FEED THE FUTURE GHANA AGRICULTURE POLICY SUPPORT PROJECT (APSP)

Documenting Various Sustainable Land and Water Management Technologies into Forms that can be used for Extension Service Provision: The experience of Northern Ghana

October, 2017

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Contract No. 641-C-14-00001

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List of Acronyms/Abbreviations

AEAs	Agricultural Extension Agents
CAADP	Comprehensive African Agriculture Development Programme
CEMC	Environmental Management Committees
DFID	Department for International Development
DADU	District Agriculture Development Units
DA	District Assemblies
DEMC	District Environmental Management Committees Community
DPs	Development Partners
EPA	Environmental Protection Agency
FACS	Faculty of Agribusiness and Communication Sciences
FtF APSP	Feed the Future Agricultural Policy Support Project
FBO	Fixed Base Operator
FASDEP	The Food and Agriculture Sector Development Policy
GAAGDP	Ghana Accelerated Agriculture Growth and Development
GEMP	Ghana Environmental Management Project
GNAP	Ghana's National Action Programme
GPRS	Ghana Poverty Reduction Strategy
GSGDA	Ghana Shared Growth and Development Agenda
GSLWMP	Ghana Sustainable Land and Water Management Project
GDP	Gross Domestic Product
ISSER	Institute of Statistical, Social and Economic Research
INM	Integrated Nutrient Management
IFDC	International Fertilizer Development Center
METASIP	The Medium Term Agriculture Sector Investment Plan
MDGs	Millennium Development Goals
MEST	Ministry of Environment Science and Technology
MoFA	Ministry of Food and Agriculture
NEPAD	New Partnership for Africa's Development
NPK	Nitrogen Phosphorus Potassium
ORGIIS	Organisation For Indigenous Initiatives And Sustainability
REMC	Regional Environmental Management Committees
SLWMP	Sustainable Land and Water Management Project
SSA	Sub-Sahara Africa
SOP	Social Opportunities Project
SLWM	Sustainable Land Water Technologies
WASCAL	West African Science Service Center on Climate Change
WB	World Bank

Executive summary

Food deficits continue to rise in Sub-Sahara Africa (SSA) and with increasing populations, the situation is likely to worsen as a result of climate change. To tackle food insecurity, the underlying causes such as land degradation and climate change must be addressed by increasing the resilience and capacity of the communities. Towards this end, researchers have over the years developed various Sustainable Land Water Technologies (SLWM) technologies, which have been integrated in a National Sustainable Land Management Strategy by Ministry of Food and Agriculture (MoFA) and Ministry of Environment Science and Technology (MEST). The SLWM technologies preserve land, increase environmental services which can lead to increased yields. Another significant effect is that they may result in lowering the costs of production.

Despite the proven evidence of the positive impact of SLWM technologies in environmental regeneration and in raising agricultural productivity, there is paucity of information/ knowledge database that documents available SLWM technologies for easy access and use by development organisations, FBOs, and both public and private sector extension service providers.

This study was undertaken by the Faculty of Agribusiness and Communication Sciences (FACS) with the support of Feed the Future Agricultural Policy Support Project (FtF APSP) to document key SLWM technologies for use by MoFA and other organisations.

The study was undertaken in the three Northern Regions of Ghana and the methodology employed included the administration of questionnaires, Focused Group discussions and key informant interviews. Both quantitative and qualitative approaches were used to analyse the data. Quantitatively, the data was analysed using descriptive statistics and Poisson count model, while the qualitative analysis was done based on themes and relationships.

The study established low levels of adoption across all the technologies identified. In terms of the level of adoption, tree planting was most adopted (44.7%), followed by composting (39.7%), bushfires (35%)bushfire (35%) and bunding (34.7%). It was established that factors such as support received, labour, water availability, exposure, access to information and farm size influence the adoption of SLWM technologies.

SLWM technologies are making great impacts on farmers, particularly in terms of yield increases, nutrient retention and water conservation. The study established that SLWM technologies project support are in pilot bases, and therefore many farmers are not able to access support. MOFA faces serious challenges with capacity. The study found that MOFA personnel were generally low in all the district. Also, basic logistics

such as vehicles and motorcycles were seriously lacking in all the districts. Furthermore, some of the MOFA staff lack adequate knowledge on some of the SLWM technologies, and this is likely to affect the effectiveness extension service delivery. Although almost all respondents have adopted at least one SLWM technologies, the score on the individual technologies was poor. Widely practiced ones include bunding, composting, growing cover crops, farming across slopes, bushfire control tree planting, crop rotation. Farmers have limited access to the inputs due high costs and low extension services, which tends impacting negatively on SLWM technology adoption.
The study recommends the following for policy attention

1. MoFA with support of Development partners (DPs) should facilitate the development of a national knowledge database on proven key SLWM technologies which have achieved results in key agroecological zones across the country
2. SLWM projects should move from pilots to high levels of upscaling in whole communities
3. It should be a mandatory requirement that all major agricultural development projects by both public and private sector integrate SLWM technologies in their implementation
4. MoFA, DPs and the private sector should consider adopting a Public Private Partnership model in the implementation of SLWM technologies across the country, with the beneficiaries required to make in kind/monetary contributions towards SLWM
5. MOFA with support from DPs needs to immediately employ more Agricultural Extension Agents (AEAs) and provide basic logistics, such as vehicles and motorcycles, in order to facilitate extension activities.

1.1 Background: Context of Sustainable Land and Water Management Technologies

Land is one of the most important factors of production. Land is used for several purposes, which include agriculture, industry, infrastructure and other development service. Despite the importance of land, its degradation is on the rise, a situation which risks depriving the future generation of their livelihood resources. Recent estimates indicate that nearly 2 billion hectares of land globally are already seriously degraded, some irreversibly (Gowing & Palmer, 2008). This includes large areas of cropland, grassland, woodland and forest areas whose degradation reduces productivity, disrupts vital ecosystem functions, negatively affecting biodiversity and water resources, and increases vulnerability to climate change, as well as negatively affecting livelihoods (Gowing & Palmer, 2008). Degradation continues to be a major threat to agricultural lands, which is about 60% of the total land area of Ghana. For example, 69% of the total land surface of Ghana is considered prone to severe erosion and this is estimated to be costing the nation between 1.1-2.4% of its GDP (ISSER/DFID/WB, 2005). A number of activities result in the degradation of land. These include mining, deforestation, and bad farming practices (continuous cropping, fertilizer application, etc). Arable land is continuously lost to urbanisation, road construction and mining activities. There is a relationship between land degradation and food production. Land degradation impacts negatively on the livelihood of both present and future communities/households who directly depend on it for their sustenance.

As land becomes scarceit becomes increasingly overexploited in its use. Sustainable Land and Water Management (SLWM) has been identified as a prerequisite for enhanced agricultural production, food security, incomes and livelihoods for its population. The World Bank has defined SLWM as "a knowledge-based procedure that helps to integrate land, water, biodiversity, and environmental management (including input and output externalities) to meet rising food and fiber demands while sustaining ecosystem services and livelihoods. SLWM is necessary to meet the requirements of a growing population. Improper land management can lead to land degradation and a significant reduction in the productive and service (biodiversity niches, hydrology, carbon sequestration) functions of watersheds and landscapes". Vancutsem (2008) explains that "Land management covers the debate about norms and visions driving the policy-making, sector-based planning both in the strategic and more operative time spans, spatial integration of sectoral issues, decision-making, budgeting, implementation of plans and decisions and the monitoring of results and evaluation of impacts." SLWM technologies have become necessary because food deficits continue to rise in Sub-Saharan Africa (SSA), coupled with rapid increase in population (Gowing & Palmer, 2008). Researchers over the years have developed various SLWM technologies that will enhance productivity without adverse impact on land and environmental services for farmers across the globe, and these have been found to increase yield, reduce soil erosion and reduce cost of production in several agriculturally rich countries (Bolliger et al., 2006). In Sub-Saharan Africa, the application of SLWM technologies during trials in countries such as Ethopia, Kenya, Tanzania, and Zimbabwe led to an improvement in yield between 20-120% among smallholder farmers (Rockstrom et al., 2007).

SLWM technologies that have been introduced by researchers include integrated nutrient management, conservation tillage, land rotation, agroforestry, water harvesting, livestock integration and integrated pest management (Bolliger et al., 2006). Creating awareness and building the necessary technical capacity at all levels of the agriculture value chain to support the promotion of SLWM technologies as a way of ensuring sustainable management of land and environment have been envisaged as a major output in Ghana's Medium Term Agriculture Sector Investment Plan (METASIP).

