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Overview of indigenous water conservation among dry season farmers in Northern Ghana

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Abstract

Water plays a key role in the agricultural sector for sustainable food in Ghana. Climatically, a northern region like the rest of the regions in Ghana has uncertainty with rainfall, food security for households and poverty alleviation. There is the need to create innovative ways to access and develop limited water resources for agricultural sector advancement in developing countries especially Ghana. Water conservation has an impact on groundwater and surface water interaction. Generally, small dams, earth dams, reservoirs and dug out are created across the regions in northern Ghana. These enable dry season farming, animals' consumption and household uses. The study identified mulching, mixed cropping, furrow irrigation, flood irrigation and others as a way of water conservation in northern Ghana. The study demonstrated various water conservation practices by indigenous farmers in the dry season. It was observed that farmers adapted these practices due to the limited water access for irrigation. The study shows that farmers have witnessed a sharp decline of both surface water and groundwater as result of climate variability. The study revealed different materials used for irrigation in the region include tomatoes tins, buckets and calabash. The study indicated that farmers use manure to conserve soil moisture. The study employed a mixed method to gather information and a descriptive-qualitative method was used for the analysis.

Introduction

Water is the most valuable element on earth for coherent development of social, political, ecological and human existence. Water for agriculture is derived from precipitation or from a stream, lake, reservoir and aquifer where irrigation is practiced, Unger, Kirkham & Nielsen, (2010). Agriculture in northern regions is basically subsistence farming for that matter heavily depends solely on rainfall. In Ghana rainfall is critical in determining agricultural output, Baidoo, Derkyi & Derkyi (2016). This type of farming has a great negative effect on household food security, hence the need to engage in dry season farming. Agriculture constitutes the major occupation of the population in most communities of northern regions as their point of livelihood.

Moreover, groundwater is very important for agricultural intensification to improve the livelihood of many farmers. The intensiveness of irrigation could provide for the growth of irrigated areas and guarantee increased food production. Irrigation is not sustainable if water supplies are not reliable, Chartzoulakisa & Bertaki (2015). Ground water constitutes the second major source of water supply, comprising 30 percent of total freshwater use from all sources. But the availability of groundwater is also shrinking in many areas as water tables and well yields fall. Water supply development is not keeping pace with expanding demand, creating fierce competition for existing supplies, Pérez Blanco & Essenfelder & Perry, (2019).

However, agriculture not only uses 70% of global freshwater and 90% of global groundwater, Shen & Pei (2019). They further pointed out the necessity to conserve water if we are to feed the booming global population by supporting sustainable agriculture. Also to combat water resources shortage and efficient use of water, hence water conservation methods and technologies need to be developed. The water resources will be able to support current generations in quality and quantity as well as future generations. Approximately, 1% of this freshwater is accessible in lakes, river channels and underground for domestic use, Yeleliere, Cobbina, & Duwiejuah,

(2018). Only 3% of the earth's water is freshwater, upon which there are various demands, Sullivan & Delp (2012).

Water conservation contributes a lot to sustainable agriculture and efficient use of available water. It is evidence in literature that human activities are the major threat to both surface and groundwater in Ghana especially agro-ecological zones. The availability of water resources facilitates environmental hygiene, adequate food to ensure stable livelihood, FAO (2003). Most areas in northern Ghana developed different innovative ways towards water conservation which play a major role in agriculture and water resources. The developments of locally based systems for water conservation in agriculture help to protect the limited water resources.

Kumawat et al (2020) pointed out that the availability of water is vital for productivity in all kinds of terrestrial ecosystems. Also, the appropriate method of water conservation contributes to prevention of water and soil nutrient losses in agricultural lands. The efficient use of water helps to sustain sustainable growth of crops and the environment. The watering of farm crops at the right time and the right amount of water to crops sustain the available water resources. The conservation of water resources prevent the declining and diminishing of surface water, ground water for agricultural and domestic uses. Therefore, there is the need to create awareness among farmers especially dry season farmers in northern Ghana.

Also, farmers in northern Ghana depend on surface water and groundwater which are the major sources of water for irrigation. The excessive use of these water leads to a declining water table for sustainable agriculture in the future. The irrigation water conservation practices are a major component in the process of reducing groundwater use when applied as a complete system, Sullivan & Delp (2012). The presence of climate change, water supply limits and continued population growth have intensified the search for measures to conserve water in irrigated agriculture. They further added that Conservation programs that target reduced water diversions or applications provide no guarantee of water conservation, Ward & Pulido-Velazquez (2008).

A study by Shen & Pei (2019) added that agriculture contributes a lot to environmental problems such as drying up of rivers, groundwater depletion and pollution.

