Innovation Lab for Small-Scale Irrigation: Ghana

Discussion Paper

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Promising small-scale irrigation and fodder interventions in Ghana

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Contents

ACRONYMS

AfDB	-	African Development Bank
AgWMS	-	Agriculture Water Management Solutions
AWM	-	Agriculture Water Management
FAO	-	Food and Agriculture Organization (of the United Nations)
FASDEP	-	Food and Agriculture Sector Development Policy
GIDA	-	Ghana Irrigation Development Authority
GSS	-	Ghana Statistical Service
IFAD	-	International Fund for Agricultural Development
LACOSREP	-	Land Conservation and Smallholder Rehabilitation Project
METASIP	-	Medium Term Agriculture Sector Investment Plan
MOFA	-	Ministry of Food and Agriculture
NGOs	-	Non-governmental Organizations
NRGP	-	Northern Rural Growth Project
SSI	-	Small-scale Irrigation
UWADEP	-	Upper West Agricultural Development Project

1 SMALL-SCALE IRRIGATION IN GHANA'S AGRICULTURAL DEVELOPMENT

1.1 Relevance of Small-scale Irrigation

Agricultural production in Ghana and indeed the West African sub-region is still dependent on rainfall. However, the rainy season in the arid and semi-arid areas are very short and rainfall erratic. In the three regions of northern Ghana (Northern, Upper East and Upper West), rainfall is between April/May to September/October. The total quantity of rainfall in the northern regions continues to be between 900mm to over 1000mm, but erratic distribution and delays in the rainy season poses challenges. Sometimes droughts and floods occur in the same year; parts of the Upper East Region now experience the commencement of the rainy season in late May or even June. Droughts and other types of unseasonable weather pose risks for farmers (Namara et. al., 2011). Many farmers have in several years lost considerable quantities of their crops (under cultivation) and animals to floods and drought. In addition, the seasonal distribution of rainfall does not match the seasonal water requirements of crops (and animals) in parts of the country. In such situations irrigation provides a good solution, because it can match water availability with the water requirements of crops and animals.

It is common knowledge that while over the years poverty in Ghana has declined, poverty in the northern part of the country has increased or decreased only marginally (compared to other regions) as shown in Table 1. Poverty rates are not unconnected with rainfall and reliance on rainfed agricultural practices; the north of Ghana experiences one short rainfed cropping season per year. Small farmers are the most affected.

Table 1: Comparative Analysis of Poverty Incidence in Northern Ghana 1991-2006

	1991/92		1998/99		2005/06	
Administrative Region	**% poverty incidence**	**% extreme poverty incidence**	**% poverty incidence**	**% extreme poverty incidence**	**% poverty incidence**	**% extreme poverty incidence**
All Regions (Ghana)	51.7	36.5	39.5	28.8	28.5	18.2
Northern Region	**63.4**	**54.1**	**69.2**	**57.4**	**52.3**	**38.7**
Upper East	**66.9**	**53.5**	**88.2**	**79.6**	**70.4**	**60.1**
Upper West	**88.4**	**74.3**	**83.9**	**68.3**	**87.9**	**79.0**
Brong Ahafo	65.0	45.9	35.8	18.8	29.5	14.9
Volta	57.0	42.1	37.7	20.4	31.4	15.2
Central	44.3	24.1	48.4	31.5	19.9	9.7
Greater Accra	25.8	13.4	5.2	2.4	11.8	6.2

Note: Poverty line: ¢3,708,900/G¢371 per adult equivalent per year
Extreme poverty line: ¢2,884,700/G¢289 per adult equivalent per year
Source: Ghana Statistical Services, April 2007.

Irrigated agriculture is one the means to overcome constraints. According to Zhinong (2011) irrigation has permanently changed the social fabric of many regions around the world; it has provided major economic development semiarid and arid areas, stabilizing rural communities, increasing income, and providing new opportunities for economic advancement.

The need to overcome limitations of agricultural production in the arid and semi-arid areas of the country through irrigated agriculture has been known for a long time by farmers, the government, non-governmental organizations and others. Farmers have over the years been cultivating dry season vegetables on very small acreages using dug-outs and shallow wells as well as along the banks of rivers and streams. Small dams most of which were constructed during the colonial era for animal watering have been redesigned for irrigation purposes, especially in the Upper East Region of the country, and have been very good sources of water for irrigated agriculture. Larger multi-purpose dams, such as those at Tono and Vea in the Upper East Region and Bontanga in the Northern Region, have been constructed by the government for irrigation and other purposes. A new large multi-purpose dam is being planned for the Pwalugu area of the Talensi District, Upper East Region.