To this end, there have been a number of projects and policies aimed at protecting the environment, particularly land and water, from degradation and improving the livelihood strategies of smallholder farmers for the benefit of both the present and future generations. Two main SLWM projects have been implemented in the Northern Savannah zone, where land degradation is more critical. The first was Ghana Environmental Management Project (GEMP), which was meant to support the implementation of Ghana's National Action Programme to Combat Drought and Desertification (NAP). The goal of the GEMP was to strengthen Ghanaian institutions and rural communities to enable them to reverse land degradation and desertification trends in three regions of Northern Ghana and to adopt sustainable water and land management systems that improve food security and reduce poverty. The second is the Ghana Sustainable Land and Water Management Project (GSLWMP), which aims at promoting and scaling up land management practices within these communities towards enhancing agricultural productivity and restoring eco-systems integrity. Through GEM and GSLWMP implemented between 2008-2013 and 2014-2020 respectively, and other MOFA projects, various technologies have been strengthened or implemented to help control and manage the practices of smallholder farmers in order to protect the environment from degradation.

However, despite this support there are major gaps in the achievement of these objectives in GEMP and GSLWMP, which include limited knowledge on the various available SLWM technologies and their associated benefits to potential users. Another limiting factor to the promotion and adoption of SLWM technologies in Ghana is the weak capacity of extension agents to demonstrate SLWM technologies to farmers. Furthermore, there is paucity of documentation in a single platform/database of all the available SLWM technologies that have been developed and proven for easy use for extension service provision by both public and private sector service providers.

Under the SAKSS NODE 4 of the METASIP, which is "Sustainable Management of Land and Environment", the Faculty of Agribusiness and Communication Sciences (FACS) was commissioned to document Sustainable Land and Water Technologies to be used by MOFA for their extension activities. The remaining part of the report comprises of the methodology, literature review, results and discussions and conclusions and recommendations.

1.3 Research Objectives

- To establish the awareness and adoption levels of relevant stakeholders covering the development, dissemination and uptake of SLWM technologies in Ghana.
- To identify existing SLWM technologies and provide detailed information on their use and effectiveness as experienced by farmers in Northern Ghana.
- To determine the level of uptake of existing SLWM technologies by farmers
- To determine the factors influencing the adoption of SLM technologies
- To assess the capacity within MoFA to deliver SLWM technologies to farmers and make appropriate recommendations.
- To identify and recommend possible policy measures that can successfully be implemented to improve the development, dissemination and uptake of SLWM technologies in Ghana.

2.0 Literature Review

2.1 The Medium Term Agriculture Sector Investment Plan (METASIP)

The Medium Term Agriculture Sector Investment Plan (METASIP) is the agriculture investment framework of the Ministry of Food and Agriculture. The investment framework is a sector-wide investment plan aimed at implementing the Food and Agriculture Sector Development Policy (FASDEP) II, the current policy document for the development of Ghana's agriculture sector (MOFA Report, 2011). The METASIP was designed for the period 2011-2015 to implement development policies outlined in the FASDEP II. The objectives of the METASIP are consistent with FASDEP II and therefore clearly outlined the strategy and budgetary requirement for the implementation of FASDEP II (FASDEP II, 2007).

The overall objective of METASIP was to increase investments in the agriculture sector to at least10 percent of annual budgetary allocation in line with the Maputo Declaration of 2003. The Maputo Declaration commits member states to allocate up to 10 percent of their national budgets to agriculture in order to improve food security in Africa (Boateng and Nyaaba, 2014). According FASDEP II, METASIP was expected to lead to:

- At least a 6 percent growth rate in the sector's contribution to overall Gross Domestic Product (GDP)
- Increase yields in the sector by an average of at least 50 percent by 2015;
- Improve productivity of all operators along the value chain;
- Enhance access to agriculture markets and;
- Promote value chain development of selected agriculture commodities for food security and growth in incomes.

The strategy for implementing the METASIP was to identify and enhance participation of key stakeholders with greater interest in the agriculture sector to facilitate the attainment of the 6 core pillars of FASDEP II. These core pillars are food security and emergency preparedness; increased growth in incomes; increased competitiveness and enhanced integration into domestic and international markets; sustainable management of land and environment; science and technology applied in food and agriculture development; and improved institutional coordination.

On sustainable land and water management, the METASIP identified weak policy environment and low adoption of SLWM technologies at the community level, low capacity and weak collaboration of relevant agencies to ensure SLWM mainstreaming at all levels of implementation, as core developmental concerns needing attention (METASIP, 2010). To address these fundamental challenges, the METASIP envisioned the implementation of strategic programmes, including but not limited to:

- Strengthening the capacity of the Environment and Land Management Unit of

MOFA to facilitate and provide technical support to promote and implement the SLWM agenda at all levels;

- Developing a comprehensive payment scheme for environmental services provided through the adoption of SLWM technologies developed and functional;
- Facilitating the development and implementation of 50 community land improvement plans annually and;
- Documenting and publicising successful SLWM interventions.

2.2 The Food and Agriculture Sector Development Policy (FASDEP II)

In response to the increasing global food crisis, both developed and developing countries committed to improving global food production through increased investments and strategic planning in the agricultural sector. MOFA has since developed both short and medium-term sectorial and comprehensive policies and programmes seeking solution to the situation. The Food and Agriculture Sector Development Policy (FASDEP) is a government of Ghana agriculture policy blue print committing to "a modernized agriculture culminating in a structurally transformed economy and evident in food security, employment opportunities and reduced poverty" (METASIP, 2010, p.3).

Government of Ghana key agricultural policies since 2002 are the first Food and Agriculture Sector Development Policies (FASDEP I) designed and implemented between 2002 and 2007. FASDEP I focused on the main components of the Ghana Accelerated Agriculture Growth and Development Policy (GAAGDP) that advocates for a private sector led approach. The apparent weaknesses or limitations of FASDEP I were: The expectation of modernising smallholder agriculture was unachievable, problem analysis was weak and did not sufficiently address client perspective on their needs and priorities, the process MoFA was to stimulate response from MDAs for interventions that fell outside the domain of MOFA was bot specified (MOFA, 2007). These limitations emanated from the policy review paved the way for the introduction of the second Food and Agriculture Sector Development Project (FASDEP II) in 2007.

FASDEP II sought to enhance the environment for all categories of farmers. FASDEP II realigned the development of the agriculture sector to the long-term policy objectives of the Government of Ghana with the ultimate aim of ensuring that the sector's stakeholders are best placed to benefit from emerging opportunities in the agriculture sector.

There is also significant relationship between FASDEP II's vision for the food and agriculture sector on the one hand, and the national vision for the sector as expressed in past policy documents, such as the Ghana Poverty Reduction Strategy II, the New Partnership for Africa's Development (NEPAD's) Comprehensive African Agriculture Development Programme (CAADP), and the Millennium Development Goals I on the other hand (MOFA, 2007 p.15). For instance, both the Ghana Shared Growth and Development Agenda (GSGDA) and the CAADP framework had targets for agriculture sector performance that aimed at contributing to achieving the broader goal of a modernized agriculture for Ghana.

FASDEP II builds on the lessons learnt in implementing past sectorial policy documents through a comprehensive review process. In his foreword to the FASDEP II document, the then Honourable Minister for Food and Agriculture, Mr. Kwesi Ahwoi, disclosed that FASDEP II is the "outcome of a consultative process, which began with inputs from inter-ministerial teams working on different areas of intervention" with emphasis on "the sustainable utilization of all resources and commercialization of activities in the sector with market-driven growth in mind" (FASDEP II, 2007 p.7).

Specifically, the FASDEP II policy objectives included:

- Food security and emergency preparedness
- Improved growth in incomes
- Increased competitiveness and enhanced integration into domestic and international markets
- Sustainable management of land and environment
- Science and Technology Applied in food and agriculture development
- Improved Institutional Coordination

Under this policy document, the government of Ghana aimed at mainstreaming and supporting efforts at up scaling best practices in SLWM to achieve the core objectives and resolve key challenges to achieve environmental resilience and agricultural productivity in the wider scope of the country's overall development agenda (FASDEP II, 2007 p.37).

This policy document recognized that agriculture extension services in the country did not sufficiently take into account issues of sustainable land and water management. To remedy the situation, the policy strategy was to "mainstream sustainable land and environmental management practices in agricultural sector planning and implementation" (FASDEP II, 2007 p.37-38).

