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Flood Recession Agriculture for Food Security in Northern Ghana

Literature review on extent, challenges, and opportunities

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1. INTRODUCTION

The reduction of poverty and the achievement of sustainable food security are major challenges in the semi-arid areas of West Africa, including northern Ghana (Devereux and Maxwell 2001; Challinor et al. 2007). This agro-ecological zone has intermittently experienced food insecurity in the past. Since the food crisis of 2008 and with an increased frequency of extreme weather events, such as floods and droughts, there is renewed interest in finding alternative solutions to guarantee adequate nutrition and to improve the resilience of populations living in this zone, especially in rural areas (Braun 2008; UN 2011). The Sahel, including northern Ghana, is one of the most vulnerable regions of the world. Public authorities with their development partners are increasingly committed to addressing the risks to agriculture and food security of this area (UN 2011). In Ghana, chronic food insecurity is more prevalent in the northern savannah regions than in the southern regions of the country, despite several years of concerted efforts. Recent trends suggest that changes in climate patterns are occurring in northern Ghana. Average temperatures have increased since 1960 by more than one degree Celsius and projections predict that further increases in temperature of 1 to 2 degrees are to be expected by 2030 (McSweeney et al. 2010; Van de Giesen 2010; CDKN 2014). This combination of factors suggests that new options are needed to solve agricultural and food security problems in northern Ghana (Laube et al. 2012).

Most of the farming systems in northern Ghana are rainfed. Public irrigation projects in the area have resulted in rather modest outcomes, because of the high upfront financial investment and the burden of operation and maintenance costs (Namara et al. 2011). Full control irrigation systems (canals, gravity systems, etc.) require high initial capital investment. Their maintenance also require both significant skills and strong institutional arrangements. In this context, innovative agricultural water management solutions can help to solve food security problems while providing options for mitigating floods. It is essential to investigate alternative and complementary options to both purely rainfed agriculture and public irrigation schemes in order to increase food production.

In areas dominated by flood-prone lands, flood recession agriculture can potentially be an effective solution to meet the food requirements of rural populations and increase their incomes. In several African countries, flood recession farming is used to harness flood water for productive agricultural use (Delaney 2012). While the frequency of flood events seems to be increasing, it is possible to take advantage of floods and increase overall annual agricultural production by growing adapted crops once the flood waters recede. Floods bring fertile nutrients and increase residual soil moisture, making flood-prone lowlands favorable to productive farming activities for several staple crops such as rice, maize, sorghum, soybean, potatoes, and melons. Poor and vulnerable communities living around rivers, lakes, and wetlands use flood recession farming as a strategy to sustain their livelihoods (Motsumi et al. 2012). The practice of flood recession farming is common in the basins of the Senegal and Niger Rivers and also around lakes in Nigeria, Mali, Mauritania, and Niger (Comas and MacPherson 2001).

Northern Ghana is endowed with large floodplains created by several tributaries of the Volta River. The productivity potential of the floodplains is high because of seasonal flooding that occurs in August and September each year. Also, because flood recession agriculture is mainly a dry season activity, the contribution of the harvests to household nutrition may be significant as they occur in a period when other food resources are depleted (Comas and MacPherson 2001). However, in order to secure increased benefits from flood recession farming, it is important to understand the influence of river system hydrological patterns and the possible implications for agricultural productivity. It is also important to more accurately assess the potential of flood recession farming in terms of its impacts on food security and income generation.

As part of a proposed larger project on the potential for flood recession agriculture in northern Ghana, the objective of this document is to review the incidence and characteristics of current traditional flood recession farming in northern Ghana with a focus on how it can be used to improve food security and reduce poverty. The review identifies the hydrological features of areas where flood recession agriculture is currently practiced in Sahelian countries and the socio-economic conditions that could make flood recession agriculture viable and profitable in plains that are similarly annually inundated in northern Ghana. It also frames and gives direction on specific issues related to flood recession agriculture that need to be addressed through research. It attempts to answer three specific questions: What is the current state of knowledge about flood recession agriculture in northern Ghana? What lessons can be learnt from other areas of semi-arid West Africa where flood recession agriculture is common? What are the knowledge gaps, and how can the present study address them?

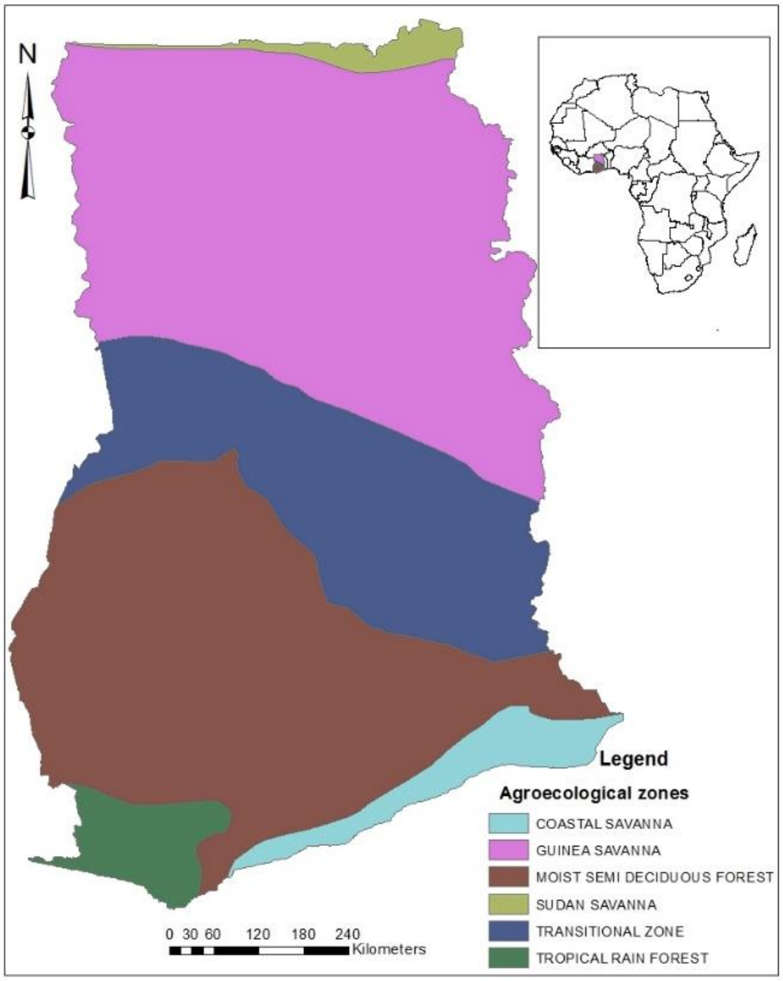
This paper is organized as follows. Section 2 provides background information on the hydro-climatic, socio-economic, and agricultural characteristics of northern Ghana, showing how the conditions in the savannah zone may be conducive to wider adoption of flood recession agriculture. It also highlights the opportunities for and the possible constraints to this farming method, focusing on specific districts. Section 3 reviews flood recession agriculture as it is practiced in Ghana and elsewhere in West Africa. It also briefly presents the socioeconomic and hydrological profile of selected areas in northern Ghana. Section 4 details various knowledge gaps and discusses how this study proposes to address them. This is followed by the concluding section, which includes a presentation of some key elements for the design of the broader research program being planned around flood recession agriculture in northern Ghana.

