme (WFP) and FAO (2010) posited that about 870 million people are chronically undernourished, and by 2050 the population of the world would have been 9.1 billion thereby demanding a 60% increase in global food production to feed this population. It is therefore estimated that 90% of the required global food production (of which developing countries takes up 80%) needs to be generated from increment of yields and crop intensification while 10% (of which developing countries constitute 20%) will be produced from an expanded arable land. Ending global and national poverty therefore demands special and radical attention on ending poverty and hunger in rural areas since most of the urban poor are negative externalities of rural-urban migration.

### **Theoretical underpinnings of the research**

The study was positioned within certain theories namely: Tragedy of the Commons theory, Game Theory, Theory of Access, and Neoliberal theory bearing in mind the research problem, objectives and methodology.

#### ***Tragedy of the Commons theory***

The theory was propounded by Hardin (1968) who

asserted the necessity of abandoning the commons (freedoms) in breeding. Though the theory was propounded in the context of the growing population and its foreseeable issues at the time, it is equally applicable in any instance where society appeals to individuals exploiting a common resource to restrain themselves for the general good by means of their conscience. Individuals who are locked into the logic of the commons are free only to bring on universal ruin; once they see the necessity of mutual coercion, they become free to pursue other ulterior motives. Moreover, the author posited that every new enclosure of the commons involves the infringement of somebody's personal liberty. The author therefore proposed an alternative to the commons by way of institution of private property coupled with legal inheritance.

### ***Game theory***

This theory deals with the formal study of conflict and cooperation. It is concerned with improved strategic decision-making where several players make choices that potentially affect the interests of other players (Nuemann, 1928). The theory is applicable whenever the actions of several agents are interdependent. These agents may range from individuals, firms, groups, or a combination of them.

### ***Theory of access***

It embodies a wide range of social relationships that can constrain or enable people to benefit from resources (Ribot and Peluso, 2003). Ribot and Peluso (2003) further discussed that access analysis involves firstly identification and mapping out the flow of the particular benefit of interest; followed by identification of the mechanisms by which different actors involved gain, control, and maintain the benefit flow and its distribution; and finally an analysis of the power relations underlying the mechanisms of access involved in instances where benefits are derived. Access framework therefore analyses specific resource conflicts to understand how those conflicts can become the very means by which different actors gain or lose the benefits from both tangible and intangible resources (Ribot and Peluso, 2003).

### ***Neoliberal theory***

Proponents of this theory advocates for a free market system which allows the occurrence of efficiency, economic growth, income distribution and technological progress since the intervention of the state in promoting such phenomena will aggravate the economic

performance (Kotz, 2015).

## **METHODOLOGY**

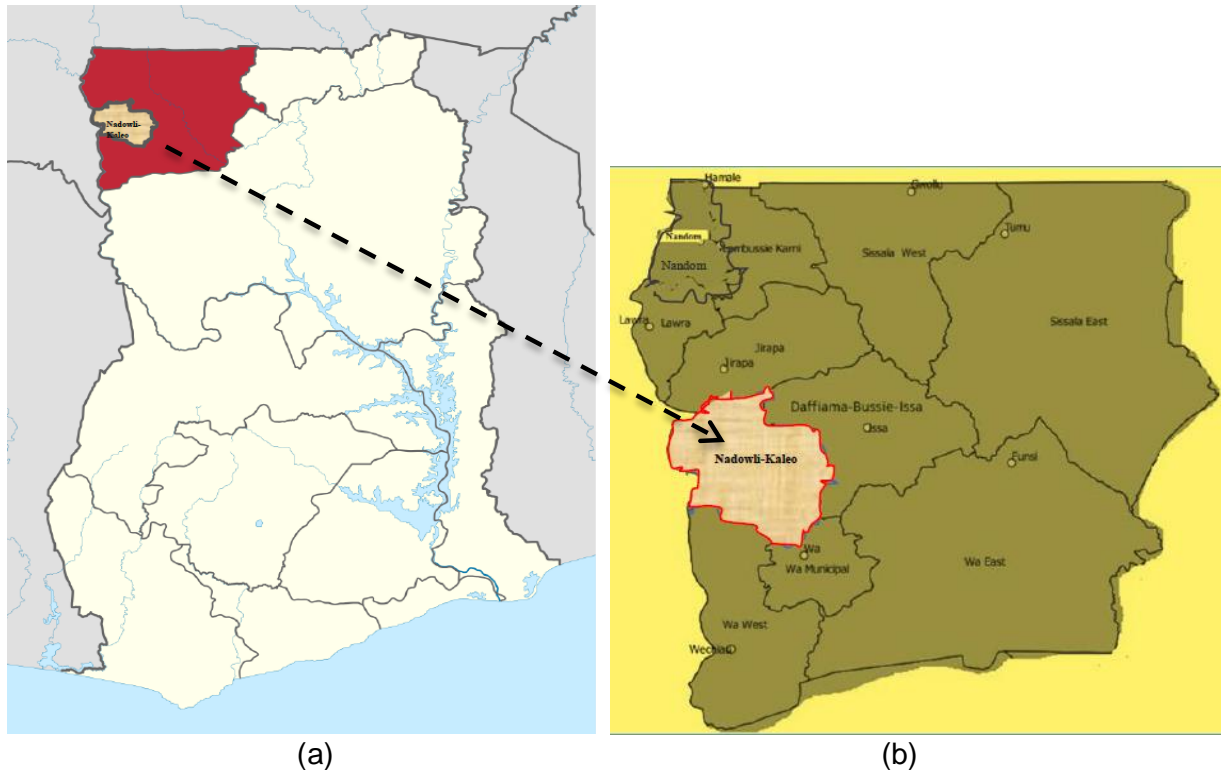
### **Geographical scope**

Geographically, the research was conducted in Nadowli-Kaleo District, a rural district in the Upper West Region of Ghana. Nadowli-Kaleo District is one of the 11 administrative districts of the Upper West Region with Nadowli as the capital. The district lies within latitude 10° 20' and 11° 30' North and longitude 3° 10' and 2° 10' West (Figure 1a, b). The district shares its northern border with Jirapa and Lambussie-Karni Districts; Southern border with Wa Municipal and Wa West District; Western border with the country Burkina Faso, and Eastern border with Daffiama-Bussie-Issa District (Ghana Statistical Service, 2014b). The district is centrally situated within the Upper West region of Ghana and covers a total land area of 1,132.02 km<sup>2</sup>. The distance between the District and regional capitals covers about 40 km. The District has a mean annual temperature of 32°C and a mean monthly temperature ranging between 36°C around March to 27°C around August. Annual rainfall is confined to four months (July to September) and is also unevenly distributed (Ghana Statistical Service, 2014b).