Other core issues related to sustainable agriculture land and water management identified by FASDEP II are the "ineffective framework for collaborations with appropriate agencies to address environmental issues, lack of a national agriculture land use policy and the high environmental degradation and abuse due to inadequate understanding of environmental issues related to agriculture". FASDEP II outlined eight specific strategies to address these challenges including a long term programme to "stimulate, support and facilitate adaptation and widespread adoption of farming and land use practices which, while in harmony with natural resource resilience, also underpin viable and sustainable production levels" (FASDEP II, 2007 p.38).

2.3 Ghana Environmental Management Project (GEMP)

The Ghana Environmental Management Project (GEMP) was a five-year government of Ghana project funded by the Canadian government and implemented by the Ministry of Environment, Science, Technology and Innovation through the Environmental Protection Agency, with the primary objective of strengthening institutions and rural communities in Ghana to "reverse land degradation and desertification trends in the three regions of northern Ghana and to adopt sustainable water and land management systems that improve food security and reduce poverty" (EPA). The project was largely carried out in line with Ghana's National Action Programme (NAP) to combat drought and desertification.

While GEMP focused on environmental factors with significant relationship to improving food security in particularly northern Ghana, it recognised the key contribution of lead agencies to "combat desertification and to promote sound land management practices" in the target areas. GEMP focused on two key strategies in its implementation approach. At the institutional level, GEMP sought to build the capacity of the Environmental Protection Agency as the main coordinating agency in desertification initiatives in the country. Beyond the institutional capacity building, the support also focused on strengthening institutional linkages between the Environmental Protection Agency and the Ministry of Environment, Science, Technology and Innovation to effectively "plan, launch, facilitate, coordinate, monitor and report on the implementation of Ghana's National Action Programme". In effect, the goal of GEMP was to strategically position the Environmental Protection Agency (EPA) to discharge its assigned responsibility in northern Ghana. On the other hand, GEMP sought to support the direct implementation of priority projects in northern Ghana in combating desertification as contained in the National Action Programme. Here, the main focus of GEMP was to support community level based sub-projects that impact on land degradation, improve vegetative cover and promote environmentally friendly alternative livelihoods in beneficiary communities.

GEMP focused on six key thematic areas during these years of implementation, all aimed at combating desertification and promoting efficient land use for improved food security in northern Ghana. Three of the six key thematic areas adopted under the project were:

- Land use and management where the project specifically focused on encouraging the adoption of soil fertility practices, such as mulching, use of organic manure and proper land preparation; awareness creation campaign on bushfire/ wildfire management; sensitization on sustainable wood/ wood fuel harvest and encouraging the protection of water bodies in catchment areas.

- Management of the vegetative cover, with specific emphasis on the cultivation of high-yielding and drought-resistant crops; establishing fodder for grazing; adopting tree growing/ woodlots establishment; control of bush burning; control of fuel wood gathering and diversifying crops on field and;

- Water Resources Management, with particular focus on the creation of buffer along water bodies to prevent farming activities along river basins; creating access to irrigated lands for dry season cultivation by constructing dugouts and boreholes; and ensuring the availability of fresh water resources for community use.

While MOFA was a key stakeholder tasked with the responsibility of implementing these priority initiatives at the community level, the project worked largely with other relevant stakeholders, including the GEMP Policy Committee (PC); Regional Environmental Management Committees (REMCs); District Environmental Management Committees (DEMCs); Community Environmental Management

Committees (CEMCs); the District Assemblies (DAs); Gender Desk officers and relevant gender networks and the GEMP beneficiary communities.

The coordinating agency of GEMP reported some significant successes, which included an enhanced capacity of government of Ghana stakeholders to plan and coordinate activities aimed at combating desertification in the country. The agency disclosed that 201 National Action Programme management structures are established and fully functional in the Northern, Upper East and West regions of Ghana.

The GEMP success story includes improved and well-established land and water management practices in all beneficiary districts and communities in the three regions of northern Ghana. The agency specifically stated the establishment of 205 acres of naturally conserved and protected community lands and 10 community woodlots, the establishment of 22 strategic tree nurseries with over 400 nursery attendants trained, reduced number of bushfires by 50% in most beneficiary communities due to the training received by almost 5000 men and women as fire volunteers and over 80 communities with fire management plans.

2.4 Sustainable Land and Water Management Project (SLWMP)

The Sustainable Land and Water Management Project implemented under the auspices of the Ministry of Environment, Science, Technology and Innovation is a five-year (2014-2018) project funded from the Global Environment Facility to support the sustainable development of initiatives for the Savannah areas of Ghana to achieve "a diversified and resilient economic zone" in northern Ghana with significant desired environmental impacts.

While the SLWM project main objectives were to "demonstrate improved sustainable land and water management practices aimed at reducing land degradation and enhancing maintenance of biodiversity in selected micro-watersheds" and to "strengthen spatial planning for identification of linked watershed investments in the Northern Savannah region of Ghana", its implementation focused on three significant components.

First, the SLWM project sought to focus on enhancing the capacities of implementing institutions by providing integrated spatial planning tools that will enable such institutions to undertake strategic economic decisions related to water and land in the Northern, Upper East and West regions. The second component of the project focused on providing support to community floods and land management at the micro-watershed level. The project sought to incorporate "labour-intensive civil works investments in small-scale flood and water management infrastructure through the Social Opportunities Project (SOP)" and finally, the SLWM project was to provide additional support to project management and coordination to the coordinating agency- the Ministry of Environment, Science, Technology and Innovation (MESTI).

The SLWM project introduced an exhaustive technique to land and watershed management at the community level by incorporating the maintenance of ecological infrastructure with planning processes feeding into a broader integrated program of water and flood management infrastructure in the Savannah areas of northern Ghana.

The Crop Services Directorate of the Ministry of Food and Agriculture (MOFA) and the District Agriculture Development Units (DADUs) were key players in the implementation of SLWMP technologies at the community levels. Whilst MOFA was to "provide oversight of, and technical backstopping and fiduciary management support to field implementation by DADUs, including the development of DADUs capacity develop programs in line with agreed menu of SLWM options and District approaches", DADUs in particular were to "strengthen extension capacities in line with menu of SLWM options to be offered, through training, receipt of equipment and establishment of a network of demonstration farms". Under the SLWMP, DADUs were encouraged to proactively identify their own capacity needs and monitor their performance in response to the support provided.

According to a World Bank Report (2015), "the agricultural landscape and the corridor areas under sustainable land and water management have been made productive through farming techniques such as contour bunds, zero tillage, crop rotation, intercropping with legumes, composting, mulching, protecting buffer zones and planting trees along river banks." Since the inception of the project in 2011, about 10,000 land users are said to have adopted SLWM practices covering an area of over 3,000 hectares with over 24,000 community members benefiting from the project intervention. Out of the latter, an estimated 40% are said to be women.

2.5 Sustainable Land and Water Management Technologies

SLWM is defined as a knowledge-based procedure that helps integrate land, water, biodiversity and environmental management to offset the consequence of rising food and fibre demands while at the same, sustaining ecosystem services and livelihoods (The World Bank, 2006). SLWM is necessary to meet the requirements of a growing population. Improper land management can lead to land degradation and a significant reduction in the productive and service functions of watersheds and landscapes (The World Bank, 2006).

SLWM also includes ecological, economic and socio-cultural dimensions (Hurni, 1997). These three are not separate rather they are interconnected. They are also referred to as the '3Es' of sustainable development - Equality, Economy, and Ecology (UNESCO, 2006).

Ecologically, SLWM technologies – in all their diversity – effectively combat land degradation. But a majority of agricultural land is still not sufficiently protected, and SLWM needs to spread further. Socially, SLWM helps secure sustainable livelihoods by maintaining or increasing soil productivity, thus improving food security and reducing poverty, both at household and national levels. Economically, SLWM pays back investments made by land users, communities or governments. Agricultural production is safeguarded and enhanced for small-scale subsistence and large-scale commercial farmers alike, as well as for livestock keepers. Furthermore, the considerable offsite benefits from SLWM can often be an economic justification for them.

It is now widely accepted that SLWM practices provide an effective way of improving the management of water resources and the reduction of soil, vegetation and biodiversity degradation, which helps to increase and maintain crop, forest and forage yields. SLWM practices application could contribute to mitigating the effects of climate change and significantly improve food security and the resilience of the rural population to external shocks. The implementation of SLWM practices, techniques and technologies is therefore a promising solution for most African countries (Winterbottom. 2013).