Irrigation in Ghana remains largely insignificant, despite the realization of the importance of irrigated agriculture and the efforts of the farmers, governments, NGOs and other organizations. It is estimated that less than two percent of the total cultivatable area in Ghana is irrigated (Namara et. al. 2011). This has been partly because of the failure of "modern" irrigation systems in Ghana, as with much of West Africa. Numerous studies suggest that irrigated agriculture (using modern constructed dams) in Africa and especially West Africa has been a failure to a large degree (Dittoh, 1991a; Sarris and Ham, 1991; Musa, 1992; Mariko et. al. 2001). Indeed the World Bank had to suspend funding of irrigation projects in the late 1980s because of poor performance and very high costs in dam construction and maintenance (Sarris and Ham, 1991). The performance of irrigated agriculture using medium and large dams continues to be very dismal. In Ghana none of the medium and large dams can claim any significant success. In any case research indicates that formal irrigation systems (surface water gravity systems) tend not to favour small, poor farmers (Pant, 1992).

While there is much dissatisfaction with formal (modern) irrigated production, informal (traditional) irrigated production appears to be performing relatively better in certain areas especially with respect to the production of varied types of vegetables. Indeed the area under informal irrigation in Ghana has been estimated to be about five times that under formal irrigation (Dittoh et. al. 2013). Others believe it is much higher (Nanes, 2012). At the final dialogue workshop of the AgWM Solutions in Accra, panel discussion members concluded that 80 to 90% of irrigation in Ghana is by smallholders (Dittoh and Akuriba, 2012). In a press release by the AgWater Management Solutions Project with respect to Ghana at the Stockholm Water Week in 2012, it was said that, "in Ghana, small private irrigation schemes already employ 45 times more individuals and cover 25 times more land than public irrigation schemes". It is partly for these reasons that there is now greater attention being paid to the development of small-scale irrigation systems. Nigeria has to a large degree 'formalized' its informal Fadama irrigation system through its World Bank funded National Fadama Development Project.

In Ghana, there is evidence of only a few attempts to develop the informal irrigation sector. One such project focused on the rehabilitation of small dams, especially by the IFAD-funded

Land Conservation and Smallholder Rehabilitation Project (LACOSREP) in the Upper East Region. Another example is the provision of motorized pumps by the Ministry of Food and Agriculture (MOFA). The Bill and Melinda Gates Foundation funded the Agriculture Water Management (AgWM) Solutions Project aimed at identifying how to support and build upon small farmer led initiatives. According to Nyamadi, the (2012) "AgWater Solutions has identified where investments can be targeted for maximum impact at the country, state and local levels". That said, there is need for much greater effort to improve what small farmers (irrigators) are already doing well.

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

The Food and Agriculture Sector Development Policy (FASDEP II) (MOFA, 2007) is Ghana's overall agricultural policy, and the Medium-Term Agricultural Sector Investment Plan (METASIP) 2011-2015 (MOFA, 2010) is Ghana's agricultural development plan derived from the policy. Both documents allude to the importance of irrigated agriculture. In FASDEP II, it is noted that "in 2002, the total area under formal irrigation was around 11,000 hectares whereas the potential area – including inland valleys – that could be developed for irrigation is estimated at 500,000 ha. The Ghana Irrigation Development Authority (GIDA) in 2000 identified 32,000 hectares of under-developed inland valleys throughout the country that could benefit from moisture improvement technologies for food production" (pp. 4-5). The policy recognizes that "formal irrigation development has been very much supply-driven, and over-reliance on the formal system is limiting the area under irrigation" and also that "the informal sector (SSI) is not serviced sufficiently to realize its potential" (p.12). Despite these realizations there is no policy guideline with regards to small-scale irrigation development in the policy document.

The METASIP however states that "emphasis should now be placed on micro and small-scale irrigation systems in the short- and medium-term since most of these have been largely successful" even though it recognizes the necessity "to also plan in the long term to develop large scale irrigation systems in large irrigable areas such as the Afram Plains, several valleys in the northern and southern savannas and the Accra Plains" (p.23). The METASIP proposes very elaborate SSI systems. For example, it proposes to develop "22,590 Ha of micro irrigation schemes by 2015 to benefit 50,000 households" (p. 29) and "62,000 Ha of sustainable water harvesting and agricultural water management schemes in Northern and Southern Savannah zones" (p.30). However, there is little indication as of 2014 that any specific activities have been initiated to achieve these goals.

The Ghana National Irrigation Policy, Strategies and Regulatory Measures (MOFA/FAO, 2010) has a goal of "sustainable growth and enhanced performance of irrigation contributing full to the goal of the Ghanaian agriculture sector". It addresses four key problem areas, namely:

1. Low agricultural productivity and slow rates of growth
2. Constrained socio-economic engagement with land and water resources

3. Environmental degradation associated with irrigated production
4. Lack of irrigation support services.

The policy clearly stresses the importance of irrigation in ensuring food security and poverty reduction. Indeed, it states that the major way of using water to reduce poverty is through the development of irrigation. It also identifies small, medium and large scale irrigation projects as well as public and private systems as all being important and necessary. The Ghana irrigation policy tries to ensure that all possibilities in different parts of the country are considered. That said, the policy does not suggest prioritization for SSI.