2. BACKGROUND CONDITIONS IN NORTHERN GHANA

In this section, we analyze background conditions in northern Ghana and examine how they may be conducive to the success of flood recession agriculture. The socio-economic context, climate and hydrology, geology and soils, and agricultural systems are included in this analysis.

Located along the Gulf of Guinea in West Africa, Ghana has experienced impressive economic growth averaging above 5 percent per year in recent decades (World Bank 2015). The country is subdivided into ten administrative regions and falls into six agro-ecological zones (Figure 1). The three northern regions, Upper West,

Figure 1—Agro-ecological map of Ghana



Source: CSIR-Soil Research Institute database www.csir-soilresearch.org

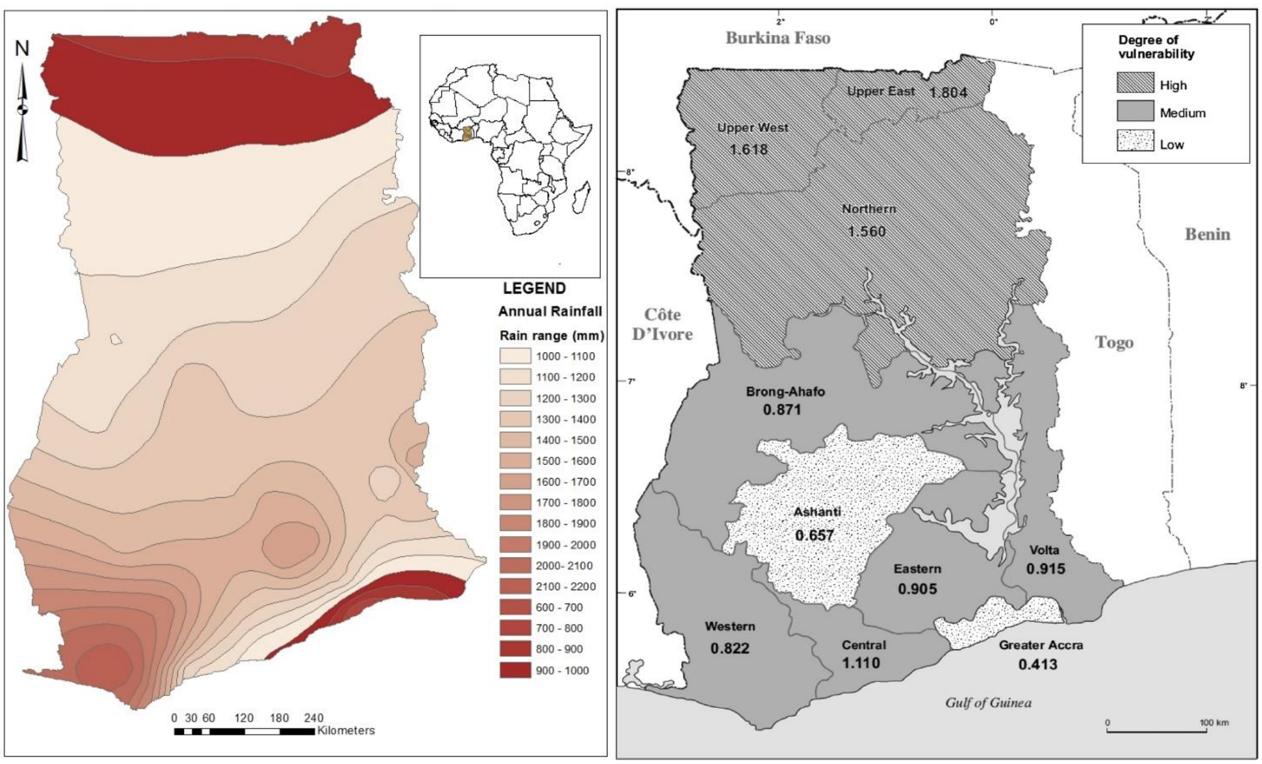
Upper East, and Northern region lie in the Guinea Savannah agro-ecological zone covering almost 100,000 km^2 (Asiamah et al. 1997). These regions persistently are the poorest regions of the country (Antwi-Agyei et al. 2012). Between 1992 and 2006, while the number of poor in the southern regions decreased by about 2.5 million, in the three regions constituting northern Ghana (Northern, Upper East and Upper West) the number of poor actually increased by 900,000 (IFAD 2012). Despite the fact that Ghana attained lower middle income status in 2011, poverty prevalence in Upper West Region remains at about 88 percent of the population. This chronic and severe poverty situation is associated with poor agricultural performance, seasonal hunger, low incomes in rural areas, and a lack of viable economic alternatives (Schraven 2010). In the northern regions, southward migration of young people significantly affects farm labor availability (Namara et al. 2011).

Northern Ghana is characterized by poor communications networks. Major towns are not connected by good roads (Blench 2006a). As a result, many communities remain isolated from markets and other basic facilities. The poor transport network has negative implications for farming communities, since perishable crops, including vegetables, are difficult to market.

Climate and Hydrology

The climate of northern Ghana is relatively dry, with a single rainy season that begins in May and ends in October. In contrast, southern Ghana has two rainy seasons over a seven-month period from April to October (Ghana Gov. 2015). In the north, the climatic regime is of a semi-arid type with annual rainfall ranging from 700-1200 mm per year (Blench 2006a; Blench 2006b). However, there is considerable inter-annual rainfall variability (Nicholson 2005). Because of this, coupled with seasonal variability, the northern regions are particularly exposed to generalized droughts, dry spells, and considerable flooding. Floods are closely related to peak rainfalls in August and September. The left map in Figure 2 shows a rainfall map of Ghana. Temperatures vary significantly according to the season from 14°C to 40°C. Potential evapotranspiration is relatively high, up to 2,500 mm per year (Amisigo 2006). The long dry season from October to April is associated with dry *harmattan* winds with low humidity and low night temperatures, making the area suitable for growing under irrigation several crops, including tomatoes, pepper onions, watermelons, okra, and other leafy vegetables.