### **Selection of study area**

The interest to undertake this research was triggered by a preliminary review of studies conducted by researchers on irrigation utilization in the Upper West Region. The reviewed articles revealed that formal and public irrigation schemes are underutilized in the region (Inkoom and Nanguo, 2011). Inferences from the reviewed papers further revealed that two of such underutilized irrigation facilities in the region situated at Sankana and Goli are within Nadowli-Kaleo district. The major reasons being attributed to the underutilization was the charging of water user fees and the application process people had to go through to qualify for the dams' utilization. According to the findings of the researched papers, such factors therefore deterred people from accessing the facilities for irrigation (Acheampong et al., 2014; Inkoom and Nanguo, 2011).

These revelations on the public irrigation schemes therefore propelled the researchers to enquire more about irrigation development and utilization across the entire Nadowli-Kaleo district. The investigations were intended to ascertain whether such underutilization pertains only to the two cited irrigation facilities or reflective across the whole district. In view of this, the researchers visited the Planning Unit of the District Assembly to access information on the other existing facilities and their locations. A study of the district profile from the District's Medium Term Development Plan revealed that there were about thirteen (13) facilities across the district including the two cited by other researchers. Some of the communities with community dams and dugouts included: Duong, Goli, Kaleo, Kalsegra, Konkonpari, Kulpieni, Kuuri, Loho, Nadowli, Saan, Sankana, Takpo, and Zang among others. Information from the Planning Unit also revealed that the only facilities where access was restricted were the two located at Sankana and Goli. However access to the other dam facilities across the district was open to all in the respective communities. To confirm this, enquiries were made through phone calls with Assembly members of the respective communities as well as personal visits to these facilities to verify the authenticity of their existence. It was intriguing and worth noting that even though irrigation was on-going in some of the visited communities, the open-access community dams and dugouts were not utilized for the intended purposes of irrigation especially by private irrigation



**Figure 1.** Nadowli-Kaleo District in (a) National Context (b) Upper West Regional Context.

operators. Such anomalies therefore prompted a further explorative study into rural irrigation operations in Nadowli-Kaleo District.

### Selection of study cases

Five community dams and dugouts within the district were selected for the study based on certain developed criteria which included: the presence of a community dam/dugout; and the existence of on-going private initiated irrigation activities. Communities where these facilities were located are namely: Duong, Kaleo, Kalsegra, Nadowli, and Saan as shown in Figure 2.