Finally, the National Water Policy has implications for the development of irrigation. The Water Resources Commission Act (No. 522 of 1996) Legislative Instrument (LI 1827- 2006) regulates drilling activities for groundwater resources in Ghana. The National Water Policy (June 2007) provides a framework for the development of Ghana's water resources, including irrigation development. The National Water Policy clearly distinguishes between surface water and groundwater and notes that groundwater has a number of advantages over surface water. According to Policy document, the key objectives of the policy for irrigation are:

i. ensure availability of water in sufficient quantity and quality for cultivation of food crops, watering of livestock and sustainable freshwater fisheries to achieve sustainable food security for the country; and
ii. ensure availability of water in sufficient quantity and quality to support the functions of the eco-systems in providing alternative livelihoods.

The measures outlined for the achievement of the objectives are:

i. support the establishment of micro-irrigation and valley bottom irrigation schemes among rural communities with the assistance of district assemblies;
ii. strengthen district assemblies to assume a central role in supporting community
iii. operation and maintenance of small-scale irrigation and other food production
iv. facilities;
v. promote partnership between the public and the private sector in the provision of large commercial irrigation infrastructure taking into consideration effects on economy, culture, environment and health;
vi. encourage the efficient use of fertilizers to reduce pollution of water bodies and
vii. ensure conservation of water;
viii. promote and encourage water use efficiency techniques in agriculture and reduce
ix. transmission losses of water in irrigation systems; and
x. manage land use and control land degradation, including bush fires, to reduce soil loss and siltation of water bodies.

FASDEP, METASIP, the National Irrigation Policy and the National Water Policy all recognize the importance of irrigation for food and nutrition security, poverty reduction, increased employment, reduction in rural-urban migration, stability of rural communities etc.. And, the objectives and measures to be adopted toward achieving them clearly recognize the

importance of SSI. At the same time, there is very little indication across all levels of governance that there is any priority on irrigation development in Ghana.

In addition, it is clear that there is need for strong inter-ministerial collaboration. The Ministry of Water Resources, Works and Housing and the Ministry of Food and Agriculture need to ensure coordination of all the policies and their implementation through programmes and projects. This is particularly critical in the case of groundwater, because groundwater for domestic use will compete with groundwater for agricultural and other purposes. There is the need for close inter-ministerial monitoring of the use of groundwater resources.

1.3 Key Public and Donor Programmes that Prioritize Irrigation

There is limited evidence of some priority given to irrigation. The Ghana Irrigation Development Authority is a semi-autonomous authority responsible for irrigation development. In addition, there are the 22 irrigation schemes noted in Table 2 below, albeit underperforming. However, Government of Ghana funding for irrigation development has been very dismal, and low funding has been cited as the main constraint to the development of irrigation in the country. According to the current Chief Executive of GIDA, business models of bankable irrigation projects have been developed for the irrigation of 23,000 hectares, but funding has not been forthcoming (Nyamadi, 2012b). MOFA recently provided pumps at 33% of the market price to irrigators as a stop gap until other projects can be implemented.

Several donor supported government and NGO projects and programmes have emphasized irrigated agriculture over time. The most prominent of them has been the IFAD-supported LACOSREP in the Upper East Region, which rehabilitated several small dams. IFAD also sponsored the Upper West Agricultural Development Project (UWADEP) which rehabilitated and built a few dams in the Upper West Region. The performance of rehabilitated and new small dams has still been below expectation due to several constraints (Birner et. al. 2010). Another IFAD and Africa Development Bank (AfDB) supported programme, the Northern Rural Growth Project (NRGP), has an elaborate irrigation plan, though not much has been implemented as yet. Several NGOs, including Care International and the Catholic Diocesan Development Office in Bolgatanga have supported irrigation activities in the Northern and Upper East Regions.

There are currently 22 public irrigation schemes in the country, as listed by mode in Table 2. Almost all the projects have been supply-led, rather than demand-driven. Research suggests that problems with sustainability and effectiveness, reflected in underutilization and lack of maintenance, is at least partly attributable to the supply-led approach. Most donor-funded projects now insist on evidence of demand prior to support for irrigation schemes. Some communities however, request dams without plans for irrigation, which still hinders efficiency and limit overall impact on reducing poverty and improving nutrition (cite the country case study under challenging context project).

Table 2: Mode of Irrigation and Location of Public Irrigation Schemes in Ghana

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

Source: Ghana Irrigation Development Authority (GIDA), 2012

2 RECENT RESEARCH ON SMALL-SCALE IRRIGATION IN GHANA AND THE WEST AFRICAN SUB-REGION

2.1 Findings of Agricultural Water Management Solutions Project in Ghana and Other Countries

The Agriculture Water Management Solutions project covered five countries in Africa; Burkina Faso and Ghana in West Africa, Ethiopia and Tanzania in East Africa and Zambia in Southern Africa as well as two states in India, namely Madhya Pradesh and West Bengal (http://awm-solutions.iwmi.org/). The goal of the AWM Solutions Project was "to help unlock the potential of smallholder farming by focusing on agricultural water management (AgWM)". That was to be done by "stimulating pro-poor, gender-equitable AgWM investments, policy and implementation strategies through concrete, evidence-based knowledge and decision-making tools". It was pointed out that to obtain concrete, evidence-based knowledge for the purpose of stimulating development, there was need to focus on the potential of varied groups of people in varied locations, the opportunities open to them and the constraints. The project sought to obtain disaggregated, locally-based agricultural water management information so that solutions to agriculture water management problems could be well targeted. The results concluded that "the three-year AgWater Management Solutions Research Initiative showed for the first time the scale at which enterprising smallholder farmers themselves are driving (an agriculture water management) revolution by using their own resources innovatively rather than waiting for water to be delivered". The AWM Solutions project emphasized what the people were doing and what improvements could be made upon those farmer-led initiatives to broaden the use.