2.6 Profile and use of proven SLWM technologies

SLWM Technologies/concept definition and use	Benefits/Advantages	Limitations/Disadvantages
Planting trees (Afforestation) It is the establishment of a forest or stand of trees in an area where there was no previous tree cover. It is highly important to maintain the biodiversity, combat the issues of global warming, check soil erosion, reduce pollution as well as maintenance of biodiversity and ecological balances. The Guinea Savannah area is particularly critical for afforestation since it is much closer to desert (Sahel and Sahara)to	• Increases organic matter • Act as barrier to dangerous wind • Strengthen and stabilise earth structures for erosion control • Provide fuel, fodder, fruits, etc. • Reduce air pollution through absorption of carbon dioxide Maintain biodiversity	• Seedlings are sometimes not accessible by farmers • Water may not be available during the dry season to irrigate tree seedlings • Livestock may destroy seedlings if proper fence is not put in place
Bush fire control Bush burning causes destruction to forest resource (both plant and animals), as well as to all farmlands. Burning usually occurs during land preparation and harvesting seasons. The practices kill microorganisms and expose the soil to erosion. Farmers are advised to do control adhere to control burning. Although burning fires destroy farmlands and other valuable assets through the country, the Guinea Savannah, transitional zone and Semi-deciduous areas are more prone to bushfires. Several hectares of farmlands are destroyed particularly during the Harmattan season.	• Prevents vegetation from destruction • Saves farmlands and other properties from being destroyed • Conserves soil fertility • Prevent the destruction of soil micro-organisms • Reduces air pollution • Saves the killing of animals • Maintain the biodiversity	• The fire fighting equipment may not be readily available to farmers • Some farmers are difficult to adopt preventive measures • Hunting which is one of the causes still persist among farmers

The construction of fire belts and control burning are recommended by MOFA for control measures.		
Bunding It is the construction of small embankment across the slopes of land. Bunds can be done either by using earth or stones. Stones are commonly used in the upper East region of Ghana. The bunds are referred to as contour bunds when they are constructed on the contour. The practice is highly recommended for areas where slopes exist. Bunds traps water and prevent run-offs.	• Bunds act as barriers to run-off • Conserves water for crops • Reduces erosion • Conserves soil nutrients	• Construction of bunds is labour-intensive • Constructing bunds may be costly • They may be conflicts among farmers regarding the direction of water.
Farming across slopes (Contour) The practice whereby farmers carry out their land preparation activities (e.g. ploughing, planting, etc.) across the slope instead of up and down the slope. Hilly and sloppy areas are suitable for contour farming. The practice helps to reduce run-off and erosion of soil.	• Stabilizes and enriches the soil for growth of food crops. • Conserves plant nutrients and moisture essential for the crops.	• The practice may lead to conflict due to direction of water • Farmers need some level of skills to undertake the practice
Retention ditches They are large ditches, designed to trap and retain all incoming water and hold it until it infiltrates into the ground. The practice is highly recommended for areas where rainfall patterns are unreliable. The Guinea Sava Savannah areas and transitional areas good for the practice.	• It conserves water for plants • It controls soil erosion • It conserves nutrients for the plants	• It is labour demanding • It can facilitate the occurrence of erosion erosion
Use of compost	• Provides slow release of nutrients to plants	• The technology is labour-intensive

The controlled decomposition of crop residues, weeds manure into a humus-like end product in which the end product cannot be identified. The end product is a clean-smelling earthy substance that provides a concentrated supply of humus and plant nutrients when applied to the soil. It takes about 6-8 weeks to prepare compost. Composting is recommended for areas where lands are degraded and less fertile.	• Increases organic matter in the soil • Improving soil tilth • Increases soil ability to absorb and hold rainfall • Resists soil compaction and improving aeration • Buffering soil pH.	• Farmers needs time to understand the concept • Materials may not readily be available to farmers • The area of preparation may be far from farmers' farm • It can be smelly depending on what materials you use
Planting drought resistance varieties It is the use of varieties that can withstand the effects of drought for sometime during poor rainfall. Research scientists have come out with new varieties of the various crops that are capable of resisting the effects of drought. Drought resistant varieties usually use less water. In Ghana some varieties of cereals such as maize, cowpea, sorghum have been developed as drought-tolerant varieties. Dry areas such as the Guinea Savannah areas and transitional areas are prone to climate variability and suitable for use of resistant varieties.	• They still do well in the event of erratic rainfall • The farmers get the fullest benefit from plants	• Drought- tolerance genes produce additional, undesirable effects on crop growth. • Farmers may have difficulty accessing the varieties
Fallowing land It is a system of subsistence farming in which land is cultivated for a period of time and then left uncultivated for several years so that its fertility can be	• Balancing soil nutrients • Re-establishing soil biota • Breaking crop pest and disease cycles • Providing a haven for wildlife	• There may be difficult where land is limited. • It may lead to wastage of land

restored. Fallowing is suitable in areas where land is abundant.		• It may lead to the destruction of valuable forest resources like timber
Planting early maturing varieties Early maturing crop involves the cultivation of varieties that mature early and escape unfavourable weather conditions. The early maturing varieties are promoted to minimise the climate variability and unpredictable weather patterns. The Guinea Sava Savannah areas and transitional areas are more prone to climate variability and suitable for early maturing varieties.	• It prevents environmental stress • The farmer derives the fullest benefits from farm	• It may contain traits not healthy for the crop • Harvesting may coincide other major farming activities
Crop residue management The practice of leaving crop residue on the soil surface during cropping. Crop residue input is vitally important for soil fertility replenishment leaving crops in the field to serve as soil cover and organic matter. Crop residue can be made more effective if intergraded into the farming system as mulch, composting material for trash lines. It is recommended that farmers apply NPK to make up the nutrient losses during the breakdown of stovers.	• A good source of organic material for biofuel production • The residue can help check soil erosion • It may improves the soil structure	• It leads to disease attack • Additional nutrients may still be needed since the residue may not contain all the essential nutrients need by the plants • The residue if not handle well can lead to fire outbreaks
Crop rotation Crop rotation is the systematic planting of different crops in a particular order over several years in the same growing space. This process helps to maintain	• It improves soil structure • Increases soil fertility • Control of pests and diseases. • Production of different outputs	• It requires more machinery. • It may give lower financial returns during certain times.

nutrients in the soil, reduce soil erosion, and prevents plant diseases and pests. The practice is suitable for intensification purpose where land is less available for fallowing.	• Risk reduction	• It requires more knowledge and skills.
Strip cropping It involves the planting of alternating strips of several crops aligned to the contour in the same field. It is an affective conservation measure on slopes between 5% and 10%. It is well suited to well-drained soils because the reduction in runoff velocity	• It produces a variety of crops, which serves as an advantage • The residue from strip and can be used as a cover for neighbouring strip.	• It is labour-intensive • It requires more knowledge and skills.
Planting cover crops Planting certain crops to cover cultivated ground or fallow land thereby providing protection for the purpose of reducing erosion by raindrop splash and surface run-off. Examples include mucuna, stylosanthes, canavalia, dolichos, etc. Cover crops add nutrients to the soil and prevent run-off. They are more appropriate in soils that are depleted in nutrients.	• Protect soil against the impact of raindrops leading to a reduction of surface sealing and crusting. • Reduces volume and speed, holds water and allow water in take • It reduces evaporation of soil moisture • Reduces variation in soil temperature, suppress weed growth, • Serves as a source of organic matter, increases the activity of micro-organisms in the soil,	Obtaining seeds of cover crops are sometimes difficult for farmers
Mulching The process of applying any material to the surface of the soil to reduce water loss by evaporation, reduce weed growth and regulate soil temperature.	• It controls soil erosion by preventing raindrop. • It maintains high soil infiltration. • It enhances soil organic matter	• It is sometimes difficult to obtain mulching materials • It may facilitate the growth of weeds.