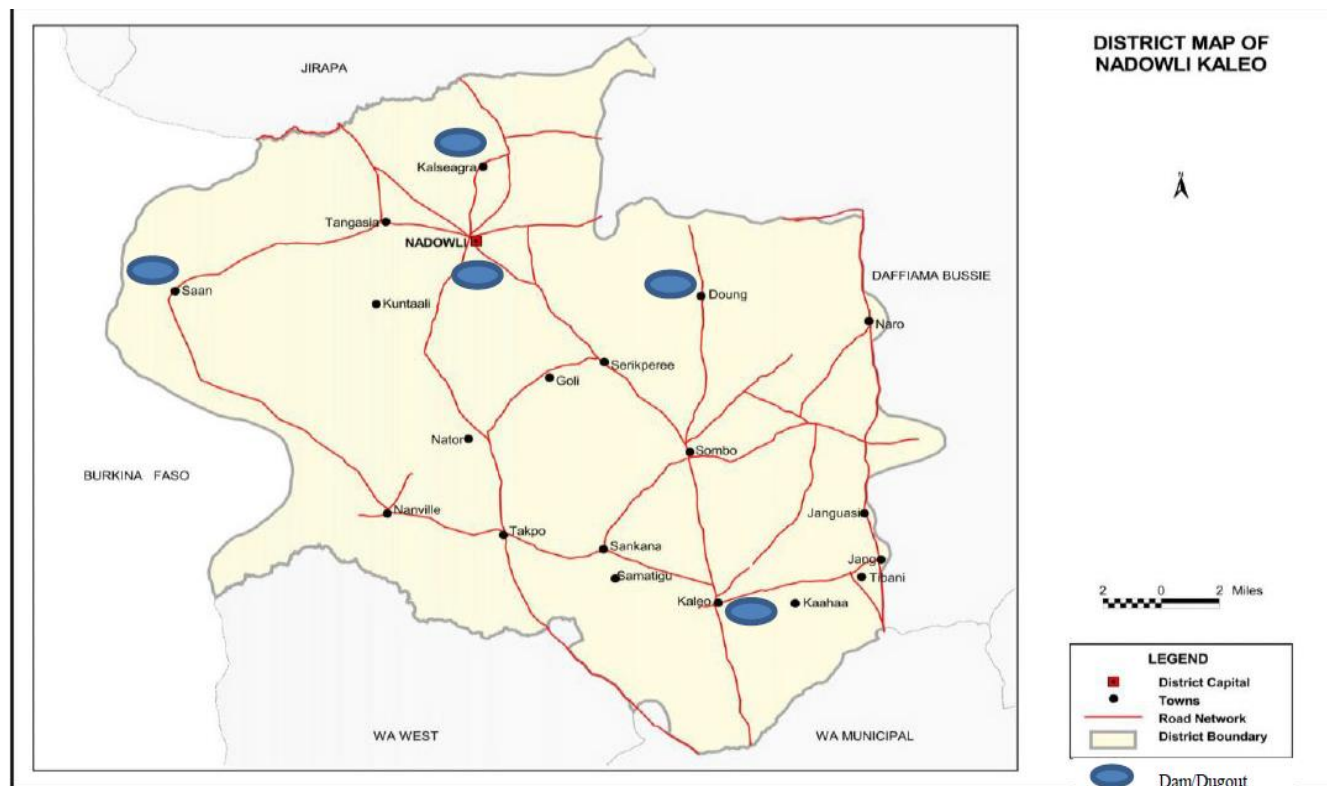
### Sampling

The non-probability sampling method was more appropriate for the study since some units of the study population had zero chances of being selected and the probability of selection could not be accurately determined (Babbie, 2016); besides, there was no sample frame of registered irrigation farmers from which a sample could be selected. The researchers further employed the expert (purposive), convenience and snowball non-probability sampling techniques in the collection of empirical data. Expert (purposive) sampling technique was used to collate data from key institutions as well as District Assembly and Unit Committee members engaged in promoting agricultural development in the district. Convenience sampling technique was applied in selecting the first respondent (irrigation operator) in each of the studied communities. The Snowball sampling technique was then employed to access data from the other irrigation operators through recommendation from the interviewed respondents, other community members as well as personal observation by the researcher. Personal observation

was employed to remedy instances in which the respondents were not in a position to recommend others.

### Data collection and analysis

The empirical research pertained to more of qualitative as compared to quantitative, and the study was carried out in a rural setting involving farmers who had low literacy levels; hence the collation of data by means of focused-group discussions, face-to-face interviews with the use of structured and open-ended questions as well as direct observation including picture taking and voice recordings for transcription. In each of the selected communities of study, three categories of interviews were conducted based on the study variables consideration. These categories included: irrigation operators on the context of one-on-one interviews; non-irrigators in the form of focused-group discussions (consisting of a mixture of men and women); and community leaders (Assembly and Unit committee members) which also took the form of one-on-one interviews. In all, thirty irrigation operators were interviewed for the entire study. Additionally, five focused-group discussions were conducted for non-operators with one discussion in each of the selected communities while seven Assembly members and key informants were interviewed. These interviewed persons were based on the availability and willingness of the respondents to offer the needed information. Moreover, key institutions including Agriculture Department, Works Department, and Planning Unit of the District Assembly were contacted for information on their contributions to irrigated agricultural development in the study district. The gathered data were analysed using the coding process, which involved sifting through data and sorting them into themes, pattern or the concepts it reflect. The aim of the coding was to look for connections and patterns in the



**Figure 2.** Map of Nadowli-Kaleo District with studied cases.  
Source: Ghana Statistical Service (2014b) with Authors' Insertion (2017).

data from which the findings were generated. An analytical framework was also used to minimize subjective views of the researcher as much as possible.

## RESULTS AND DISCUSSION

The findings of the study were categorized under themes based on the various objectives of the research namely: factors influencing the choice of irrigation operations; effects of irrigation operations on rural livelihoods; and factors hindering private irrigation development in the study district.

### Overview of studied community dams

#### *Duong*

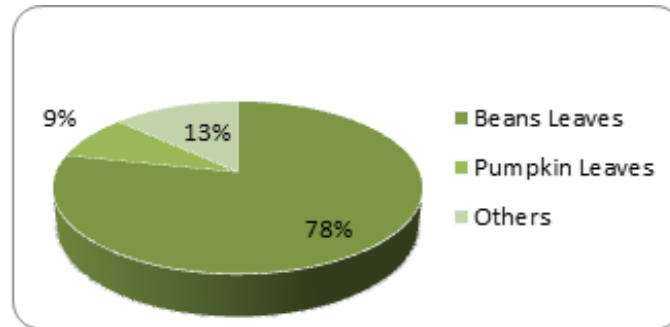
The earth dam was established in the 1970s and currently serves a projected population of 2,751 persons. The dam is patronized by the community for different purposes including animal watering, fishing, domestic chores and construction activities among others. However, water from the community dam facility is not utilized for crop irrigation although dry-season farming has been going on yearly (Field Study, 2017).

#### *Kaleo*

The community earth dam was constructed in 1963 for a population of 2,500 persons with a targeted irrigable area of 12 hectares (Acheampong et al., 2014). With a current projected community population of 4,564 persons, the community dam is utilized for varied purposes such as industrial activities and animal watering, other than crop irrigation.

#### *Kalsegra*

The earth dam facility was first established in 1989 through the community initiative. It was later on rehabilitated in 2015 by the local government with funding from the World Bank, Ghana Irrigation Development Authority (GIDA) and the Government of Ghana under the auspices of Ghana Social Opportunities Project (GSOP). The dam currently serves a projected population of 3,108 persons who utilize the dam water for diverse purposes including swimming (undertaken by children), fishing, animal watering as well as construction and other industrial activities. The crop irrigation component for which the earth dam was rehabilitated is however not activated by the community (Field Study, 2017).



**Figure 3.** Types of crops grown on irrigated fields (in percentage).  
Source: Field Study (2017).

### ***Nadowli***

The community dam was initiated in the year 1999 and completed in 2000 but has not been rehabilitated since its construction. With a projected community population of 4,579 persons, the community earth dam is currently resorted to by community members for different purposes including fishing, animal watering, water for construction and industrial activities among others (Field Study, 2017). However, farmers in the community who are engaged in dry-season farming do not utilize water from the dam facility for crop irrigation though cluster of vegetable gardens are sited closer to the dam (Field Study, 2017).

### ***Saan***

The community dugout was created in the 1980s to serve varied needs including crop irrigation. It serves a community population of 2757 persons. Although crop irrigation is scantily undertaken in the community, the dam water is not patronized by farmers for such irrigation activities.