Nevertheless, water conservation is a key if dry season farming is to continue yearly by smallholder farmers. As part of researcher's thesis field work, various crops irrigation aiming at water conservation in the dry season farming was studied. Therefore, this paper looks at an overview of indigenous water conservation among dry season farmers in northern Ghana.

Materials and Methods

A thematic literature search on various water conservations was studied for communities in the northern regions predominantly engaged in dry season farming. The aim was to identify indigenous water conservation for effective and efficient agricultural practices based on the regions during dry season farming. A case study was adopted to view agricultural irrigation practices in the dry season farming of northern regions. The study made use of both primary and secondary sources of data. The primary data was gathered directly from the field at Upper West Region. Participatory observation method was used to collect data from farm plots. The secondary data was gathered using Google scholar, books, journals were carefully studied and included in this study. The data from secondary serves as an important source for this study. The study employs descriptive-qualitative analysis.

Results and Discussion

Availability of water for irrigation in dry season farming

The available water motivates regular farmers to engage in dry season farming. The sustainability and permanent delivery of water is a key drive of many farmers to engage in all year round farming. Farmers in northern Ghana are involved in dry season farming only there are accessible and stable amounts of water that support dry season farming. Majority of the

farmers used the following available sources of water for irrigation; Dam, Reservoir, Personal hand dug out wells, Boreholes, Rivers and Earth dams.

Dam water is regulated and managed by the users. The water from dams passes through open drains to farmers for irrigation. The availability of well constructed dams in the communities of each region encourages large dry season farming. These were witnessed in Sankana, Yeleyiri, Tono, and Vea irrigation dams both in Upper West and Upper East Regions. Communities along black and white Volta use its sources for irrigation. The picture below shows the irrigation dam at Sankana. It is one of the largest dams in the Upper West region.

Figure 1: Irrigation dam at Sankana

Source: Field survey, 2021

Farmers in communities where they have limited access to water resources resort to community boreholes and pipe born water for crop irrigation. The farmers revealed that household food security and to prevent idling in dry season were their target of farming. WFO (2009) supported that small and large-scale irrigation projects have played a major role in ensuring food supply for a rapidly growing population, and in contributing to poverty alleviation by providing food security. It is assumed that dry farmers in the regions have already adapted some measures to combat climate change/variability. However, uncertainty of the temperature may negatively affect water table and quality of water for irrigation and domestic uses.

Personal shallow dug wells are created by smallholder farmers on farm plots. Farmers used this water for crop irrigation. They de-silt them during a decline in volume of water for irrigation. Farmers' plant trees and left weeds around dug wells. The farmers revealed that it is to prevent evaporation because of the intensity of sunshine in the area. The picture below shows some shallow hand dug wells with weeds surrounding it.

Figure 2: Personal shallow dug well on farm plot (Right) and method of water withdrawal (Left)
Source: Field survey, 2021

It is evidence from the literature that, the determinant of dry season farming is the availability of water resources for irrigation since dry farming is not practiced in the regions. The shallow groundwater created by farmers is used for irrigation in the dry season. Water retained in valleys

contains alluvial materials close to rivers. The study revealed that farmers cultivate crops during the dry season on alluvial materials.

Indigenous water conservation in dry seasons farming

The consistent drought induced by climate variability/change in northern regions of Ghana has prompted indigenous farmers to adopt a different approach to conserve limited water for irrigation and domestic uses. Farmers in the study regions are in a vicious cycle of food insecurity due to low yield and sudden heavy rainfall and reduction.

Besides, many farmers lost farm crops due to declining surface and groundwater in dry season farming. Dietz et al (2001) supported that insufficiency of rain for an extended period causes a considerable hydrologic imbalance and consequently water shortage, crop damage, stream flow reduction and depletion of groundwater and surface water. Where water is scarce, advanced irrigation technologies aiming at conserving agricultural water consumption such as drip and sprinkler systems are widely advocated. Across the regions studied, smallholder farmers' adapted different technology and indigenous methods in conserving water since climate change/variability is not the same across the regions. According to Texas water Development Board pointed out several technologies and methods used to conserve and manage water as shown below:

Table 1: Agricultural Water Conservation Management and Best Management Practices.

System	Methods	Description
Surface (Gravity)	Flood	Water is diverted from ditches to fields or pastures
	Furrow	Water is channeled down furrows for row crops or fruit trees.
	Border	Water is applied to sloping strips of fields bordered by ridges.
	Surge	Valves control delivery of water to fields in intermittent surges
Sprinkler (Pressurized	Pivot & linear systems	Pressure (High, Medium or low)
	Side rolls	Mobile pipelines deliver water across fields using sprinklers
	Solid set	Pipes placed on fields deliver water from raised sprinkler heads.
Micro-irrigation (Pressurized)	Surface	Emitters along pipes or hoses deliver water directly to the soil surface
	Sub-surface	Emitters along pipes or hoses deliver water below the soil surface
	Micro-sprinklers	Emitters on short risers or suspended by drop tubes sprinkle or spray water above the soil surface

Source: Texas Water Development Board. Retrieved August, 26, 2021

However, methods of water conservation in northern Ghana differ from communities. The adaptation of appropriate methods of irrigation depends on the typology, soil, land, socio-cultural dimension and the climate of the region. Some of the water conservation methods and technologies are outlined below:

Mulching by farmers was one of the indigenous practices used to conserve water and soils.