Common materials used for mulching at the farm level include grass, crop residue. Mulch densities range between 30-70%.	• It retains soil moisture • Add nutrients to the soil	
Minimum tillage It involves the preparing of a seedbed with little disturbances to the soil or minimum usage of farm of farm machinery. Zonal tillage is being commonly promoted practiced-a process whereby only the seed/seedling zone is tilled.	• It reduces soil compaction • It maintains high infiltration rates • It increases aggregate and water retention in the root zone	• Weeds may grow faster • It may disturb the growth of roots • Cost of weed control may be high
Mounds They are conically shaped heaps of soil of about 50 cm base diameter. Mounds are traditional method used to conserve moisture and nutrients. They are commonly made for the growing tuber crops such as yam, cassava, etc.	• It improves the exploitable volume of soils for the crop. • It conserves moisture and nutrients	Making mounds is quite labour-demanding
Zero/No tillage It involves slashing or mowing the weeds, cover crops and previous crops or spraying herbicides for pre-plant weed control to obtain a seedbed covered with mulch. Planting done directly in the mulch covered with mulch covered undisturbed soil by opening a small hole just enough plant and cover the seeds.	• It creates a favourable soil temperature regime • Improves soil structure and control run-off and erosion	• Weed pressure and insect infestation from previous crop residue is a major problem • It may involve additional cost for controlling weeds
Constructing ridges Ridging involves making narrow earthen bunds along the contour intervened by furrows at spacing of about	• It useful for water conservation and erosion control measure when the ridges are aligned to contours.	Making ridges is quite labour-demanding

1-2 meters. Ridges are commonly used in the Savannah areas where land fertility poses serious challenge.	• It is labour-intensive	
Integrated Nutrient Management (INM) It involves combined use of organic and mineral fertilizers. Organic fertilizers play a key role in maintaining soil fertility it contains nutrient, which is readily available to plants when it decays. Mineral fertilizer can provide the major plant nutrients (nitrogen, potassium, phosphorous, sulphur, etc)	• It improves soil structure • It enhances infiltration • It increases soil resistance to erosion.	• It may increase the cost of production • It may require some special skill to combine the two nutrient sources
Zai It is a technology recently introduced into the country from Burkina Faso, which is used as an effective strategy to conserve both water and nutrients in the soil. It is a land preparation practice whereby farmers dig areas of their farmland where crops are to be planted. The zai pits depth of 10 to 15 centimetres, and put in manure before planting crops. Pits are sometimes dug during the dry season, which alleviates the labour burden for land preparation at the onset of the rains.	• It captures rainfall and runoffs. • Promotes the efficient use of limited quantities of organic matter. • Ensures the concentration of water and soil fertility at the beginning of the rainy season. • Increases the amount of water stored in the soil profile by trapping rain water. • It retains moisture in-situ and holds water long enough to allow it to infiltrate. • It improves soil fertility in completely barren soils where nothing could grow before. • Protects seeds and organic matter against being washed away, in addition to conserving nutrients.	• It is labour-intensive • It may increase the cost of production

Source: EPA reports (guidelines for proven SLM technologies for landusers and extension providers); MOFA reports (METSIP, IFAD, FASDEP & AgSIP)); MEST reports (GEMP& SLWMP); NGO reports (ACDEP, IFDC, ProNET, & WASCAL)

3.0 Methodology

3.1 Introduction

The section discusses the methodology of the study. It covers aspects such as the description of study area, population and sampling, data collection techniques, training of enumerators and data analysis.

3.2 Description of Study Area

The Northern Ghana is made up of Northern, Upper East and Upper West regions. The Northern Regions are much drier than southern areas of Ghana, due to their proximity to the Sahel and the Sahara. The vegetation consists predominantly of grassland, especially Savanna with clusters of drought-resistant trees such as boababs and acacia. The dry season occurs between January and March. The wet season is between July and December, with an average annual rainfall of 750 to 1050mm (30 to 40inches). The highest temperatures are reached at the end of the dry season, the lowest in December and January. However, the hot Harmattan wind from the Sahara blows frequently between December and at the beginning of February. Temperatures can vary between 14 C (59 F) at night and 40 C (104 F) during the day.

The **Northern Region** is one out of the 10 regions of Ghana (Fig. 3.1). It is located in the north of the country and is the largest of the ten regions, covering an area of 70,384 square kilometers or 31 percent Ghana's area. The Northern Region is divided into 26 districts. More than 75% of the economically active population are farmers. The low population density is partly caused by migration, in addition to geography and climate. The study randomly selected two districts out of the three (3) districts implementing SLWM technologies. These included Yagba-Kubori and West Mamprusi.

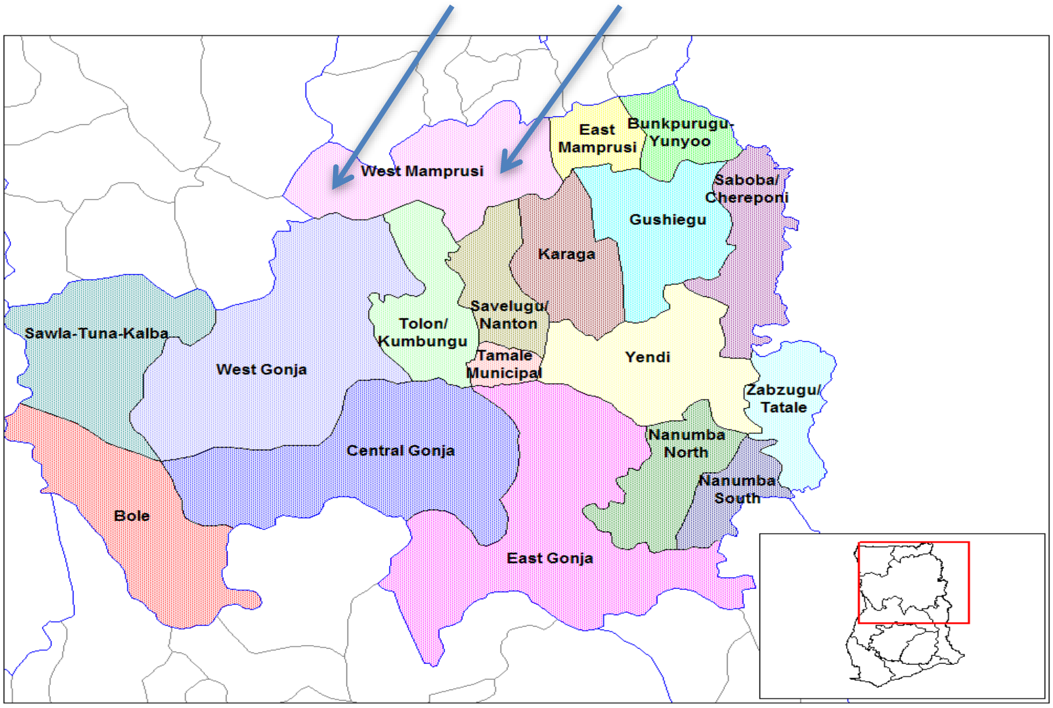

Figure 3.1 Map of Northern Region of Ghana

The **Upper East Region** is located in north Ghana and is the second smallest of 10 administrative regions in Ghana, occupying a total land surface of 8,842 square kilometers or 2.7% of the total land area of Ghana. The Upper East regional capital isBolgatanga,sometimes referred to as Bolga. Other major towns in the region include Navrongo, Paga, Bawku and Zebilla. The study randomly selected two (2) districts, which includes Kasena-Nankana East and Bawku West districts out of the four (4) districts implementing SLWM technologies.

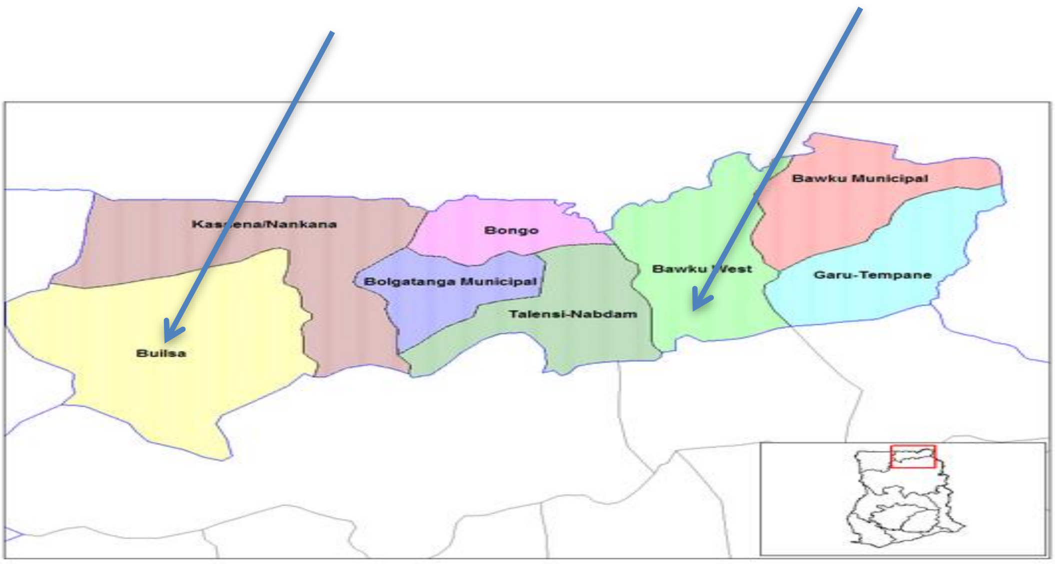

Figure 1 Map of Upper East Region

The **Upper West Region** of Ghana is located in the northwestern corner of Ghana, and is bordered by Upper East Region to the east, Northern Region to the south, and to the west and north. The Upper West regional capital is Wa. Upper West is the youngest region in Ghana and was created in 1983 under the Provisional National Defense Council. The area was carved out of the then Upper Region, which is now the Upper East Region. Two (2) districts out of the four districts implementing SLWM technologies were randomly selected for the study.