## **Forms of rural private irrigation operation**

### ***Types of crops grown on irrigated fields***

Based on aggregate of irrigated crops from the field study, the mostly grown single crops include beans leaves (78%), and pumpkin leaves (9%) as shown in Figure 3. The major crops (grown beans and pumpkin leaves) are mostly cooked as sauce with 'Tuozafi' which is a local delicacy in the district. The dominant crops grown are therefore dependent on the demand by the consumers, availability and the maturation period. For instance, beans leaves take an average of one month to mature for consumption, and as such can be cultivated about four times within the irrigation season. However, vegetable crops including tomatoes, okra, eggplant and

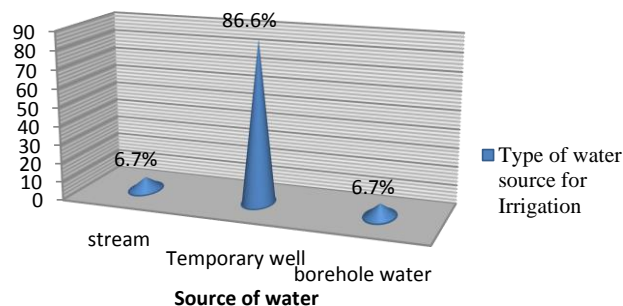
cabbage which take about three (3) months to mature are only grown once within the irrigation period although such crops are re-harvested 2 to 3 times during the season. Moreover, crops like banana, plantain, and oil palm which are of southern origin are sparsely grown in certain areas of the district especially in Nadowli. These crops are mostly irrigated on seasonal wetlands thereby affirming Blench (2006) findings of the cultivation of such crops in the Upper West Region.

### ***Source of water for irrigation***

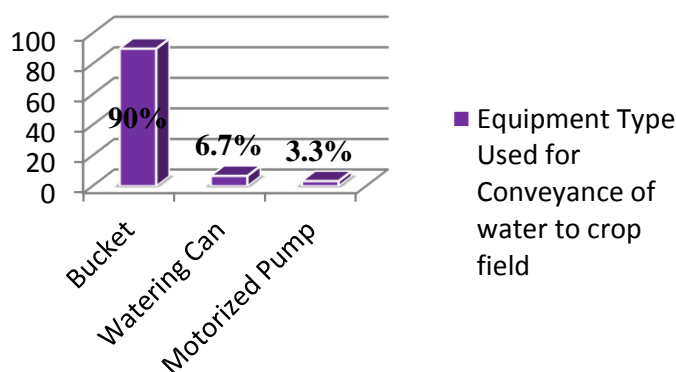
Water sources for rural irrigated agriculture is dominated by temporary shallow wells (ponds) representing 86.6%, with the others being stream (6.7%) and borehole water (6.7%) as illustrated in Figure 4. The temporary wells are mostly located within the fenced crop field. Average distance from the water source to the farthest part of the crop field is about 60 m. From observation, water from boreholes was used to irrigate backyard gardens at the home level, whereas the temporary wells were purposely constructed for irrigation located far away from houses on lowlands and areas liable to flood (seasonal wetlands). Consumers of rural irrigated produce are conscious of the quality of water used for irrigating crops and often verify the source of irrigation water before purchase of irrigated vegetables. This is also attributable to the homogeneity of population in rural areas making it easier for inhabitants to identify one another. These findings however opposes Bougnom and Piddock (2017) assertion that the use of wastewater for irrigated agricultural lands is increasing globally, since the use of freshwater for irrigated agriculture is still gaining grounds in rural areas.

### ***Equipment used for watering crops***

Materials used for watering irrigated crops are key determinants for the scale of irrigation operations in the study district. Regarding the empirical study, the



**Figure 4.** Water sources for crops irrigation (in percentage).  
Source: Field Study (2017).



**Figure 5.** Types of materials used for watering crops.  
Source: Field Study (2017).

equipment used for transmission of water from the water reservoir for crop irrigation were predominantly rubber and metal buckets (90%). Other watering equipment included watering can (6.7%) and motorized pump (3.3%). Averagely, irrigation farmers use about 2½ h daily to water crops. The duration of time spent in watering a crop field is influenced by the size of the watering material, the types of crops grown and the nature of land under irrigation. Figure 5 illustrates the percent patronage of materials used for watering crops.

The type of equipment used for watering depends on the financial capacity of the irrigation operator. Farmers with better financial status patronize the use of pumping machines and watering cans while farmers in financial distress adapt to the use of buckets for crop watering.

#### **Factors influencing the choice of irrigation operations**

The field study revealed astonishing reasons for the preference of private water systems to that of open-access communal dams and dugouts for irrigation. The empirical findings within this theme in the study district

therefore counteract Acheampong et al. (2014) and other researched propositions that the development of small dams and dugouts generate high satisfactory performance in terms of irrigation utilization. These empirical findings include:

#### ***Contamination of dam water by other users***

The use of clean water for rural irrigation farming in the studied communities is a paramount priority to the farmers as a result of the requisite standard demanded by consumers due to the nature of the irrigation produce (mostly green leaves) being patronized and the high homogeneity of population in the studied settlements. The use of polluted water for vegetables irrigation is an eyesore to consumers. On the contrary, the multipurpose functions and open-access usage of the community dams and dugouts by competing users resulted in the contamination of the water facilities by their activities thereby making water from such facilities unwholesome for vegetable crop irrigation. Due to the communal ownership of the dams and dugouts in the studied cases, restrictions pertaining to who and what the dam facility is



to be used for does not exist and as such there are several users in each community who utilize the dams and dugouts for diverse purposes other than irrigation. Users of these community dam facilities included: funeral undertakers, water vendors, nomadic herdsman, fishers, children and animals which resort to such reservoirs as swimming pools, and car washers among others. In Nadowli for instance, the community dam is a resort by funeral undertakers for the washing of clothes and cloths used for wrapping the dead during funerals as well as vehicles used for such purposes. An irrigation operator in Nadowli recounting his preference for self-initiatives to that of the open-access dam is quoted to have said:

*“Anytime there is a funeral in this community, the vehicle that is used to carry the dead body is usually washed in the dam water. Also, the clothes that are used to cover the dead during funerals are washed in the dam. Other drivers have also been washing their vehicles here (referring to the dam). As a result, if consumers know that the green leaves we sell are irrigated with water from the dam, they will not buy it”.*

The use of the dam for fishing is also a deterrent to irrigation farmers in utilizing such water for crop irrigation. Frequent fishing activities in the community dams and dugouts through the use of crude methods culminate in muddiness of the water after such fishing expeditions.