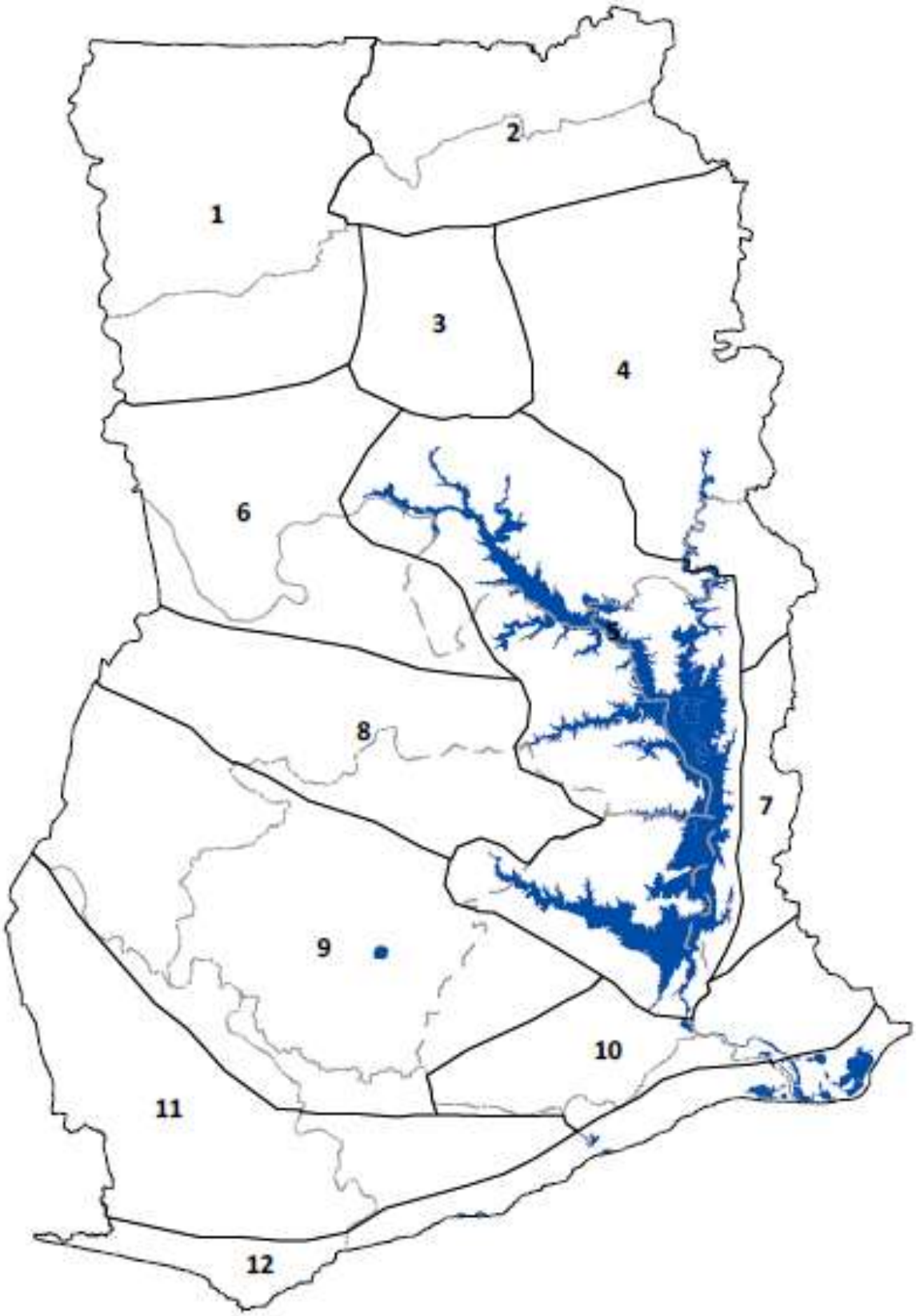
In Ghana the project started with scoping studies to know what is on the ground followed by livelihood mapping analysis. Twelve livelihood zones were identified as given in Table 2 and Figure 1. The livelihood mapping analysis was considered important; understanding existing varied livelihood sources of people is needed to develop appropriate programs that meet people's expectations. It is appropriate to start with what one has and what one can do to be able to successfully move to where one wants to go. Livelihoods mapping makes it possible to identify which type of water management technologies fit the livelihood zones and areas with high AWM investment potential. Well-targeted interventions in water have significant potential to contribute to rapid improvements in livelihoods of the rural people in Ghana

(Santini, 2010). Table 3 indicates agricultural activities prominent in the various zones and gives indication of what investments are likely to be acceptable, and thus likely to succeed in the various zones. It also indicates stakeholders' perceptions of water as a limiting factor in agricultural production in the various zones.