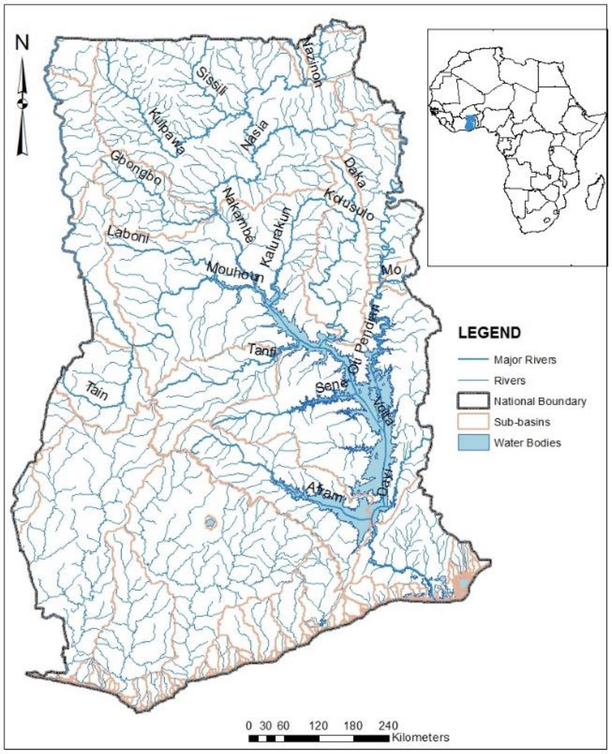
Figure 2—Annual rainfall map (left) and vulnerability map (right) of Ghana



Source: Rainfall map - CSIR-Soil Research Institute database www.csir-soilresearch.org; Vulnerability map – Antwi-Agyei et al. 2012

As shown in the right map in Figure 2, the three northern regions are also considered to be the ones most vulnerable to drought based on exposure, the sensitivity of crop harvests to rainfall perturbations, and adaptive capacity of these regions to cope with drought (Antwi-Agyei et al. 2012).

Figure 3—Hydrological map of Ghana



Source: McCartney et al. 2012

Figure 3 shows the hydrological network of Ghana. The Volta river basin covers a considerable area of Ghana, being one of the major rivers in West Africa (McCartney et al. 2012). Its main tributaries include the White and Black Volta, Oti, Daka, Pru, Sene, and Afram (Namara et al. 2011). Northern Ghana is mainly drained by the Black Volta, the White Volta and the Oti. Most of these tributaries experience seasonal flooding, although attention is usually only paid to catastrophic flood events (UNDP 2009; Stanturf et al. 2011; Amikuzuno and Donkoh 2012; Baba et al. 2013). For example, months of low rainfall followed by intense rainfall in 2007 adversely affected the Upper West Region, resulting in a humanitarian crisis. The aggregate effects of excessive rainfall and spillage from Bagre Dam caused floods which affected several thousand people and caused considerable material losses (UNDP 2009). High daily rainfall may trigger floods and topsoil erosion (Tambang Yengoh et al. 2010).

Only a limited body of literature, however, has studied the flood patterns of the river basins of northern Ghana. Focusing on one district in Northern Region and another one in Upper West Region, UNDP (2012) analyzed options for coping with floods using an early warning system based on identification of flood-related needs and challenges of communities. The report recognized that scientific and statistical data on floods appears to be quite scanty and only cover very recent periods. This is a major challenge for effective flood pattern analysis.

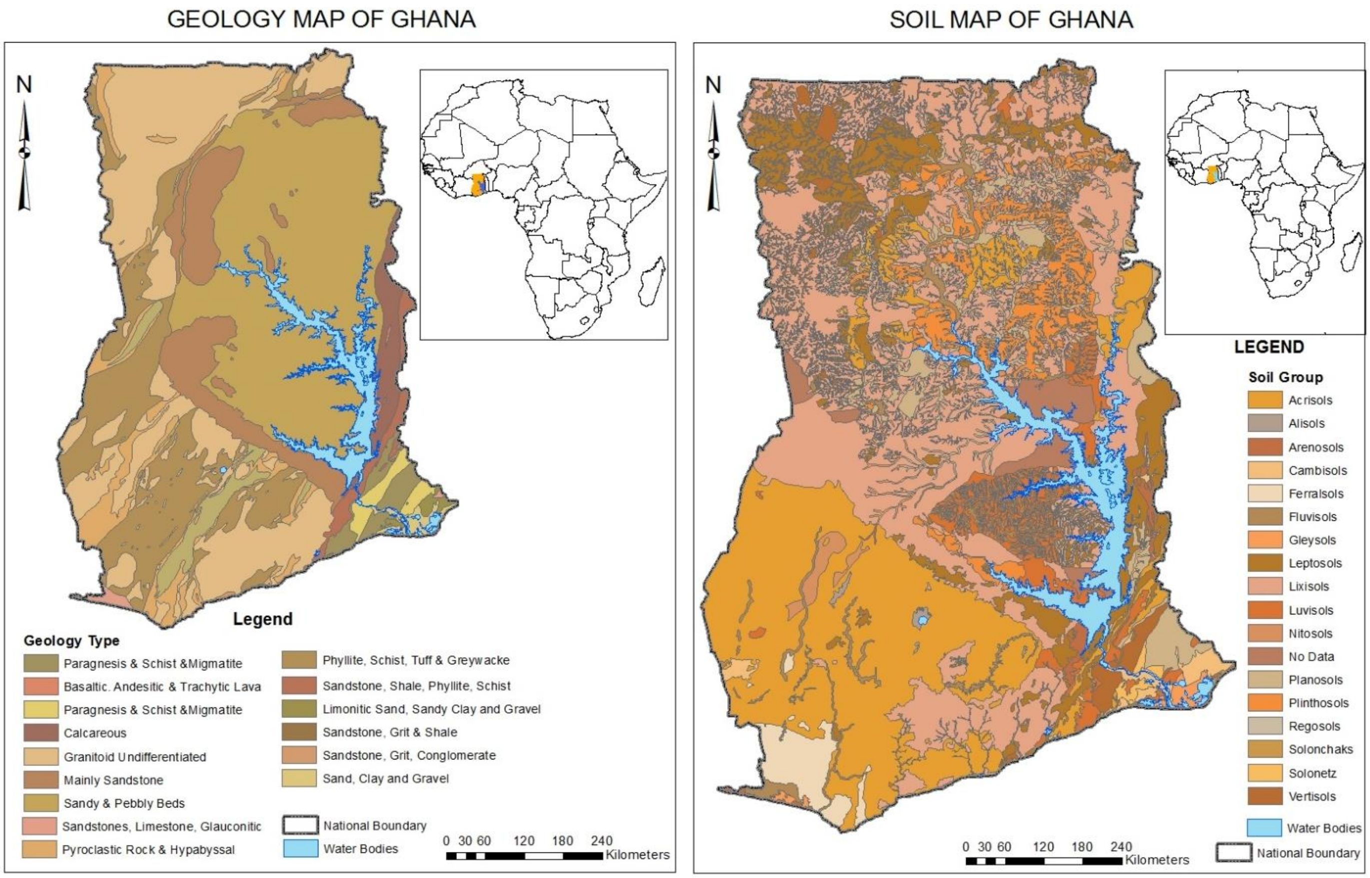
The available hydrological datasets have considerable gaps. The GLOWA Volta Project (GVP) collected data to contribute to filling this gap, but important aspects of the river are not well known or understood (Andreini 2000). For example, there is no operational data collection of the fluvial sediment loads of some rivers. Knowledge of sediment loads can give an indication of the quantity of nutrients which can be deposited annually by receding floods. Moreover, more recently, Taylor et al. (2006) highlighted the problem of missing data especially at small scales of areas of a few square kilometers.