A farmer highlighted that with mulching irrigation is done every three (3) days because of consistent moisture of the soil. The materials used for mulching by indigenous farmers are dry leaves or grass and manure to conserve water. Farmers used both organic and inorganic methods of mulching to conserve water. Basically mulching creates a micro-climate for crops to grow well. Also mulching enables stable and suitable temperature for fast growth of crops. The method is effectively practiced in the northern regions. The crops germinate through the grasses or leaves covering the beds.

Figure 3: Mulching

Source: Field survey, 2021

Mixed cropping was identified as an effective method to conserve water in dry season farming. Mixed cropping enables farmers to irrigate two or more crops at the same time. Dry season farm

size is small, approximately 1.0-1.5 acres, hence mixed cropping is the best for smallholder farmers to conserve water, Hirst (2020). The picture below display mixed cropping in Sankana of Upper West Region.

Figure 4: Mixed cropping in dry season farming

Source: Field survey, 2021

Furrow irrigation is practiced by some farmers in the region. The water is channeled down a furrow for rows of crops. The method is best practiced on ridges. It was observed that crops were planted in rows, parallel and evenly spaced between ridges containing crops. From literature, furrow irrigation is cheap and the oldest method of irrigation. Also it is the type of surface irrigation. The use of gravity is best appropriate for furrow irrigation. It was observed that water discharge flows between beds and without beds (bare farm plots) depending on the slope either gentle or uniform flat. The crops absorbed water through beds due to moisture of the farm beds. The picture below shows the indigenous furrow irrigation methods. Also, sudden rainfall is captured by furrows.

Figure 5: Furrow irrigation

Source: Adams, 2017

Flood irrigation is the most common type of surface irrigation. The water is diverted from canals, ditches to farm lands or crops. The water flows freely to farms from water sources such as dams, reservoirs and rivers. Flood irrigation may be controlled at well built dams. The discharged water floods the entire farm depending on the landscape. If flood irrigation is controlled and regulated, it helps in storing required amounts of water in the crop roots and reduces the wastage of water resources. From observation, few farms were flooded with water at Sankana as shown below:

Figure 7: Flood irrigation

Source: Field survey, 2021

The study revealed that farmers usually adopt this irrigation type where water is abundant. Few areas are in the northern regions such as Tono, Vea, Sankana, Yepei, Bolgatanga and Goliga.

The study also pointed out that some farmers used petrol machines to pump water from reservoirs, canals, dams and wells to flood farms.

Shallow holes irrigation: Farmer irrigation crops manually on the circular holes created. The shallow holes planting and irrigation by farmers has been practiced to conserve water. Farmers water crops only by pouring water manually on the holes where crops are planted. Mostly buckets and tomato tin or metal bowl are used in watering crops on the holes thereby conserving limited water available for irrigation in the dry season. Figure 8a and 8b display shallow holes planting and irrigation in the region.

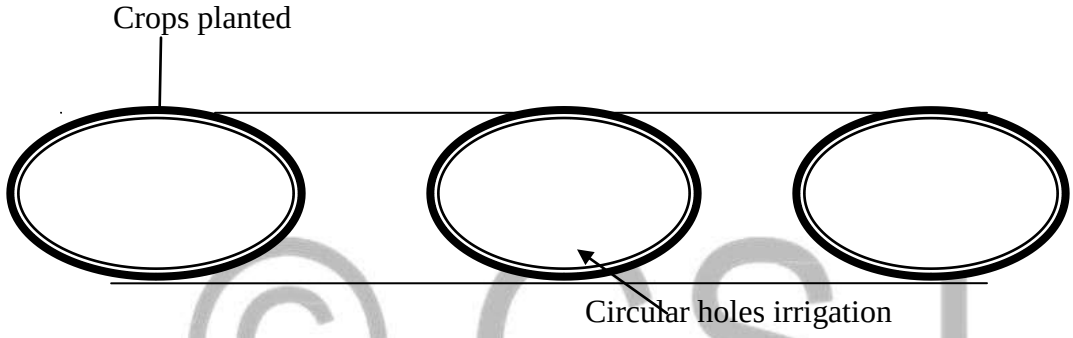

Figure 8a: Indigenous innovation for water conservation and management
Source: authors' design, 2021

Figure 8b: Crops planted in circular holes Shallow holes irrigation

Source: Maanibe, (2016)

However, the study identified other methods used by farmers which include bucket sprinkles; untiming watering of crops and this may not be economically beneficial to dry season farmers. Field observation and secondary data studies shows that farmers also use modernized systems of irrigation such as drip, sprinkler and macro-irrigation.