Table 3: Ghana Livelihoods Mapping and Stakeholders' Perceptions of Water as a limiting Factor for Agricultural Production in the Zones

Zone	Name of Livelihood Zone	Perception of water as a limiting factor for agricultural production
1	North-West Millet/Sorghum-Legumes-Cattle Livelihood Zone	High
2	North-East Millet/Sorghum/Rice-Legumes-Small Ruminants/Guinea Fowl Livelihood Zone	High
3	North-Central Maize/Rice-Mango-Groundnut-Small Ruminants Livelihood Zone	Moderate to low
4	North East Corridor and Upper Volta Yam/Cassava-Groundnut- Cattle Livelihood Zone	High
5	Volta Lake Inland Fishing Livelihood Zone	Moderate to low
6	Upper Middle Belt Maize-Yam/Cassava Livelihood Zone	Moderate
7	Middle Volta Cocoa/Coffee-Cassava-Small Ruminants Livelihood Zone	Moderate
8	Central Middle Belt Commercial Maize-Cassava-Small Ruminants Livelihood Zone	Moderate to low
9	Lower Middle Belt Cocoa/Oil Palm/Citrus-Commercial Poultry-Mining Livelihood Zone	Moderate
10	Inland Greater Accra and Lower Volta Commercial Rice-Cattle Livelihood Zone	Moderate
11	High Forest Timber-Cocoa/Oil palm/Rubber-Mining Livelihood Zone	Moderate to low
12	Coastal Belt Marine Fishing-Vegetables-Salt Livelihood Zone	High

Feed the Future area in Ghana is approximately Zones 1 to 6. It is basically the northern savanna and derived savanna ecological areas where the target crops (maize, rice and soybean) are grown.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The following are the identified AWM solutions. They were arrived at through the scoping studies and in-depth workshop discussions.

1. Shallow groundwater
2. Tube well (Borehole)
3. Private pump from rivers and streams
4. Communal pump
5. Large commercial pump from rivers
6. Out-growers
7. Private small dams/dugouts
8. Public private partnership (to include public surface reservoir systems)
9. Communal small dams/dugouts

These solutions can be re-categorized into:

1. Groundwater (shallow and tube wells),
2. Pumps (motor and hand/pedal),
3. Outgrowers, and
4. Surface water

It was emphasized that each of the AWM solutions will best suit particular livelihood zones. A workshop was organized for stakeholders to identify which AWM solutions were best for which particular livelihood zones using criteria of relevance, physical suitability, livelihood impacts, gender equitable benefits, level of upscalibility, environmental impact and constraints. Table 4 gives a summary of the stakeholders' assessment. The results clearly indicate that Zones 1, 2, 4 and 12 are very suitable for all the identified AWM solutions assessed. The others are suitable for some and unsuitable for others. Zones 5, 9 and 11 are not suitable for any of the solutions.

Table 4: Overall Assessment of Suitability of AWM Investments in the Various Livelihood Zones

AWM Solutions		Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7	Zone 8	Zone 9	Zone 10	Zone 11	Zone 12
Ground-water irrigation	Motor pumps (private or communal)	***	***	*	***	*	**	**	*	*	*	*	***
	Manual pumps	***	***	*	***	*	**	**	*	*	*	*	***
	Bucket-Fetch	***	****	*	***	*	**	**	*	*	*	*	***
Surface water irrigation (rivers/ streams, dams, dugouts)	Gravity flow	***	***	***	***	*	**	**	***	*	**	*	***
	Motor pumps (private or communal)	***	***	***	***	*	**	**	***	*	**	*	***
	Manual pumps	***	***	***	***	*	**	**	**	*	**	*	***
	Bucket-Fetch	***	***	***	***	*	**	**	*	*	*	*	***

*** Very Suitable ** Suitable *Not suitable

The project finally recommended the solutions given in Table 5 for consideration for investment and promotion by stakeholders. Throughout the project, stakeholders' views were paramount; most recommendations came from extensive dialogue with stakeholders at all levels.

Table 5: Summary of AWM solutions, recommendations, potential beneficiaries and estimated cost.