Because different institutions and agencies are in charge of collecting, assessing, monitoring and analyzing different types of information on water resources in Ghana, existing data is scattered in different databases across the country. Aware of this problem, UNEP-GEF Volta Project (2008) has made an inventory of all the datasets available in different governmental and non-governmental agencies throughout the country. The inventory is now outdated, however. Overall, detailed new hydrological studies are needed if the agricultural potential of the floodplains is to be harnessed.

Geology and Soil

The geology of the terrain and the properties of the soil layers, especially the topsoil, condition the feasibility of different irrigation methods and the types of crops that can be successfully grown (Letey 1985). Figure 4 shows both a geological map and a soils map for Ghana.

Figure 4—Geological map and soil map of Ghana



Source: CSIR-Soil Research Institute database www.csir-soilresearch.org

Northern Ghana has two distinct geologic features: Precambrian basement rocks and Palaeozoic rocks from the Volta sedimentary basin. The topography of the area is mainly characterized by gentle slopes of less than one percent, which is favorable for crops such as rice.

Soils in Northern Ghana are heterogeneous (Veihe 2002). In the Savanna Zone where the northern regions are located, there is a diversity of soil types. These include major soils such as Black and Brown Clays, Savannah Lithosols, Groundwater Laterites, Savannah Ochrosols, Rubrisols, Gleisols, and Alluvisols (Obeng 2000).

Extensive floodplains are adjacent to the Volta River (Kranjac Berisaljevic et al. 1998). The floodplain soils vary from brown sandy clays to silty clay loams (FAO 1967). Black and brown clays occur along the White Volta in the extreme northeast of the country. Savannah Gleisol and Alluvisol intergrades are predominantly found in the vicinity of rivers (particularly along the lower part of the White Volta River) and are suitable for cultivation of maize, sorghum, beans, tomatoes and onions (Obeng 2000). Although, valley areas have higher natural fertility levels, they are more difficult to till and are prone to seasonal waterlogging and floods (Donkoh at al. 2013).

A priori, the geological and soil characteristics of floodplains are compatible with flood recession farming. However, socio-economic and cultural aspects must also be examined to identify the best options for this agricultural practice and the potential for its adoption. For example, given the nature of the soils in northern Ghana, Braimoh and Vlek (2004) and Braimoh (2004) suggest that integration of crop and livestock production systems may help to improve soil fertility and also help to relieve pressure on ecosystems. These same objectives can be achieved through flood recession agriculture as will be discussed later.

Agricultural Systems

Agricultural systems in northern Ghana are mostly rainfed although some small and medium-scale irrigation schemes have been developed or are planned. Because of the heavy reliance on rainfall, most agricultural activities are carried out from May to October with very little farming activity carried out during the rest of the year. The most important crops in terms of food security are sorghum and millet. However, the growing importance of maize, as demonstrated by its expansion to even the drier areas of northern Ghana where it is progressively replacing sorghum and millet, reflects possible shifts in farming patterns (Martey et al. 2014). Farming systems in northern Ghana face several challenges that severely undermine their productivity. For example, average maize yields are very low below 1.5 tons per hectare. In 2011, over an area of 245,000 hectares in northern Ghana maize production was only about 350,000 tons (SRID 2012). However, research has shown that 55% of the area currently under rainfed maize production could achieve yields of over 3 tons per hectare, the threshold at which the basic subsistence needs of smallholder families are likely to be met (Sebastian, 2014). This demonstrates that maize productivity gap is still high in northern Ghana.

There are a number of irrigation systems in northern Ghana, including those incorporating small dams and reservoirs generally constructed by public authorities and privately-owned shallow groundwater irrigation systems in which water lifting technologies, such as diesel pumps, are used (Namara et al. 2010; Namara et al. 2011). The proportion of potentially irrigable land that actually is irrigated is insignificant (Namara et al. 2011). The low level of irrigation use can be explained by several factors. With respect to large-scale public irrigation systems, this include:

1. The high costs of full control irrigation because of the extensive infrastructure (e.g. dams and canals, (MoFA 2007). Public irrigation schemes usually face persistent operational problems due to lack of sufficient funds to maintain, operate, and rehabilitate irrigation infrastructure (Namara et al. 2011).
2. The high level of skills needed to put such an irrigation systems into productive use.
3. The complex institutional framework needed to ensure the maintenance and sustainability of the irrigation system.

With regard to farmer-owned irrigation systems, the main constraint is financial. Farmers generally have no access to credit to start their activities. When credit is accessible, the terms of the loan are rarely favorable for poor farmers, primarily due to very high interest rates. Inadequate access to inputs, such as improved seeds, fertilizers, herbicides, and insecticides, and technical services also mean that they are unable to derive the full benefits of irrigation.

Farming systems in northern Ghana require sustainable new options for a number of reasons. Shifting cultivation, which is dominant in much of the Northern Region, is not a sustainable agricultural model because it contributes significantly to destruction of already fragile ecosystems (Blench 2007). However, a model that reconciles productive agriculture with ecological assets would sustain livelihoods. It is also important to diversify livelihood strategies to build more resilience (Laube et al. 2012).

Erratic rainfall coupled with eroded soils that are prone to waterlogging are some of the main constraints that make rainfed agriculture particularly unproductive. Rainfall, yield, and socioeconomic data all indicate that these regions are the most vulnerable to drought in the country (Antwi-Agyei et al. 2012). Changing climate patterns will probably have important impacts on crops and livelihoods in the area in the near future (Dietz et al. 2004; Cairns et al. 2012; Mertz et al. 2011). Much of northern Ghana is characterized by shallow and nutrient-poor soils (Blench 2006). Furthermore, food and livelihood security are threatened by desertification, deforestation, and inequitable access to, and control over, resources such as fertile land and irrigation opportunities (CARE 2010). The fact that these regions in the north are prone to flooding can be an advantage for flood recession agriculture (Namara et al. 2011). The following subsection characterizes specific areas prone to flooding.