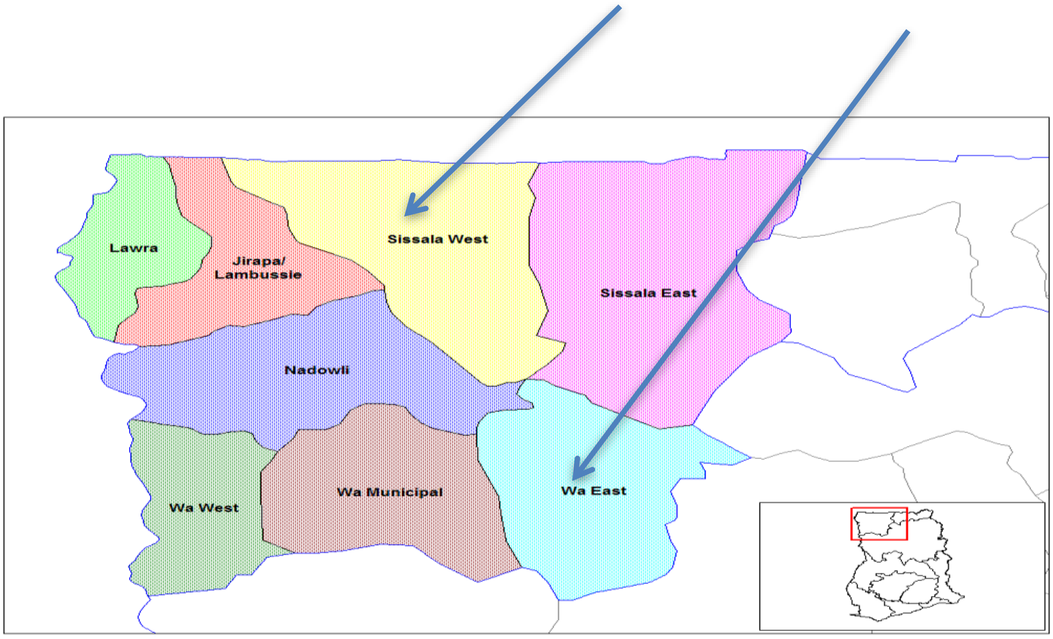

Figure 2: Map of Upper West region

3.3 Population of the study

The study targeted farmers in the three Northern regions along the watersheds belt where SLWM technologies have been implemented, as well as institutions implementing SLWM technologies.

3.4 Sampling

The fieldwork was carried out in the three Northern regions of Ghana. These regions were focused on because they remained critical in environment degradation due tis proximity to the Sahara and Sahel, which are desert in nature. Aside that, Ghana's two major environmental sustainable projects- GEMP and SLWMP have largely focussed in those areas. A multi-stage sampling technique was used to select respondents for the study. First, two districts were randomly selected from each of the three regions. Second, 5 communities were randomly selected from each district. Finally, 10 households from each community were randomly selected for survey. In addition, three (3) focused group discussions were held in each district to elicit in-depth information from farmers. Table 1 details the sampling of study communities.

Table 3.1: Sampling of study communities

Region	District	Communities
Northern	West Mamprusi	Takorayiri, Gugya-pala, Buakudow, Tiya, Bugya-Kuraa
	Mogduri	Buhiyingah,Yagaba, Prima, Goriba, Loagri
Upper East	Kasena-Nankana	Awenia, Nakongdong, Afania, Achangoson, Aniu-Adongo
	Bawku West	Namog, Sheiga, Zopkalga, Kunkuo, Farig
Upper West	Sisala West	Kusala, Gbal, Jawia, jeffesi, Bullu
	Wa East	Zinye, Vissee, Gudayiri, Naaha, Manwu

3.5 Data Collection techniques

Questionnaires were administered to 300 farmers who were selected randomly. Besides, focus group discussions were held in three communities per district. The study also engaged stakeholders working on SLWM technologies. These institutions included MOFA, EPA, Forestry commission, and Wildlife division. The private institutions that were also engaged in SLWM-related activities included IFDC, ProNet, Plan Ghana, ACDEP and ORGIIS. The details of officers interviewed during the data collection in the various institutions are captured in Appendix 3.

3.6 Data analysis

All questionnaires were coded, cleaned and inputted into the SPSS package. The questionnaires were then analysed using descriptive statistics, such as frequencies and percentages. Poisson model was employed to analyse the factors influencing adoption. Data from focus group discussions and key informant interviews were transcribed and categorised into themes and relationships, and presented as text narratives. Secondary data were analysed using content analysis. With regards to the level of uptake of existing SLWM technologies by farmers, the study delved into level of adoption of SLWM technologies, the factors responsible for the current levels of adoption of SLWM technologies and as well as its impacts on livelihood outcomes. Thus, to achieve this objective, the study employed different approaches. On the question of adoption levels and impacts on outcome, the study employed descriptive statistics such as frequencies and percentages. Content analysis was used to profile SLWM technologies.

3.7 Training of enumerators

As part of the processes to ensure the quality of data obtained, the research team organised a day's workshop to train field enumerators. Sixfield enumerators were trained, with 2 for each region. Enumerators were made up of graduate students who hadbeen exposed to some level of research data collection. Theywere carefully selected based on familiarities with the area terrain, as well as ability to speak local language. The training session lasted approximately 8 hours, with about 45 minutes break between two sessions. The lead researcher took enumerators through the various aspects of the questionnaires, as well as the focus group guide. Participants were also made to practice some of the technical terms in their various languages to ensure that they all grasped the interpretation of the questions in their various languages. Participants asked questions for clarification of areas they were not clear about. Details of field enumerators are captured in Appendix 3.

3.8 Challenges encountered during data collection

- Some of the communities were not easily accessible by enumerators
- Farmers were not willing to give a true picture of their situation
- Some staff of stakeholder institutions demanded remuneration before assisting enumerators.
- Low staffing of MOFA made it difficult to get readily available extension officers to assist in accessing respondents.
- Data collection coincided with farming season, affecting the availability of farmers.

3.9 Validity and Reliability

- People who could speak the local language were used to collect the data
- Enumerators were well trained to ensure that the fully grasp the content of the instruments
- Questions were pretested to ensure that all discrepancies had been addressed before administering the survey.

4.0 Findings and Discussions

The section discusses the results of the study. Aspects covered under the section include the bio-data, copying strategies, types of SLWM technologies, adoption of SLWM Technologies by farmers known by farmers and capacity of MOFA in handing SLWM technologies.

4.1 Bio-data of Respondents

This section discusses the biodata of respondents. It includes respondents' gender, marital status, formal education, household size, major occupation, and farming system practiced. Table 4.1 details the bio-data of respondents.