Environmental potential benefits of water conservation

Groundwater and surface water interaction is very effective at places where water conservation has been practiced. Water conservation plays a key role in groundwater and surface water interaction. It is clear from literature that surface seeps and recharge groundwater. Surface water includes rivers, reservoirs, lakes, dams and wetlands interacting with groundwater. When it rains surface receivers of water such as rivers, oceans and wetlands discharge water collected to seep through porous rocks to reach the water table. The available groundwater helps to sustain surface water from drying up. The study revealed that most surface water has reduced in volume for irrigation due to climate variability/change invariably declining groundwater. Earlier researchers have proven that climate variability/change has negatively affected both groundwater and surface water in the World. We therefore need to conserve and manage the available water judiciously for sustainable development.

Also, the study found out that water conservation promotes effective groundwater and surface water interaction. The interaction helps to sustain human life and ecological well-being, Sefeeq & Fares, (2016). The hydro-ecological interaction is very effective and sustainable where water conservation is being practiced. These may advance many irrigation schemes in the regions for dry season farming and domestic uses. Toran (2019) highlighted that effective understanding of

groundwater and surface water interaction provides insight into responses to both natural dynamics and global change.

Moreover, the study examined environmental potential benefits of water conservation in northern Ghana and it was reported that water conservation helps to maintain soil fertility, prevent runoff, and effective and efficient utilization of limited water in the regions. The study revealed that water conservation prevents soil erosion; hence soil nutrients remain in the soil for agricultural purposes. The appropriate conservation and management of the limited available water helps to sustain agriculture in the regions. Agricultural sustainability in the regions is the surest way to maintain food security. Food security in Ghana can never be sustained without dry season farming. Farmers in Upper West, Upper East and Northern regions respectively engaged in dry season farming to increase food security and maintain household livelihood.

Beside, most farmers combined different mechanisms to conserve and manage limited water to meet food security and alleviation of poverty in the regions. The study shows that indigenous farmers continue to conserve and manage limited water resources for irrigation. These allow farmers to practice different methods in agriculture such as cover cropping, mixed cropping/farming, crop rotation, intercropping and organic farming for sustainable agriculture. It well established that practicing sustainable agriculture is one way of ensuring sustainability in pro-poor farming communities in low income countries, Makate, Marshall & Mango (2017).

Also, it is also revealed that water conservation has improved water quality. This prevented stunted growth of farm crops. The quality of available water resources increases the quality and quantity of harvested crops. This assertion is supported by Okorogbona et al, (2018) that poor water quality negatively affects crops and soil productivity. The excessive uses of water for irrigation decline the quality. The study observed that excessive use of water for irrigation will wash away agro-chemical into available water for irrigation consequently may affect groundwater quality. It is evidence in literature that poor quality water reduces soil quality for

crops growth leading to increase in food insecurity and poverty. The research finds that to improve water quality for irrigation turfgrass and vetiver grasses need to be grown around water sources. Growing grasses and trees by farmers along water sources helps to conserve water. Abdulai (2020) supported that vetiver grasses planted along water sources are recommended for water conservation. These grasses also check erosion, runoff or waste of water and maintain soil fertility. The picture below shows vetiver grasses for water conservation and soil erosion management.

Figure 9: Vetiver grasses
Source: Abdulai, (2020)

Conclusion

The research has highlighted various water sources for irrigation in northern Ghana. The fundamentals covering the study include dry season farming, indigenous technology or method of water conservation and environmental potential benefit of water conservation. Water is a

determinant for dry season farming in northern Ghana. It was observed that farmers adapted irrigation type of farming but not dry farming due to lack of knowledge and skills. Dry season farmers are self motivated and targeting increasing household food security and eliminating idling during off-season. The study found out that mulching, mixed cropping, furrow irrigation, flood irrigation and others are outlined in the study as a way of water conservation in northern Ghana.

The open canals have broken down which reduces the gravity of surface water flow from available water to each farm. The excessive use of water for irrigation washes away used agro-chemicals into any available water and consequently may seep into groundwater affecting its quality hence water conservation is vital. The study revealed that farmers already adapted indigenous technology and methods to conserve agricultural limited water for irrigation. It was realized that farmers irrigate farmer crops timely, that is early morning and evening. These practices were well accepted by early researchers as a means of water conservation.

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