3. FLOOD RECESSION AGRICULTURE IN GHANA AND ELSEWHERE IN WEST AFRICA

Flood recession agriculture is an agricultural practice that relies on residual moisture left by receding floods to grow crops (Adams 1993, Saarnak, 2003). Floods bring sediments from the upper catchment which get deposited along the floodplains and enhance soil fertility. Flood recession farming is thus based on natural irrigation and fertilization of low lying plains by flood water. It is considered a traditional agricultural system because historically farming communities in different parts of the world have used it. For example, flood recession agriculture has been practiced in the Mekong Delta for thousands of years where it is described as both productive and sustainable (Fox and Ledgerwood 1999). Flood recession rice cultivation in the Niger basin also has a long history. Barbier et al., (2011) estimate that this practice existed as early as 1500 year B.C. The potential of this farming system has not yet been fully explored, however, and sometimes it has even been neglected in both research and irrigation policy making.

The Ghanaian Government is committed to reducing rural poverty through agricultural and rural development (MoFA 2007). Sustainable management of water, land and the environment is part of its strategy. This strategy encompasses flood recession agriculture.

In the following section, we present flood recession agriculture as it is practiced in the northern regions of Ghana. We then show how in major West African river basins, communities have relied on this form of farming to secure food provision throughout the year and to generate additional revenue. We also indicate ways in which these experiences can be used to develop flood recession agriculture in Ghana, taking into account both opportunities and possible constraints.

Flood Recession Agriculture in Ghana

Flood recession farming in Ghana is limited and poorly documented. AQUASTAT database showed that from 1993 to 1997, no land was under flood recession agriculture in Ghana whereas 33,000 ha and 109,000 ha were under flood recession agriculture in Senegal and Mali, respectively. By 2009, Mali had 250,000 ha under flood recession agriculture. After a literature review of agricultural water management in West and Central Africa, Delaney (2012) concluded that flood recession farming in Ghana accounts for an insignificant fraction of the available agricultural land. Although, it is often mentioned that flood recession agriculture is a critical climate change adaptation strategy for livelihoods in northern Ghana (IWAD 2015), no indication is provided of the nature and extent of it. Ghana has mostly opted for full control irrigation systems.

Namara et al. (2010) noted that residual moisture irrigation is used by fishing communities around the Volta Lake in the Eastern Region to engage in vegetable farming (watermelon, okra, chilies, etc.). Practiced as a supplementary income activity, flood recession farming contributes to the livelihood diversification strategies of these communities. However, the sustainability and spread of this activity may be constrained by two factors: firstly, settlers in the area (fishing communities) have no land tenure security as indigenous households often claim ownership to the land inundated by the lake. Secondly, due to recent policy debates about buffer zones that aim to prohibit irrigation within a 50m reach of a water body, flood recession agriculture potential may be limited (Namara et al. 2010). Land tenure issues need to be carefully examined in order to promote flood recession farming systems. In the Sissili and Kulpawn river valleys in Builsa district in the Upper East Region, considerable flood recession agriculture is being undertaken (Wienco 2013). Seasonal flooding has been used by communities along the Volta River to grow crops, including maize, before impoundment behind the Akosombo dam (Tsikata 2006). A recent study in Ghana suggests that residual moisture could also be used to grow vegetables like okra (Sam-Amoah 2011). This opens up a profitable opportunity for those engaged in flood recession agriculture since vegetables have a high market value and can bring substantial additional revenues to rural populations, especially to women who are the ones most often involved in vegetable cultivation (Laube et al. 2008; Keraita et al. 2008; Faulkner et al. 2008).

Although flood recession farming is not recognized in the Ghana Irrigation Development Authority categorization of irrigation systems, since 2000 the Authority has identified more than 32,000 hectares of underdeveloped inland valleys throughout the country which could benefit from moisture improvement technologies for food production (MoFA 2007; MoFA 2011). Several lowlands can also be used for flood recession agriculture. Large scale irrigated perimeters with complex distribution systems cannot in all environments be used as substitutes for flood recession farming (Adamczewski et al. 2011). This underscores the need to explore and develop this alternative agricultural water management solution. Improved understanding of the potential use of these seasonally inundated floodplain could contribute to higher incomes for farmers and reduced food insecurity at both community and national levels.

Various knowledge gaps need to be filled to enable possible expansion of flood recession agriculture in northern Ghana. First, the lack of understanding of the hydrology of river systems in northern Ghana, as it pertains to the productivity and potential of flood recession agriculture, needs to be adequately addressed. Most studies have focused on catastrophic flood events with negative impacts on lives and property (UNDP 2009; Stanturf 2011; Amikuzuno and Donkoh 2012; Baba et al. 2013). The often destructive nature of floods should not overshadow the potential benefits that can be derived from them. In fact, considering the areas that experience annual flooding in northern Ghana, significantly positive results could be expected from flood recession farming. Because, the occurrence and the duration of flood events become more predictable only when the underlying hydrological factors are well captured, water resource variability patterns need to be analyzed from a basin perspective.

Positive impacts on poverty and food security can be achieved, but a better understanding of agronomic conditions, the socio-economic and institutional context, and constraints and opportunities needs to be achieved first. The feasibility of flood recession agriculture will also be determined by biophysical factors, such as the geology and nature of the soil, climatic patterns, and the ability and willingness of communities to adopt new practices, their access to markets, and other cultural or economic factors.

Flood Recession Agriculture in West Africa

Flood recession farming is practiced in floodplains, wetlands, inland valleys and lake banks in several parts of West Africa. Farmers derive benefits from seasonal floods that simultaneously bring both moisture and fertility to soils along the river banks. Worldwide, flood recession farming is practiced in areas where the climate has two distinct seasons: a wet and dry season. Generally, crops are planted after the flood has receded from areas around the river bank and harvested before the following flood.

Countries in West Africa where the practice of flood recession agriculture is important in terms of the area of land under this system include Nigeria, Chad, Mauritania, Mali, Senegal and Niger (Delaney 2012). For example, Saarnak (2003) identified farming practices based on the remaining soil moisture from the yearly inundations of the Senegal River Valley. He showed that by cultivating sorghum, beans, and melons, which supported household subsistence, families could cope with food insecurity for several months. Also Adams (1992; 1993) suggested that in many regions of Africa, indigenous systems were and are still used to take advantage of the agricultural potential of floodplains. Seasonal flooding of the banks of rivers Niger (Niger, Mali), Senegal (Senegal, Mali, and Mauritania), Sokoto (Nigeria) and the Waza-Logone (Cameroon) in the Sahelian region of West Africa have been used for ages to grow millet, sorghum, sweet potato, and other crops.