AWM solution	Beneficiary households (% of rural households)*	Area (% of total agricultural land)*	Estimated investment costs (USD)
Inland valleys can be used to increase the extent of rice cultivation. Improving water management, agronomic and post-harvest practices will all be required for success.	261,000-377,000 (7-10%)	391,000-565,000 (2-3%)	600/ha
Motor pumps can increase yields and incomes but problems need to be overcome in areas like financing, cost reduction (e.g. electricity supply), distance to pumps suppliers, poor operation practices and maintenance.	564,000-730,000 (16-20%)	451,000-584,000 (2-3%)	400/household
Small reservoirs need better management at all stages to reduce costs and improve equity.	74,000-163,000 (2-4%)	74,000-163,000 (1%)	750,000/m^3 of water stored
Outgrower schemes could provide a means to support smallholder farmers, including women, but they need facilitation, regulation and support.	Not calculated	Not calculated	Not calculated

Note: * Figures assume that out of the total potential beneficiary households calculated, 50% adopt the AWM option.
Source: Evans et. al. 2013; FAO, 2012

2.2 Other Research Findings on SSI in Ghana and the West African Sub-region

Apart from the Ag Water Solutions project, other researches have established the important role SSI plays and can play in agricultural development in Ghana and West Africa. Indeed, Ghana's northern neighbors who are in a more arid zone have embraced SSI more than Ghana, in addition to the National Fadama Development Project in Nigeria. Research and evaluations have pointed to the quite significant success of the Project (Kudi et.al. 2008; Takeshima, 2009; Abric et. al., 2011). It has also been found that across West Africa (Ghana, Burkina Faso, Niger, Mali and Senegal) there is general preference of farmers for small-scale irrigation systems, which are manageable with limited resources and low technological knowledge (Dittoh et. al. 2010). Also, in the Upper East Region, it has been established that the use of small pumps for irrigation "is far more beneficial than other irrigation methods" (Dittoh et. al. 2013b, p. 449).

Both surface and groundwater are used for small-scale irrigation. Surface water is obtained from rivers, streams and small dams. The rivers and streams could be perennial or dry up in the dry

season. Usually little can be done to maintain rivers and streams and to control their use. They are essentially common goods and the "tragedy of the commons" has been very much applicable to them. On the other hand, maintenance of small dams and some control over their use is possible. They are to some degree "public goods", but with some controls and governance. Thus small dams have a great potential to be developed for use by small irrigators.

Small dams are relatively common in many parts of the rural areas in Ghana, particularly in the Northern, Upper East and Upper West Regions. Over 500 small dams and dugouts are known to be in these regions (Namara et. al. 2011). Most of them are multipurpose dams used for livestock watering, irrigation, domestic use and fisheries. Though their performance has also not been excellent they have been rated better than medium and large scale dams (Dittoh, 1996).

As already noted irrigation by shallow (temporary) and permanent wells using groundwater is very widespread and highly regarded by farmers in Ghana as a whole, and in the northern regions in particular. However there has been hardly any significant groundwater development for agriculture in Ghana and most parts of Sub-Saharan Africa. It has been argued that Sub-Saharan Africa does not have large, high-yielding shallow aquifers like those found in Asia (Calow and MacDonanld, 2009) but the fact is that there has been paucity of information of Africa's groundwater potential. Recent research on groundwater however, indicates that groundwater irrigation is growing in extent and importance in arid and semi-arid areas of Sub-Saharan Africa (Giordano, de Fraiture, Weight and van der Bliek, 2012, Pavelic et. al. 2013) and there is potential for expansion (Obuobi et. al. 2013; Ayenew et. al., 2013). That clearly supports the view that small farmers are doing the right thing by expanding groundwater irrigated production despite the lack of official recognition and planned development of groundwater irrigation. Foster et. al. (2008) have noted that there is need for "urgent and substantial investments" in groundwater resources development and management because without effective use of available groundwater resources, reducing poverty and stimulating livelihoods in Sub-Saharan Africa will not be possible. Allaire (2009) has also stated that groundwater irrigation offers potential to mitigate the effects of drought and erratic rainfall on agricultural production because groundwater levels are less correlated with rainfall. Others have however cautioned that groundwater development has to be carefully managed because over-exploitation of groundwater can easily take place (MacDonald et. al., 2009) and cause more serious livelihood problems. Gyau-Boakye and Tumbulto (2000) have noted that increasing abstraction of groundwater has led to depletion of groundwater resources in some areas in Ghana. That could be so due to the high dependence on groundwater for domestic water-supply, rural livelihood and livestock rearing, and increasingly for urban water supply in parts of the country.

It is estimated that Ghana has more than 56,000 groundwater abstraction systems, comprising boreholes, handdug wells and dugouts (Kortatsi 1994). A study in Nabogo basin (a subcatchment

of the White Volta river basin), showed that current well pumping rates yield significantly less water than annual groundwater recharge to the basin (Lutz et al. 2007).

3 LIVESTOCK AND FODDER PRODUCTION IN GHANA

3.1 Livestock in Ghana's Agriculture Policy and Development Plan

Livestock does not seem to be very prominent in Ghana's agriculture. Apart from a few organized commercial poultry and pig farmers, the livestock sub-sector consists of small-scale operators who are primarily crop farmers that also keep livestock to supplement their incomes. That does not however imply that livestock does not play important roles in the livelihood strategies of the people. It is important for food and cash security especially in the rural areas of northern Ghana. "Diversification into livestock production by crop farmers is a key strategy to reduce risk associated with rain-fed agriculture" (Amankwah 2013). That said most of the animal protein needs of Ghanaians are obtained from fish. While only about 102,000 metric tons of meat was produced in 2008, fish production was about 431,000 metric tons (MOFA, 2010).