Moreover, children and animals which resort to the dams and dugouts as swimming pools in Kalsegra for instance, often defecate and urinate in the water during usage. These bizarre actions by other users of the communal water reservoirs therefore compel farmers to initiate their own water systems for irrigation utilization during the dry season where the usages of self-water systems could be controlled, therefore upholding Hardin’s (1968) proposition in ‘Tragedy of the Commons’ theory that the unguarded utilization of a common resource often result in the exploitation and abuse of that common resource if such is unchecked. It also affirms Neumann’s (1928) argument in ‘Game theory’ that in the utilization of a common resource, its competing and varying users adopt diverse strategies to maximize the benefits of such commons irrespective of the consequences of their actions on fellow users. The multipurpose functions of the public dams and dugouts therefore defeat the irrigation motive behind the constructions. However, these claims and explanations given on dam water contamination have not been scientifically proven to ascertain the content and level of pollution within the water facilities.

### ***Drying up of water from dams and dugouts***

Regular availability of water is a major prerequisite for the success of irrigation farming in the dry season. However, volume of water in these communal facilities diminishes

as the dry season progresses due to siltation and the loss of water by evaporation as a result of absence of tree cover. Also, the unregulated demand of water from the dams and dugouts for multiple purposes such as industry and construction, domestic and household chores as well as animal watering among others also culminates in the drying up of water from such facilities. Such actions therefore make dam facilities as unsustainable and unreliable sources of water for continuous irrigation during the dry season. Alternatively, irrigation farmers construct their own water systems to maintain regular water access for crop watering. For instance, an irrigation farmer in Kalsegra is quoted to have said:

*“.....I do not want to be chasing the dam water as it dries up, so I decided to construct my own system so that I can have full control over its usage”*

Another farmer also puts it:

*“When the water dries-up, because of the open-access nature of the dam, I cannot scoop it alone. So I decided to dig my own shallow well so that when it dries-up, I can scoop it myself” (female irrigation operator)*

Whereas other developing countries such as India (Siebert et al., 2010), Kenya (Keller, 2001) among others are drifting from conventional systems such as open surface water to emerging groundwater systems for rural irrigation using improved technological implements, successive governments in Ghana are still glued to the promotion of the former mostly in the form of community dams for rural irrigation.

### ***Absence of complementary irrigation equipment***

The presence of necessary implements propels the utilization of community dams and dugouts for irrigation. From the field study, irrigation farmers distant the crop fields from the community dams and dugouts due to the absence of suitable soils within the catchment areas of the water reservoirs for vegetable cultivation. For instance, the land around the dams and dugouts are either rocky (as in the case of Kaleo), sandy (as in the case of Kalsegra) or hardy (as in the case of Nadowli). Also, irrigated farms are distant from community dams and dugouts to minimize siltation of such water facilities. Moreover, farmers distant their crop fields from the dams and dugouts to prevent intrusion of animals which drink from the water facilities. Even though farmers distant the crop fields from the dams and dugouts for the outlined reasons, there is no corresponding provision of water harvesting implements such as canals, pipes and pumps among others to propel water from the dams and dugouts to the irrigated crop fields (Namara et al., 2011) due to technical and engineering negligence (Acheampong et

al., 2014). As such, farmers resort to the initiation and utilization of private water systems within the crop fields for irrigation. One such irrigation farmer (name withheld) is quoted to have said:

*“As for me I do not use water from the dam for irrigation because the land around the dam is not fertile. As such, I farm on the other side of the water bank, and because of that I cannot climb the high bank and fetch water from the dam with my bucket and climb it again to water my crops. So I decided to construct my own water system”.*

### **Access to land**

Land ownership in the study district is dominated by the freehold system (97%), thus land is majorly owned by families and not individuals. This implies that in cases where a non-title holder of land intends to utilize land for a specific purpose, all the family members entitled to the land need to approve the request before such could be granted. From the empirical study, knowledge of this cumbersome process of land acquisition for temporary usage deters individuals from seeking lands around community dams and dugouts for irrigation farming during the dry season and as such only those whose lands are within the catchment areas of the respective community dams and dugouts can utilize the water for irrigation. Although the dams and dugouts are communally owned and openly accessible to the respective communities, access to the surrounding lands (catchment areas) is restrictive. Farmers therefore resort to initiating private water systems on their own lands for irrigation utilization. A respondent in Kaleo puts it:

*“I do not understand what these government people have done. How do they expect every community member to gather around this small area for farming? Is that how rainy season farming is carried out? So, imagine I am interested in farming but do not own land around the dam site, what will I do?”*

A fisherman at one of the dam site is quoted to have said:

*“Since I do not have land around the dams, I prefer to fish in the dams so that I can also benefit from it. Why do I have to go through this long procedure to get a small piece of land around the dam to farm on, when I know I will have to release it during the rainy-season?”*

This study outcome avows Ribot and Peluso's (2003) 'Theory of Access' which explains that people use different mechanisms to gain, control, and maintain the utilization of resources. It also resonates with Elimnh's (2013) assertion of the vital role land resource plays in the production of crops for farmers whose livelihoods depend on it.

### **Effects of rural irrigated agriculture on livelihoods**

This theme of the research objective sought to examine the effects of irrigation engagement to the livelihoods of farmers and the community at large. These include:

#### **Food supplement for household consumption**

The dry season is also known as the 'lean season' in the study district and the Savannah regions as a whole due to hardships encountered by subsistence farmers during the period resulting in malnutrition which is mostly visible in stunted growth especially among children. During these periods, subsistence farmers who engage in farming as the main source of livelihood highly depend on their stored food produce. Such produce therefore serve various purposes such as food and collaterals among others. An engagement in irrigation farming during the dry season is definitely a relief and asset enhancement to the farmers. These irrigated outputs mostly in the form of fresh vegetables which are often rare during the dry season boost up the nutritional content of households' diet. Also, such irrigated produce complements the other staple produce for the rest of the season thereby buttressing Inkoom and Nanguo (2011) and other researchers' submission that farmers engage in irrigation farming during the dry season to increase food supply.