In Mali, in particular, flood recession farming is practiced from October (when floods recede from the banks of the Senegal River) to July (when the floodplain starts to be inundated again). Comas and MacPherson (2001) have documented sorghum cropping in West and Central Africa using flood recession farming. Because of the semi-arid nature of the climate, sorghum is singularly adapted for flood recession farming in the Sahelian-Sudanian continuum. It is among the lower water demanding crops with water requirements varying from 380 to 630 mm for maximal yield. However, during the germination phase, the crop water requirement is high, which makes it suitable for flood recession farming since sowing takes place when the soil is adequately wet. Although vertisols with high water retention capacity are preferred, sorghum has considerable varietal diversity and some varieties can be productive on marginal lands (McGuire 2002; FAO and ICRISAT 1996; Deu et al. 1999). In addition, the fact that in flood recession farming systems the plants mature in dry conditions (no rainfall on the leaves or on the grains) means they are less exposed to crop diseases. As a result, the quality of grain and crop residue is exceptionally good. Under ideal crop management, yields can reach 2.5 t/ha. In addition, because of the submersion of the soil preceding cultivation, there is a reduced need for weed control.

Flood recession sorghum cultivation plays a strategic role in ensuring the food security of the poorest communities, because the crop cycle takes place during the dry season when other crop harvests are depleted. Sorghum is sown in October in the Senegal River Valley and harvested around April. In Mali, flood recession farming is increasingly being recognized as an important way to ensure food security, especially in the northern regions of Gao, Timbuktu, and Kidal (IER 2010). Sorghum provides considerable quantities of calories, protein, and lipids and is considered a nutritional crop.

Studies by CIRAD showed that Durra varieties of sorghum are mostly used for flood recession farming (Sapin 1971). In Senegal, this variety is extensively cultivated in flood recession systems. The average area under this system in the Senegal River valley is about 100,000 ha. Flood recession sorghum is also a major crop in India. However, Indian varieties have not yet been experimented with in Africa. JGRC (2001) highlights that different rice varieties are recommended for flood recession farming depending on the duration and level of submersion.

Statistics from Mauritania show that flood recession agriculture can be highly productive.[1] Here flood recession sorghum production can provide as much as a quarter of national cereal production in favorable years (Comas and MacPherson 2001). This contributes substantially to food self-sufficiency and to the generation of extra revenue for Mauritanian farmers. In addition, crop residues are used to feed cattle.

Although rice and sorghum appear to be the two main crops under flood recession agriculture in the West African Sahel (Barbier et al. 2011), in Senegal maize is also cultivated in combination with other crops around lakes and small river streams covering an area of up to 25,000 ha (Tardieu and Le Conte 1976). This *bas fond* farming system enables many people to extend their livelihoods and successfully maintain their food security to the next rainy season. Sweet potato is another important flood recession crop in Senegal. It covers an estimated area of 2,750 ha in the Senegal River valley, where yields can be as high as 8 t/ha, thanks to the nutrient rich floodplains (CNCFPD 2009). Farmers also derive considerable benefit from flood recession sweet potato cultivation downstream of the Selengue Dam in Mali where women are very active in this form of agriculture. Flood recession farming can also be used to grow fruit, as in the Horo Lake in northern Mali (Adamczewski et al. 2011).

Nonetheless, flood recession agriculture, which is based on traditional knowledge, has been neglected, as precedence has been given to other irrigation systems. This may be due in part to flood recession agriculture often being regarded as a “primitive system” because of its relative simplicity and the low control of water in such systems (Koundouri et al. 2003) and because research has not yet developed best practices for adoption in flood recession systems. In addition, the socio-economic and cultural aspects of this agricultural practice remain poorly understood (Oyebande 2001).

[1] Mauritania is the only country in West Africa for which there is reliable information on the contribution of flood recession farming to total national food production.

The lower control of water under flood recession agriculture can be compensated for by continuous adaptation and adjustment to changing hydrological conditions. The adjustment potential can be enhanced by early warning systems and through coordination between different institutions at the basin level. This can lead to improvement in flood recession farming. For example, the Manantali dam on the Senegal River made it possible to regulate floods so that farmers could count on more regular flooded areas and duration and so plan their flood recession agriculture accordingly (Koundouri et al. 2003). Combinations of modern water control technologies and methods with traditional soil moisture conservation systems have the potential to result in much more productive outcomes.

Finally, there is evidence that flood recession farming tends to have a lower environmental impact than traditional irrigation systems (IUCN 2000; Oyebande 2001). It is compatible with the protection of African floodplain ecosystems, many of which are presently being modified with negative consequences as a result of large-scale irrigation schemes that do not account sufficiently for the ecosystem services provided by wetlands (Barbier and Thompson 1998). More research and data is needed to inform decision making at the farmer and policy-maker levels on ways to promote flood recession agriculture.

Profile of Selected Areas for Study of Flood Recession Agriculture in Ghana[2]

For the broader proposed study on flood recession agriculture in Ghana, specific districts were selected in collaboration with a panel of stakeholders, including representatives from the Savannah Accelerated Development Authority, Wienco Ghana Ltd., the Water Research Institute and Savanna Agricultural Research Institute (both from the Council for Scientific and Industrial Research), the Ghana Irrigation Development Authority, and the National Disaster Management Organization. Study areas were selected based on history of flooding, information on the existence of some form of flood recession farming in the area, availability of hydrologic data, and accessibility to various locations and communities in the area. The study communities selected are outside the immediate zone of influence of existing or planned irrigation projects in the area. These projects include the Volta River Authority Pwalugu Multipurpose Dam, irrigation projects planned by the Northern Rural Growth Program, irrigation development plans by Wienco Ghana Ltd. in the Sisili-Kulpawn river basins and the Ghana Commercial Agriculture Project in the Accra Plains. The promotion of flood recession farming should complement the above mentioned projects because such efforts will target areas in which no full control irrigation projects are planned and, more importantly, areas where poverty incidence is highest. The selected study districts are Talensi and Bawku West District in the Upper East Region and West Mamprusi in the Northern Region. Brief socio-economic and hydrologic profiles of the three study areas are presented here.

TALENSI DISTRICT IN UPPER EAST REGION

With an area of 838 km^2, Talensi district has a population of 81,194 inhabitants and 15,748 households. Seventy-eight percent of the population work in agriculture and 91 percent of the households engage in agricultural activities, with an average land holding of 1.2 ha according to the 2010 population and housing census. The average household size is 4.5 people. Average income in the Upper East Region is about 1800 GH¢ per capita per year (compared with a national average of 16,645 GH¢). Several communities in the district are flooded annually, including Pwalugu, Balungu, Shia, Winkogo, Yinduri, and Tongo. Rice and maize are the main flood recession crops, but their productivity (yield/ha) is not known.

Agriculture plays an important role in the socio-economic development of the district. Apart from contributing to food security, it also provides employment and incomes for over 90 percent of the population (MoFA 2015). Diverse crops are grown including cereals (millet, sorghum, rice, maize), legumes (groundnut, cowpea, soybean, Bambara bean), vegetables (tomato, pepper, okra, garden egg) and tubers (sweet potato, frafra potato). However yields are poor. For example, average maize yields are 1.39 t/ha and millet yields are even lower

[2] These are areas where some form of flood recession agriculture is already being practiced or where the potential to do so exists. The suitability of these locations for expansion and intensification of flood recession farming was one of the key points that was discussed and confirmed during an inception workshop for the broader research project.

at 0.98 t/ha. Livestock is also an important component of the local agricultural system. Livestock plays an insurance role in case of crop failure.