The development of the livestock sub-sector is definitely important and Ghana's agricultural policy (FASDEP II) and the METASIP recognize that. FADEP II notes that livestock breeds are of low productive capacity and there are no interventions that effectively address problems of lack of feed and water, particularly in the dry season. This problem of inadequate availability of quality feed has been identified in the livestock development policy as an important issue confronting the livestock sector and that there is need to "improve access to quality feed and water" (MOFA, 2007 p. 37). The goals of livestock policy are to "increase the supply of meat, animal and dairy products from domestic production at the current aggregate level of 30% to 80% by the year 2015; and contribute to the reduction of the incidence of poverty among farmers (who are also livestock keepers) from 59% to 30% by the year 2015" (ibid).

The METASIP proposes the following with regards to livestock nutrition:

1. Promote communal grazing lands
2. Facilitate and support establishment of pastures and fodder crops by farmers
3. Facilitate and support improvements in livestock housing by farmers

The proposal is to help enable "income from livestock rearing by men and women increase by 10% and 25% respectively by 2015" (p.33). It is doubtful if any of these proposals has started.
Donor funded livestock development programmes have been implemented in the past and there is an on-going African Development Bank supported Livestock Development Project. These have however not been visible and past projects and programmes have proved to be unsustainable; it is difficult to trace the benefits now.

The poultry industry has been in distress for decades due to numerous problems, including high production cost, lack of feed and unrestricted 'dumping' of frozen chicken into the Ghanaian market, despite being the main commercial livestock industry in Ghana (USAID, 2013).

3.2 Irrigated Fodder Production in Ghana: Current Status and Opportunities for Investment

Background and current status

Ghana Irrigation Development Policy was approved on June 30th 2010 to address the problems, constraints and opportunities across the whole irrigation sub-sector. The policy is meant for informal, formal and commercial irrigation. The target of the policy is to put an area of 500,000 ha under irrigation in the medium term. There has been more than twenty irrigation schemes/projects implemented in Ghana since 1970s with the main focus on crops such as rice, maize, cowpea, and vegetables such as tomato, okra, pepper, and onion. Irrigation is easily associated with rice, maize and vegetable production and not forage or pasture production. However, residues from irrigated cowpea production are used for livestock feeding and often in high demand for peri-urban small ruminant (sheep and goat) fattening. Research and development work on irrigated forage production in Ghana is virtually absent even though the necessary facilities (dams, rivers, fodder species, etc.) exist throughout the country.

The absence of investment in irrigated fodder production could partly be attributed to extensive and semi-intensive livestock production systems in Ghana with associated multiple production objectives, which essentially depend on natural pastures and crop residues from rain-fed crop farming. There have been research efforts in the past to improve the natural pastures under rain-fed conditions. Some of the forages largely tested at research stations often on small plots are presented in Table 6 below. Fodder banks were established in Northern Ghana in the 1980s and 1990s using some of the forage grass and legume species listed in Table 6. Trials in the 1980s and 1990s at the agricultural research stations, state owned ranches and few smallholder farmers with sown pastures using indigenous and exotic species of grasses and legumes were implement with no major success story.

Table 6: Forages Tested and Adapted to Farming Systems in Ghana

	Grasses	**Legumes**	**Trees/Browses**
1	*Panicum maximum*	*Stylosanthes hamate*	*Leuceana leucocephela*
2	*Brachiara ruziziensis*	*Centrosema pubescens*	*Sesbania grandiflora*
3	*Cenchrus ciliaris*	*Macroptilium atropurpureum*	*Gliricidia sepium*
4	*Chloris gayana*	*Macroptilium lathyroides*	*Pterocarpus evinacelus*

5	*Cynodon nlemfuensis*	*Desmodium intortum*	*Afzelia sp*
6	*Andropogon gayanus*	*Mucuna pruriens*	*Ficus sp*
7	*Tripsacum luxum*	*Cajanus cajan*	
8	*Setaria sphacelata*	*Flemingia macrophylla*	
9	*Vetiveria fulvibarbis*	*Lablab purpureus*	
10	*Ctenium newtonii*		
11	*Brachiaria falcifera*		

Source: CSIR-Animal Research Institute, Accra

CSIR-Animal Research Institute maintains a display of these forages at the Pokuase station.

Lessons from past attempts on rain-fed fodder production

1. Most of these attempts were project-driven with little engagement with local populations in the design, implementation and evaluation of the activities. Hence, most of these activities were not sustained beyond the lifespan of the project.
2. Some of these projects were located in remote areas that were difficult to access and were not well linked to the market. Government interference influenced the locations of some of these projects.
3. Most of the past attempts on fodder production were largely on-station research with little or no consideration for translating research results into development outcomes (CSIR-ARI, 2012).
4. There is an absence of medium- and long-term plans for forage seed production. Forage seed production was made even more difficult with low germination rates of some of the forage species. The limited availability of locally produced forage seeds further hindered scaling up and out of promising forage species.