4.1 Bio-data of respondents

Variable	Description	Frequency	Percent
Gender	Male	215	71.7
	Female	85	28.3
	Total	**300**	**100**
Marital Status	Married	247	91.3
	Single	13	4.3
	Widowed	12	4.0
	Divorced	1	0.3
	Total	**300**	**100**
Formal Education	No Education	195	65
	Primary	34	11.4
	JHS/Middle	26	8.7
	SHS	23	7.7
	Tertiary	6	2
	Arabic	16	5.3
	Total	**300**	**100**
Household size	Less than 3	1	0.3
	3-5	46	15.3
	6-8	59	19.7
	9-12	74	24.7
	Above 10	118	39.5
	Total	**300**	**100**
Major Occupation	Farming	286	95.3
	Trader	9	3.0
	Artisan	1	0.3
	Wage labour	2	0.7
	Others	2	0.7
	Total	**300**	**100**
Farming system	Mixed farming	212	70.7
	Crops only	82	27.3
	Total	**300**	**100**

The mean age of respondents was 47.6 years, which implies that farmers were relatively young. The findings suggest that relatively active people are engaged in farming in Northern Ghana, which is good for the future of agriculture. This is contrary to the findings of several studies that the youth do not longer want go into farming (MOFA, 2011).

As seen from the results in Table 4.1, the majority (71.7%) of the respondents were males, while females constituted the minority (28.1%). On marital status, the study found the majority (91.3%) of the respondents are married. Only a small proportion (4.3%) of the respondents were single. While 4.0% and 0.3% were widowed and divorced respectively.

Formal education is critical for innovation adoption, hence the study wanted to establish the level of formal education attained by respondents. From the study it was realised that access to education is still very low among smallholder farmers. As seen in Table 4.1,the majority of respondents lack formal education, while the highest number of respondents who attained any level of formal education is primary education. Also, 8.7%, 7.7%, 2% had attained JHS/Middle, JHS, and tertiary education respectively. Furthermore, about 16 of the respondents representing 2% had attained Arabic education. The finding is a reflective of the general observation that smallholder farmers generally either have low education or lack formal education.

Household size tends to influence the labour force of households, and for that matter the study sought to establish the household size of respondents. As established by the findings, the average household size was generally large, as most (39.5%) of the households were above 10 members, followed closely by household within the brackets of 9-12 members (24.7%). The least household belonged to the household less than 3 members (0.3%)

With regard to economic activities, as seen in Table 4.1, farming recorded the highest numbers of people with 286 individuals, representing 95.3% of the respondents engaged in it. Trading, artisanal activities and wage labour recorded 3.0%, 0.3%, and 0.7% respectively. The finding is typical of rural households where farming remains the main occupation (MOFA, 2007; GSS, 2011).

A further perusal of Table 4.1 shows that respondents largely practiced two main types of farming system, which includes mixed farming and crops only. The majority representing 70.7% were engaged in mixed farming, while respondents representing 27.3% were found to farming only crops. Farmers are being encouraged to intercrop mucuna with cereal crops such as maize and millet in order to conserve nutrients and prevent water run-off. This is likely to inform the high percentage recorded by the mixed cropping.

4.2 Coping strategies

Some rural households are not able to feed themselves throughout the year. As such, they have to find other means of sustaining food security needs. The study sought to ascertain from respondents the extent to which they were able to cope under shortage of foodstuff. The majority (61%) of the respondents indicated that the food they produce lasts throughout the year and is able to take them throughout the year, while a relatively lower number (116) representing 38.7% indicated that they run out of food at some point in the year.

Table 4.2: Coping strategies of farmers

Type of coping strategy	Frequency	Percentage
Borrowing	10	8.6
Buy	26	22.4
Remittances	10	8.6
Selling of livestock	27	23.4
Cutting firewood to sell	11	9.5
Selling of charcoal	6	5.2
Engage in wage labour	4	3.4
Engage in artisan work	1	0.9
Wives support	4	3.4
Migration	6	5.2
Selling of sheanuts	4	3.4
Engage in dry season gardening	1	0.9
Selling of pito	4	3.4
Petty trading	2	1.7
Total	**116**	**100**

The study further tried to establish from respondents how they cope with shortage of food. According to Table 4.2, the highest respondents representing 23.4% who were not able to feed themselves all year-round relied on their livestock to supplement their food shortage, followed closely with buying of food (22.4%). Also, about 11 respondents, representing 9.5%, rely on firewood sales for their sustenance. The least (1) representing 0.9% each was involved in artisanal work and selling of charcoal respectively. This confirms the argument that most rural households keep livestock in order to complement their food shortage (Rahman, 2007). It is also worrying to realise that a good number of them (17) representing 9.5% and 5.2% were engaged in firewood hewing and charcoal production respectively. This raises concern about the need to intensify alternative livelihood sources in the rural communities in order to stop them from deforestation.

4.3 Existing SLWM technologies and level awareness by farmers

SLWM is dynamic and may vary from one geographical area to the other. Globally, SLWM technologies are numerous. The type of sustainable technologies used in a particular environment may depend on the resources available, the orientation of the people and the compatibility of the technology to the geographical area. In Ghana, various SLWM technologies have been developed and transmitted to farmers for possible uptake. Some are imported, but others are developed locally. MOFA has been the main implementing institution. However, some private institutions such as NGOs also support in the development and implementation of SLWM technologies on a small scale. Based on the existing SLWM technologies promoted in Ghana, the study sought to investigate the extent of awareness of SLWM among smallholder farmers in the three Northern regions among other objectives. Table4.3 presents the results of the level of awareness of SLWM technologies among respondents.

Table 4.3: Level of awareness of SLWM technologies

SLWM	Frequency	Percentage
Planting trees	207	69
Bush fire control	191	63.7
Bunding	170	56.7
Planting year-round green plants	33	11
Farming across slopes	176	58.7
Use of compost	152	52.4
Planting drought resistance varieties	45	15
Fallowing land	39	13
Sticking to weather advice	29	9.7
Planting early maturing varieties	53	17.7
Crop rotation	41	13.7
Planting cover crops	85	28.3
Ploughing back crop residue after harvest	6	2.0
Mulching	45	15
Planting in rows	20	6.7
Zai	27	9

Generally, the level of awareness of SLWM among farmers was high, with about 290 respondents representing 97% indicating that they had some level of awareness of SLWM technologiesof SLWM technologies. However, the awareness levels of the individual technologies were varied. While the levels of awareness of some technologies were high, others were very low.Perusing from Table 4.3, planting trees and bush fires were most popular, as they recorded the highest percentages of 69% and 63.7% respectively. Farming across slopes, bunding and use of compost also scored above average with 58.7%, 56% and 52% respectively. The lowest scores were recorded by ploughing back crop residue, zai, planting in rows, with sticking to weather advice recording below 10%. The findings can be understood because planting trees and prevention of bush fires have received extensive education from both government and private institutions and through diverse media for over a decade, to an extent that tree planting has more or less become synonymous to climate change remedy. The economic benefits associated with tree planting include the establishment of woodlot for firewood as well as fruits, herbs and other medicinal purposes. The low figure recorded for zai can also beunderstood because it's a practice imported from Burkina Faso and is largely concentrated in the Upper East region, which shares a border with them.

4.4 Source of information

Source of information from which farmers obtain information can be proxy in determining the effectiveness of that channel of extension service delivery and generally guide others as to where thay can access such information. As such the study sought to determine the sources of receiving information on SLWM technologies. Table 4.4 presents the details of sources of information of respondents on SLWM technologies.

Table 4.4: Source of information of SLWM technologies

Source	**Frequency**	**Percentage**
MOFA	214	73.8
NGOs	65	22.4
Fellow farmers	10	3.4
Research institutions	1	0.4
Total	290	100

As shown in the Table 4.4, respondents representing 73.8% got to know of SLWM technologies from MOFA, respondents representing 22.4% received the information from NGOs, respondents representing 3.4% got to know about it from their fellow farmers, while only one respondent received information on SLWM technology from a research institution. With the majority of respondents obtaining information about SLWM technologies from MOFA, it implies that MOFA has the greatest outreach and is effective in disseminating farming technologies to farmers.

4.5Uptake of SLWM Technologies by farmers

The section presents data on the level of adoption of SLWM technologies, the factors affecting SLWM technologies, as well as its impacts.

4.5.1Levels of uptake of SLWM technologies by farmers

Technologies are developed by researchers to be used to enhance productivity, both in increasing yields and improving quality. Rahman (2007) argues that if technologies that are developed by researchers are not properly adopted and used by farmers, all the effort and resources used in developing the technologies are in vain. Therefore, the study sought to establish the level of SLWM technology adoption among farmers. The findings revealed that the adoption rate across all the identified technologies were generally low across the communities, with none rating above average as shown in Table 4.5 below. This is contrary to the finding of World Bank (2015) report on the SLWMP which indicated high levels of adoption. This adoption rate is obtained from interaction with MOFA regional and district directorates, as well as literature the study gathered about the 15 SLWM technologies actively being disseminated to farmers in the study area. These include planting trees, bush fire control, bunding, farming across slopes, use of compost, planting drought resistant varieties, fallowing land, crop rotation, following weather advice, planting early maturing varieties, residue management, mulching, row planting and Zai. Table 4.5 details the SLWM technologies and rate of adoption.