The district is drained by the Red and White Volta rivers and their tributaries. The topography of the district is characterized by undulating lowlands with gentle slopes. Soils types in these valleys range from sandy loams to silty clays. The climate is tropical with two seasons, a wet and a rainy season.

BAWKU WEST DISTRICT IN UPPER EAST REGION

Bawku West district has an area of 979 km^2 and a population of 81,000, 80 percent of whom are involved in agriculture. Ninety-three percent of households are involved in agriculture (14,000 agricultural households). Although the people of Bawku West are highly reliant on agriculture for their livelihoods, they experience food shortages in the dry season. The main crops grown during the rainy season are millet, rice, sorghum, maize, groundnut, and bean. Dry season crops (including those grown using flood recession) are tomato, onion and watermelon. The rainy season starts in May and ends in October, with an annual average rainfall of about 956mm, and is followed by a long dry season. Natural vegetation is mainly made up of acacia, baobab trees and grassland. Most of people live in rural settings.

The White and Red Volta rivers and their tributaries are the main rivers draining the district. The floodplains are generally flat to gently undulating. Valley areas have sandy loams and clays soils with high natural fertility, although they are more difficult to till and are prone to seasonal waterlogging and flooding. The communities of Gogo, Saka, and Sapeliga are frequently flooded.

WEST MAMPRUSI IN NORTHERN REGION

With an area of 2,610 km^2, West Mamprusi district has a population of 121,000 people, 76,500 of whom live in rural settlements. Eighty-six percent of households in the district are engaged in agriculture (12,340 households). The average household size in rural areas is 8.8 people. Eighty-one percent of the employed population work in the agricultural sector. Major rainy season crops are maize, millet, rice, groundnut, bean, sorghum, Bambara bean, and yam. Dry season farming along the banks of the White Volta involve crops such as tomato, onion, soybean, pepper, and tobacco. Average income is about 3000 GH¢ per capita per year. However, farmer incomes are much lower. The yearly average household income from farming is about 950GH¢ (Meng et al. 2012) and 407 GH¢ from other activities (wage employment and non-farm self-employment). The average landholding size is 5.6 ha.

The main communities experiencing annual flooding and practicing flood recession farming are Naamiyala, Arigu, Kpasenkpe, Jadema, Kunkwa and Gbeo. The main rivers branches that drain the district are the Kulpawn, White Volta, and Nasia. Flood recession rice farming is practiced, especially on the banks of the Nasia. Cowpea and maize are also grown as flood recession crops. The district lies in the Guinea Savannah agro-ecological zone. As a result, natural vegetation comprises short trees, grasses and shrubs.

FLOOD RECESSION AGRICULTURE IN PROPOSED STUDY AREAS

In the areas mentioned, two main types of flood recession farming are observed depending on the type of crop. For cereal crops like rice and maize, floodplain farming typically starts before land is flooded. Therefore, depending on the extent and intensity of floods, floodplain farms may be very vulnerable. Young seedlings may be submerged or uprooted, resulting in little or no harvest. Farmers generally cope with this situation by replanting in cases of intense flooding. This leads to a delay in the harvest. This situation is partly due to the unavailability of or lack of knowledge about crop varieties with a shorter maturing period. Because farmers only have access to seeds with a long maturation period, post-flood farming becomes risky. Soil moisture may dry up before the harvest period of the long duration varieties, resulting in poor yields. For vegetable crops, however, which have a shorter growth cycle, farmers practice post-flood planting.

In these areas, staple food availability from rainfed farming typically lasts for less than 7 months. For the rest of the year, hunger and malnutrition are permanent threats. During the remaining 5 months of the year, households cope by reducing food intake or by having members migrate to the south of Ghana for temporary employment (Quaye 2008).

Considering the availability of inland valleys and lowlands, the potential for flood recession agriculture in Ghana varies from 780,000 to 1,200,000 ha nationally, and from 289,000 ha to 444,000 ha in the Northern and Upper East Regions specifically. In the Upper East Region, 358,000 ha is under cropping, while in the Northern Region the figure is about 709,000 ha, according to MoFA. Table 1 shows the major crops, average yields and months of food insecurity in the two regions.

Table 1—Food insecurity and average crop yields in Upper East and Northern Regions

	Upper East Region				Northern Region			
Crops	Months of Harvest	Months of stock depletion	Months of food insecurity	Average yield (t/ha)	Months of harvest	Months of stock depletion	Months of food insecurity	Average yield (t/ha)
Sorghum	August	February	6	0.58	November	June	5	0.58
Maize	October	April	6	0.76	September	June	3	0.76
Millet	July to Nov.	January	6	0.42	November	June	5	0.49
Rice	November	April	7	0.41	October	May	5	0.49
Yam	NA	NA	NA	NA	September	June	4	2.17
Groundnut	October	April	6	0.63	September	April	5	0.63
Cowpea	October	March	7	0.23	October	May	5	0.44
Soybean	NA	NA	NA	0.15	November	April	7	0.40

Source: Quaye (2008). Note : NA – not applicable.

Assuming food security from own production is proportional to the quantity of staple foods available to households, food availability will need to roughly double in the Upper East and Northern Regions to ensure food security. Improved flood recession farming can contribute towards combating food insecurity problems by significantly increasing total annual food production. For example, for sorghum, in flood recession systems, yields can reach up to 2.5 t/ha (over four times the actual yields realized in Northern and Upper East Ghana). This will enable both adequate supply of food throughout the year and additional income to be generated.

4. KNOWLEDGE GAPS TO BE ADDRESSED IN THE PROPOSED STUDY

Despite its major potential as a way to ensure food security, flood recession farming has generally not received due attention in Ghana. More consideration has been given to other irrigation systems, especially the development of large scale irrigation schemes which have a higher political resonance (Koundouri et al. 2003). This deficit of attention translates into a relative lack of coherent and reliable policies and research results on flood recession farming systems. Flood recession agriculture can contribute to the sustainable intensification of agricultural systems in northern Ghana because it can provide profitable yields with a low environmental footprint. Due to the vast floodplains and gentle slopes, the potential in northern Ghana for flood recession agriculture is considerable. However, a number of biophysical, socio-economic, and institutional variables need to be considered to derive full benefits from this farming system. Two important and interlinked sets of knowledge gaps can be identified: gaps in understanding the hydro-climatic characteristics of flooding and gaps in the socioeconomic and institutional factors influencing flood recession agriculture in northern Ghana. Filling these gaps will be necessary if productive flood recession agriculture is to be promoted to improve food security. These gaps are further elaborated below.