#### **Employment and income generation**

Economically, irrigation farming enhances the financial assets of farmers and households who engage in it. Such income is generated from the sales of harvested irrigation produce. Since few farmers are engaged in the cultivation and supply of fresh vegetables in the dry season and the demand for such produce is often high, commercialization of fresh vegetables becomes a lucrative enterprise for farmers. Average monthly income generated from the sale of vegetables is estimated at GH¢150.00. Comparatively, if such vegetables are grown in the rainy season for commercialization, the demand is often minimal since more people are engaged in the production. Income generated from the sales according to the irrigation operators is used for the provision of family needs such as health insurance premium payment, hospital bills, purchase of foodstuff, and payment of children's school fees among others. A distance education tertiary student responded:

*“...dry season farming is very beneficial to me because it is from the sale of these irrigated vegetables that I get money to support my distance education at the tertiary level and also pay my siblings school fees as well”.*

These findings endorse Eneyew et al. (2014) assertion

that irrigation operations enhance employment opportunities and increased income for the operators. The finding also avers Elimnh's (2013) assertion that irrigation farming improves income although the level of income varies among farmers and regions.

### ***Social worth and sense of fulfilment***

According to the Australasian Faculty of Occupational and Environmental Medicine (2010), working improves general health and well-being and reduces psychological distress. The absence of work therefore leads to a range of psychological problems such as depression, anxiety and low self-esteem especially among young people. The lack of work (unemployment) also increases mortality rates, cardiovascular diseases, and lung cancer among others.

Engagement in a productive activity such as irrigation farming during the dry season when most farmers are redundant therefore bequeaths a sense of worth and fulfilment to the irrigation farmer.

### ***Reduction in rural migration***

The movement of rural farmers from the savannah grasslands to the rural forest and semi-deciduous lands in the country for temporary or permanent settlement is the result of rainfall failure in the migration source. The innovation of initiating private water systems for irrigation farming during the dry season positively curtails the perennial exodus of rural farmers for greener pastures elsewhere. This empirical study outcome therefore reinforces Dinye and Ayitio (2013) as well as Kpieta et al. (2013) claims that irrigation development in rural savannah minimizes the migration of farmers in the source areas.

### ***Felling of trees for gardening***

The protection of irrigated crop fields from animals and theft demands the securing of the farmlands through fencing. Due to the absence of funds to purchase metal fencing nets, rural farmers engaged in dry season irrigation resort to the felling of trees for gardening. Such practices therefore negatively affect the environment and further deteriorate the ecosystem steadily resulting in desertification (Akudugu et al., 2016).

### **Hindrances to private irrigation development in Nadowli-Kaleo District**

#### ***Destruction of irrigated crops by invaded animals***

Since irrigation takes place during the dry-season

(characterized by dry land with dried and stale grasses), animals including cattle, goats, sheep among others which are reared through the extensive system in the dry-season often search for fresh and green grasses to graze. Such grasses can only be found on wetlands and probably around water bodies. During such moments, animals which go to the dugouts to drink water mostly in the afternoons in the absence of farmers invade the irrigated lands which are often fenced with dry grasses, stocks and sticks. Such invasions therefore culminate in the destruction of irrigated crops which are often the only greenery areas visible to the animals. The invasion of animals on irrigated farmlands located around dugouts and dams was also a major factor which deterred farmers from engaging in irrigated cropping within the peripheries of such water bodies. A respondent in Saan (one of the studied communities) is quoted to have said:

*"You know, during the dry season there are no green grasses. The only places where green leaves can be found are wetlands, areas around the dams and the irrigated crops. Therefore because our fences are not strong (mostly in the form of sticks and stocks), the animals especially the Fulani cattle usually invade the irrigated fields and destroy the crops during the afternoon and in the night time when we are not available".*

#### ***Inadequate financing capacity***

Intensification of agriculture through irrigation is highly anchored on the financial capacities of the operators. Such funds are essential to purchase the needed farm inputs and implements such as fertilizer, watering machines, pipes and pumps and fortified fencing materials such as metallic nets among others. From the field study, self-financing was the main source for funding irrigation farming in the study district. Alternative and external means of funding were non-existent and not explored as well. Such limitations inhibited the farmers' ability to expand irrigation operations resulting in micro scale farming and output. This finding therefore buttresses Elimnh's (2013) view that access to credit for financing investment and farm operations is crucial for the commercialization of smallholder agriculture.

#### ***Limited knowledge in irrigation agronomy***

The management and agronomic practices in irrigated farming are quite variant with the rain-fed agriculture. Although irrigation farmers are enthused with their farming activities, such farmers do not however possess the requisite knowledge and skills for dry-season farming due to the artificial form of applying water to the crops. Such agronomic practices include the quality and volume of water requirement for specific crops, pest and disease

control, mulching, fertilizer application, and suitability of soils for varied vegetable crops among others. Also, with a gradual drift in demand for exotic vegetables such as cabbage and eggplants by consumers especially in the district capital, knowledge on the growth of such crops is therefore necessary. From the perspective of irrigation operators however, such services are not rendered by the Agricultural Extension Officers. In a triangulated response from the Agriculture Department on why monitoring, supervision and offer of extension services to farmers were not undertaken, logistical constraints was the reason cited for the negligence of responsibilities.

### **Strategic measures for rural irrigated agricultural maximization**

Based on the study findings and ensued issues, the researchers put forth measures to be adopted by policy makers, local governments, other development think tanks and for further discourse in propelling the productive capacity of rural farmers engaged in irrigated agriculture.