Opportunities for irrigated fodder production

The potential exists for irrigated fodder production for the following reasons:

1. Increased demand for livestock products and the related growth of domestic investment (wealthier Ghanaians and government officials) in livestock enterprises, which are often integrated with crop farming and horticulture that are under irrigation.
2. Growing demand for feed for the increasing number of livestock in peri-urban areas of Ghana, where livestock was not historically common and that is less suitable to grazing. The general flow of cattle, sheep and goats in Ghana has tended to be from the three major livestock producing regions of Upper West, Upper East and Northern, as well as the Volta Region to the urban centers in the southern part of the country, but commercial cattle farming with absentee ownership by professionals and businessmen is on the rise in

the Coastal Savannah zone of the country with varying levels of management (Oppong-Anane, 2001). Zero grazing options are increasingly required; suitable forages for intensive production that are amenable to zero grazing include *Stylosanthes hamata*, *Panicum maximum* and *Cenchrus ciliaris*.

3. Demand for reduced cost feed and fodder production for commercialization of livestock production in the peri-urban areas and related increase in demand for forage seeds among both existing and emerging commercial farmers (ibid.).
4. Availability of necessary facilities such as dams, rivers and small reservoirs for irrigation and the possibility of combining irrigated fodder production with vegetable production, particularly in the late dry season when feed scarcity is acute.
5. Rehabilitation of lands that have been subjected to surface mining could provide an opportunity for fodder production (ibid.).

4 SYNTHESES OF RESEARCH FINDINGS AND IMPLICATIONS FOR GHANA'S IRRIGATION ASPIRATIONS

The research evidence clearly points to the resilience of small-scale agricultural systems. These systems continue to survive, while 'modern' agricultural systems introduced in varied ecological zones in Ghana and several other African countries have not been sustained. This has been so in irrigation and water management in Ghana and other countries. While almost all the formal (modern) irrigations systems are facing problems, SSI systems continue to expand with and without support from government, NGO, donor and the research institutions. That is not to imply that assistance from these bodies is not required or that modern technologies are not useful. It is to point out that if these bodies would assist SSI systems effectively, SSI can move from lower profitability to more profitable levels and poverty will be reduced significantly. It is equally important to state that an effective method of development is not standard technology transfer, but effective integration of modern and traditional (local) technologies through participatory technology development processes. Dittoh (1991b) suggested the adoption of an Informal/Formal Irrigation Integration Model, and recent evidence suggests that may be an effective approach with modifications to the local context.

The AgWM Solutions research, in particular, points to the importance of partnering effectively with relevant stakeholders through dialogue and the development of trust and common understandings of development issues. Many of the recommendations of the project came out of stakeholder views and recommendations which were critically debated and validated by other stakeholders and researchers. The failure of pasture and fodder development rsearch efforts in northern Ghana in the 1980s and 1990s can be attributed to lack of collaboration and dialogue with local stakeholders.

With the present, though limited, knowledge of climate change, there is no doubt that agricultural development in Ghana as a whole and in northern Ghana in particular cannot take place without some emphasis on irrigated agriculture. The limited successful irrigated production by small farmers using shallow wells, small dams and motorized pumps clearly indicate the great potential of SSI for food and nutrition security, increased incomes and employment in the long dry season. Ghana's irrigation aspirations are to comprehensively develop irrigated agriculture inclusively and to emphasize on SSI because of its advantages with respect to household food and nutrition security, poverty reduction and increased employment in the poorer parts of the country.

5 IDENTIFICATION OF RESEARCH GAPS ON SMALL-SCALE IRRIGATION IN GHANA

The discussion so far indicates some research gaps that require further discussion and interventions.

1. Testing the feasibility of the promising solutions identified by the AgWM Solutions project. Farmers and researchers testing the interventions together will determine their real potential. Constraints at farmer and other levels in the irrigation value chain cannot be easily identified until the solutions are tried.
2. So far the crops grown by irrigators are vegetables, including tomatoes, onions, the peppers, leafy vegetables and others. Already many of these are facing gluts at certain times of the seasons, requiring market and value chain research.
3. Potential for various SSI for different crops (in addition to the high value vegetables) is also important for addressing market demand and opportunities.
4. One of the main constraining areas in Ghana's irrigated agricultural development is the lack of irrigation extension personnel. GIDA has engineers, some economists and agronomists; few have knowledge of irrigation extension. An irrigation extension curriculum needs to be developed, piloted and used to train the required personnel.
5. Drip irrigation, which is largely a SSI system, has been argued to be most suitable for small farmers especially in arid and semi-arid areas (Pasternak et al., 2006). There is need to test the feasibility in the northern regions of Ghana.
6. Crop-livestock integration by irrigation households is a model that is also worth testing. Irrigation can provide fodder for livestock and livestock can in turn provide manure for vegetable crop production on irrigation sites, which is highly favoured in the Sahel countries.

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