Knowledge Gaps Pertaining to Hydro-climatic Characteristics

The first challenge is the absence of good quality climatic and hydrological data at the community level where the proposed study will be conducted. However, this is not an insurmountable problem since different techniques can be used to downscale existing hydro-climatic data or to address the problem of missing data (Taylor et al. 2006).

Quantitative information on the area under flood recession farming and related yields also are poorly documented. Land use and land cover data in flooded communities do not differentiate between different crop types, nor does it define the planting period or the duration of the cropping period.

Another important knowledge challenge is the fluctuation in the productivity of flood recession farming due to variability in the extent of flooding in most communities from one year to another. Areas of farm land already cultivated can be inundated by unpredicted floods, leading to significant portions of the potential harvest being lost. Better flood control and an efficient early warning system in the river basin could help to stabilize the area of the floodplain inundated from one year to another. This would require good knowledge of the river's hydrological regime. The hydrologic component of the research project will address this by using the following methods.

Statistical analysis of historical discharges, discharge levels for selected return periods – 2 years, 5 years, 10 years, and 50 years return period – will be established. Flow duration curves will be developed to assess the discharges for specific return periods. This will require a long time series of flows in or near the study areas. This analysis will provide estimated return periods for peak flows. Flood recession agriculture does not require only peak flows, it also requires information on the period and duration of inundation. Additional information on the duration of the flood will be used to identify possible flood recession agricultural activities. This information will include adjusted flow duration curves that will be developed and validated by interviewing members of local communities that experienced the flooding. Remote sensing analysis, using images captured around the time of the flood, will provide more accurate measurements of the extent of flooding associated with the discharge. The hydro-climatic data will be completed and validated through field visits, observations, key informant interviews, and engagement with focus groups.

Gaps Pertaining to Socio-economic and Institutional Factors

Development of flood recession farming will require close collaboration between farmers, researchers, and other decision makers. Different institutional and technical solutions can then help to improve the practice of flood recession agriculture (Comas and MacPherson 2001). Practices that enable more efficient management of soil and water resources in order to increase productivity and reduce yield variability will ensure the sustainability of the entire flood recession farming system. In addition, accompanying measures relating to access to markets and storage and preservation of agricultural products will need to be carefully examined, as there is evidence (in southern Mali for example) that these factors have constrained the development of flood recession farming.

Several socio-economic knowledge gaps exist. The socioeconomic importance of flood recession farming is not well understood in northern Ghana. The productivity of existing flood recession farming compared to what would be possible with adapted crop varieties through a yield gap analysis is not known. Moreover, the contribution of improved flood recession harvests to household food consumption and incomes is not known. Socio-cultural constraints on the expansion of flood recession farming have also not been investigated.

As observed in other countries, if potential socio-cultural constraints are not adequately managed, they could limit the potential of flood recession agriculture. For example, in Mauritania, during the dry season wandering animals pose a serious threat to dry season flood recession sorghum production systems. Moreover, poor organization among farmers and non-compliance with the cropping calendar have been mentioned as serious constraints (Comas and MacPherson 2001). Widespread expansion of flood recession agriculture would necessitate farmer training and outreach programs. In this regard, clear institutional mandates must be given to irrigation support services to promote residual moisture agriculture. Another interesting avenue to explore is the association of flood recession farming with livestock breeding because this farming system produces high quality crop residue at a period of the year when stocks of animal fodder are considerably limited. Land tenure issues in floodplains also need to be addressed to provide the right incentives to farmers (Namara et al. 2010).

Looking at it from another perspective, flood recession farming offers several potential socio-cultural opportunities in northern Ghana. Crops usually cultivated under flood recession agriculture are the main staple foods in the three northern regions. Maize, millet, sorghum, and rice cover more than 80 percent of cultivated cropland in the area. Experiences in other West African semi-arid countries has shown that those crops can be adapted for flood recession agriculture if the right varieties are chosen.

There is a need to develop agricultural policies that take into account the risks associated with specific flood recession agriculture activities and to find ways to build resilience to overcome them. Understanding and predicting floods will be key to the development of productive and sustainable flood recession farming systems in northern Ghana. In particular, knowing the patterns of the flood cycle – duration, frequency and extent – and being able to relate it to agricultural production systems in terms of the type and varieties of crops to grow and the water and soil management practices to adopt, would play a vital role in the success of such systems.

As part of the proposed research project, purposefully designed socio-economic surveys will be conducted to address the issues mentioned above. First, a stakeholder workshop has been conducted to validate the relevance of the preselected flood recession areas in northern Ghana. Next, participatory rapid appraisals will be conducted in the study communities identified as suitable for flood recession agriculture to determine the crops grown, the area cultivated per household, yield per hectare, etc. Based on this, case study communities will be selected for detailed hydrological and socioeconomic study. In sites where flood recession agriculture is already being practiced, information will be collected on the types of crops grown, soil and water management practices, current yield levels, costs of production, output prices, access to markets, and the socioeconomic and institutional constraints to expansion of flood recession agriculture. The study will particularly focus on land tenure issues. In potentially suitable sites, different crop and soil moisture management scenarios will be developed to identify realistic farming options. The potential outcome of each scenario will be scrutinized in terms of its contribution to food security by developing a statistically based microeconomic model.

5. CONCLUSION

A review of the literature indicates that flood recession agriculture is an important part of the livelihoods of several communities in northern Ghana, although several obstacles and knowledge gaps still need to be addressed if the farming practice to realize its full productive potential. Limitations posed by current land tenure and property rights regimes, poor understanding of the Volta river hydrological patterns and its implications for flood recession farming in the study communities, lack of access to adapted crop varieties that have been successfully developed for flood recession agriculture, and a lack of advisory services and risk management measures are some of the obstacles that will need to be tackled.

This review describes a range of physical and socio-economic scientific methods and field activities that will be implemented in a proposed research project to develop a better understanding of the extent and patterns of flooding and the potential of flood-recession agriculture. These activities will allow the hydrological characteristics of the river to be matched to crop-livestock systems of flood recession agriculture that are well suited to the study communities and their organizational and institutional frameworks in order to support sustainable growth of such systems. This detailed study will provide recommendations on the technical, economic, institutional and policy measures needed to achieve sustainable intensification of flood recession agriculture in northern Ghana, while complementing efforts undertaken to promote other types of water management systems. Options for out-scaling of flood recession agriculture beyond the study area to other suitable areas will also be explored. The expectation is that the proposed project will improve food security by enhancing knowledge on effective flood recession practices, enhance rural incomes through expanded dry-season farming with new opportunities for rural employment, and improve adaptation to climate change by building more resilient farming communities. To achieve these expected outcomes, proactive policies that clearly identify flood recession agriculture as an alternative farming practice and provide institutional mandates to irrigation support services to promote it through training, demonstration, and outreach programs will be equally valuable.

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