#### ***Establishment of irrigation fund for farmers***

The researchers propose the establishment of a fund purposely dedicated to irrigation development. Access to financial capital is a crucial inhibiting factor for rural irrigated agricultural intensification in the study district. The researchers however discovered that donor funding from the World Bank, FAO, and IDA among others for the promotion of irrigation development are expended in the acquisition of land, payment of compensation fees and the construction of community dams and dugouts of which the expected irrigation benefits are unattainable. The researchers therefore submit an alternative solution in which such donor funds or proportions of it could be consolidated into a funding pool from which persons with interest in irrigation farming could apply or seek assistance. This will ensure value for money and enhance accountability and transparency since the beneficiaries could easily be traced and held responsible in cases of financial malfeasance. At the district level, the fund could be managed by a Unit of GIDA or the Agriculture Department. On the other hand, such funds could be accumulated and channelled into the acquisition of irrigation machinery for farmers who demonstrate interest in irrigation farming at subsidized prices and payments made on instalment basis.

#### ***Training of irrigation farmers in basic agronomic practices***

Due to the limited knowledge in irrigation agronomy by

farmers coupled with logistical constraints of Agricultural Extension Officers for mobile servicing of farmers, thereby resulting in stagnant yields, the researchers propose the establishment of demonstration farms at substation level and the organization of periodic trainings to boost the knowledge and capacity of irrigation farmers. This initiative could be undertaken by the Agriculture Department in collaboration with the entire District Assembly and factored into the district budgetary allocations. At the demonstration farm units, stationary officers could offer training services for cluster of irrigation farmers through demonstration exercises on the farmlands. These training services could be rendered probably at the beginning of each irrigation season especially for new entrants coupled with intermittent refresher trainings in the course of the season. Such trainings could cover areas of concern such as the use of low-cost and efficient irrigation technologies, water volumes and application methods, as well as pests and disease control among others especially in the aspect of vegetable production. Also, helplines of the extension officers could be made available to farmers for enquiries in times of need.

#### ***Facilitation of the establishment of block irrigation systems***

The construction of open-access community dams for irrigation in principle expects all farmers within a community to converge around a single water system and utilize the water for farming. In practice, this approach to dry season farming has been fiercely resisted by members of the studied communities through the various actions meted out notwithstanding the conflict of interests and emanating issues of accessibility with regards to the utilization of the dam facilities. To ameliorate such incessant and recurrent issues in the utilization of existing and subsequent community dams, the researchers recommend the establishment of block water systems for rural irrigation farming. This initiative could be made possible through feasibility studies and mapping out of suitable areas for potential irrigation schemes in communities within the district. Such studies could be undertaken through a collaborative effort of the engineering units of the Agriculture Department and Works Department of the District Assembly in consultation with chiefs as well as Assembly and Unit Committee members of the respective communities. The government, together with development partners and NGOs interested in supporting irrigated agriculture could then channel their resources towards creation of block water systems at these potential sites such as permanent wells and boreholes for groundwater irrigation probably powered by solar energy. These potential irrigation sites could then be utilized by farmers with interest in irrigation. In cases where persons interested in irrigation farming do

not have access to land, such persons on their own or together with the assembly or unit committee members could then liaise with the land owners for parcels of land to farm at convenient terms of agreement. These prospects could further be explored for instance on pilot basis to ascertain its impact and relevance and if the need be, amendments made to it.

### ***Granting of awards to irrigation farmers on Farmers' Day Celebration***

It is proposed that consideration should be given to the inclusion of irrigation farming as one of the categories for Farmers' Day Celebration Awards at the district level. Farmers are mostly not enthused in undertaking dry season farming due to its labour intensive nature. The inclusion of such awards for irrigation farmers who have shown dexterity in irrigation farming in the course of the year would serve as incentives in propelling people to venture into irrigation farming during the dry season. This could be made possible by adapting similar protocols that are followed for the award of best farmer for any category such as farm visits to irrigation sites to ascertain the truth prior to the selection, grading and screening, shortlisting and final presentation of awards on the day of celebration.

### ***Proper management of existing community dams***

The researchers recommend the rehabilitation of existing community dams through the creation of canals as well as provision of pumping machines and pipes to propel water from the dams to the irrigation fields. Moreover, there is an urgent need for the enactment and enforcement of bye-laws by the District Assembly in collaboration with community chiefs to safeguard the usage of the dams and dugouts. Such legislations will minimize the hazardous impact of human activities on these water facilities. Perpetrators who are tried and found guilty should be rigorously sanctioned to serve as deterrent to other community members.

### ***Conceptualizing rural irrigated agriculture towards sustainable livelihoods***

From the illustration in Figure 6, irrigated agriculture is carried out either by individual initiative or induced by the government and development partners through the establishment of irrigation systems. The choice of type of irrigation engagement is further influenced by mechanisms including:

i) Availability and access to livelihood assets such as human, social, financial, natural, and physical capital.

ii) The institutional arrangement and government set-up including the policies, laws, customs, and cultural beliefs among others. These mechanisms either enhance the livelihood assets available to an individual and the community at large or worsen the state of exposure to issues of vulnerability.

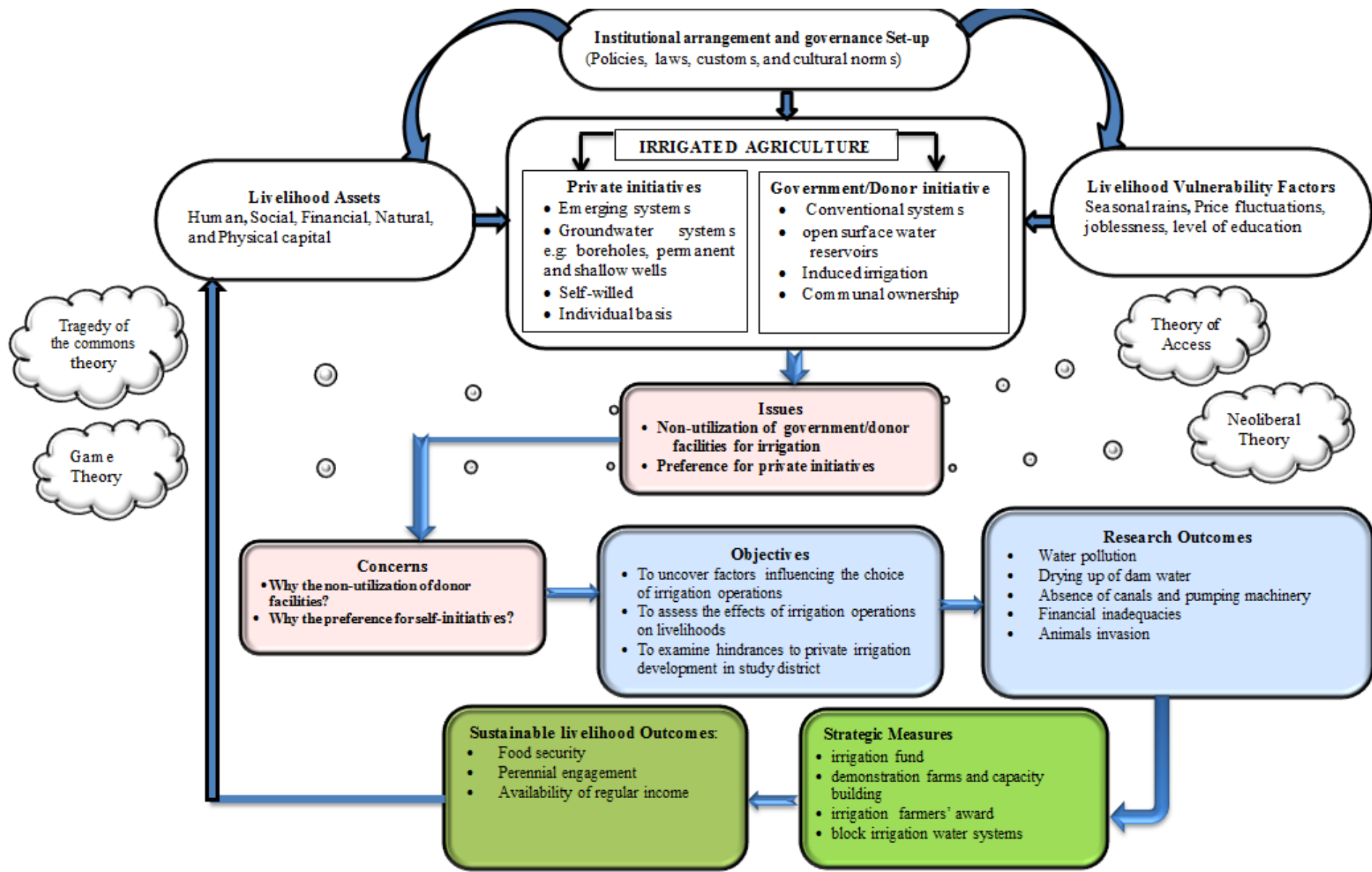
iii) Livelihood vulnerability causative factors include: seasonal rains, unemployment, and price fluctuation of produce among others.

Moreover, there is a corresponding interaction among these influencing factors. For instance, the institutional arrangements and set-ups such as fiscal policies of government can either enhance livelihood assets such as increased financial capital and physical assets or intensify livelihood vulnerability such as unemployment. The main reason for undertaking this study is in reference to the issues emanating from the utilization of these respective irrigation systems namely: private and government/donor irrigation systems. In the study district, government and donor funded irrigation systems meant for dry-season farming are deserted. Farmers engaged in irrigation rather resort to the initiation of private systems. Certain ascribed theories namely: Game theory, Tragedy of the Commons, Theory of Access and Neoliberal theory therefore sought to explain why the phenomenon under study exists.

This raises concerns including: why the non-utilization of donor facilities; and why the preference for self-initiated irrigation facilities by farmers engaged in dry-season farming? These concerns are further translated into objectives that drive the focus of the research including: uncovering the factors that influence the choice of irrigation operations, an assessment of the effects of irrigation operations on livelihoods, and examination of the hindrance to private irrigation development. Based on the study objectives, empirical outcomes are generated with strategic measures put forward to strengthen irrigation intensification. Implementation of the strategic measures will culminate in the achievement of desirable sustainable livelihood outcomes such as perennial employment, food security, and availability of regular income which will eventually enhance the livelihood assets of farmers and communities as illustrated in Figure 6.

### ***Conclusion***

Restricting access to the use of communal water systems for irrigation through the implementation of regulatory mechanisms such as charging of water user fees and filing of application letters as stipulated by the Irrigation Development Authority of Ghana, or adopting the open access mechanisms to community dams utilisation for irrigation as explored by the current study demonstrate that treading the path of establishing communal water



**Figure 6.** Conceptualizing rural irrigated agriculture towards sustainable livelihoods. Source: Authors' Construct (2017).

systems for irrigation have not produced the desired benefits. This therefore necessitates the need for a paradigm shift and reorientation in the approaches to developing and promoting irrigation especially for rural communities in northern Ghana. The multi-purpose functions of public communal surface water reservoirs (dugouts and dams) are inappropriate for irrigated farming since there are competing conflicts of interests in the utilization of such facilities. The prospects of groundwater development for irrigated farming on individual bases need further exploration.

As opined by Davis (2006), any genuine social transformation of an area must be initiated from within the society even if the results of cross-fertilization of the generated ideas are from external societies. The conscious promotion of private initiatives in rural irrigation can therefore produce a tremendous positive impact on the livelihoods of rural people most of whom fall within the class of peasant farmers especially during the prolonged dry season periods. Moreover, it will reduce burden on government's expenses in areas such as during acquisition of lands, compensation of displaced persons, procurement processes and construction costs. It will also ensure ownership and sustainability of irrigation projects, enhance peer learning and heighten innovations and creativity in agriculture. There is therefore the need for a dispassionate discussion devoid of political colouring on the prospects of the current government's 'One Village One Dam' policy aimed at promoting rural irrigation in northern Ghana since the viability and sustainability of such initiative is anchored on a situational analysis of similar existing projects.

## CONFLICT OF INTERESTS

There is no conflict of interest between the authors.

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