Table 4.5 Levels of adoption of SLWM technologies

SLWM	Frequency	Percentage
Planting trees	107	36
Bush fire control	105	35
Bunding	104	34.7
Farming across slopes	134	44.7
Use of compost	119	39.7
Planting drought resistance varieties	21	7
Fallowing land	17	5.7
Crop rotation	40	13.3
Following weather advice	8	2.7
Planting early maturing crops	20	6.7
Planting cover crops	44	14.6
Residue management	5	1.5
Mulching	9	3
Row planting	10	3.3
Zai	6	2

Tree Planting

According to proven scientific facts, the more trees we have the more the occurrence of rainfall. There is a saying that "when the last tree dies, the last man dies", which implies that trees are critical to human survival. Tree planting has been one of the oldest technologies disseminated extensively to fight desertification, which is fast approaching towards the regions Northern Ghana. Due to the challenges in sustaining livelihoods among some rural folks, they have turned to the destruction of the forest resources for agriculture and harvesting of timber/fuelwood for survival. Despite extensive sensitisation from MOFA, MEST and development partners to stop people from degrading the forest, a lot more people are still actively engaged in it because it constitutes the key resource for sustaining their livelihoods. The study sought to find out from respondents their level of adoption of tree planting. As seen in the Table 4.5, the study found that out of the 300 people sampled, only 107 respondents representing 36% adopted tree planting. The finding shows that the most of rural farmers are still not adopting tree planting.

Pic 1: A 46-year old man in Kasena-Nankana West irrigating his tree seedling

During a focus group discussion, some of the respondents attributed the poor adoption of tree planting to lack of availability of water sources. A 46-year old man in Kasena-Nankana West shared his experience on tree planting exercise as:"Its not easy to handle these trees especially this dry season. At times all the water will dry up and you will not know where to get water to irrigate the trees. In fact water is our main problem here." (Pic 4.1)

Bush fire control

Bush fires continue to occur despite efforts by MOFA, MEST and development partners to sensitize and educate farmers on bush fire prevention. They cause destruction to forest resource (both plant and animals) and reserves, as well as the fertility of farmlands. Farmers have been sensitised on the dangers of bushfires and the strategies to prevent them. The study therefore sought to determine the extent to which farmers are adopting bush fires prevention or control as a strategy to sustain the environment. Perusing from the Table 4.5, it can be seen that only102 respondents representing about 35%adopted the bushfire control. The finding indicates a situation where the practice of bush burning is most likely to continue with the attendant negative consequence for the environment, and also sometimes loss of human lives. Respondents attributed the poor adoption of bushfires prevention and control to the attitudinal behavior of people. These attitudes emanates from past cultural practices and norms imbedded in farming practices and livelihood activities such as burning of bush for hunting and also to prepare lands for new seasons. This implies that a lot of sensitization on the dangers of bush burning with alternative solutions to reasons for burning in these areas. These alternative livelihoods will serve as incentitive to encourage attitudinal change. Alternative livelihoods such as the supply of free beehives to produce honey and its derivatives should be considered.

Bunding

Bund construction helps prevent run-off and conserve water in farmlands. Due to the current erratic rainfall patterns largely attributed to climate change, bunding has become one of the SLWWtechnologies being promoted by MOFA among farmers. Farmers use either stones or earth to construct the bunds. The earth bunding activities occur in most areas; however, farmers in the Upper east Region largely use stone for their bunding. As revealed in Table 4.5, about 134 out of the 300 respondents surveyed representing 34.5% have adopted bunding. Most respondents attributed the low adoption of bunding to its labour intensity nature and the extra cost incurred in its construction. A 52-year old man (Pic. 4.2) encapsulates his experience in constructing bunds. "If you use bunds it helps you a lot because it saves your water and nutrients. Sometimes the rains pause for several weeks during the rainy season, and the bunds help to conserve water. But some people don't like it because as you can see its labour intensive, and it becomes difficult if you don't have someone to assist you". Several farmers expressed similar views during focus group discussions.

Pic4.2:A 52 year old man in Bawku West gathering stones to construct bunds

Farming across slopes (contour faming)

Some farmers are compelled to farm on hilly areas due to land scarcity and other constraints. As a measure to prevent run-off, MOFA has been educating farmers to adopt farming across slopes (contour faming). Contour farming helps to prevent water run-off and conserve nutrients. The study carried a survey to determine the level of adoption of contour farming among respondents. As seen in Table 4.5, it was found that 44.7% adopted contour farming. Contour farming surprisingly had the highest level of adoption as compared to the other SLWM technologies. Perhaps this can be attributed to the fact that there is widespread availability of stones used and also because it does not incur additional cost in in its construction.

Use of compost

Compost is one of the old technologies extensively promoted over two decades ago to gradually complement the use of inorganic fertilizer. Continuous use of inorganic fertilizer has been found to have negative impacts on soil structure as well as increase the cost of production. Compost is usually made up of readily available materials such as plant materials, rubbish and other biodegradable waste. Its advantages include improving soil structure, adding fertility to soil, conserving more moisture and improving sanitation since waste which otherwise would have been used to make the environment dirty is used to produce compost.Analysis of Table 5.3 shows that 39.7% of respondents have adopted the use of compost. The figure recorded is not encouraging giving the effort put into developing and promoting the technology. During focus group discussions in some communities, participants attributed its low adoption to the drudgery involved in preparing the compost. Two respondents opined during focus group sessions:

“Composting is good. When you apply it to your farm and you are fortunate to have sufficient rains you will gain a lot. But the problem is that if you do not have enough labour it becomes difficult.” A 47-year old farmer at Sisala East District.

“Composting is good, but for the difficulty in gathering the materials and at the same time trying to carry it to the farm remains one of its main constraints.” A 37 year old woman at Yagba-Kubori.

The implication is that although farmers are aware that composting is beneficial, they are not willing to sacrifice their effort to adopt it. This means that more sensitisation needs to be carried out to change farmers’ perception and attitude towards its usage”.

Planting drought resistance varieties

Research has been carried out on the various crops to determine drought resistant crop varieties such as Nkabom, Nkumin, yello maize, among others. MOFA and its development partners have been promoting some of these varieties. A seen in Table 4.5, 21 respondents representing 21% have adopted improved crop varieties. Focus group discussions in some of the communities revealed that farmers are not adopting these technological packages because they are not able to afford the cost of these varieties. Improved seed varities has been identified as one of the ways of enhancing yields but these seeds require additional farming practices, which hitherto was not practiced by farmers and hence comes at an additional cost build-up in production. This cost build-up was captured as cost of technology according to farmers and a source of demotivation to adopting SLWM. Others indicated that resistant varieties are not readily available for them to buy, even if they have the money. This implies that MOFA needs to find ways of subsiding the cost of these varieties to make them affordable to the low-income rural farmers

Fallowing of Land

Fallowing of land refers to the situation whereby the farmer allows the farm to stay for a year more without cultivation in order for it to regain fertility or have the soil store enough water to make crop viable. Analysing the Table 4.5, it can be seen that 5.7% have adopted fallowing. The low figure recorded is not surprising because land is becoming increasingly scarce due to increasing population, infrastructure development and other competitive uses of land.Farmers are now managing with limited land, and therefore the practice of fallowing of land is no longer possible. This implies that farmers need to pay attention to other land management strategies, such as composting and Zai, which are effective in agricultural intensification and climate adaptation.

Crop rotation

Crop rotation refers to a practice whereby farmers divide plots into about two or more plots and grow different crops on each piece of plot and alternate the growing of the crops over by year to allow effective utilisation and replenishment of soil nutrients. The study sought to establish the extent of adoption of crop rotation.From Table 4.5, it can be seen that only a few (40) out of the 300 have adopted crop rotation, representing 13.3%. The implication is that although crop rotation is one of the effective strategies to intensify farming and ensure sustainable soil and water managament, the practice is not widespread. Respondents during a focus group discussion shed light as to why crop rotation is not much adopted by them as follows:

“I know the practice is good, but my piece of land in not large enough for me to divide it into several plots.” A 55-year old farmer at East Mamprusi

“When I harvest maize it doesn’t take me up to the next season. How can I divide the land again for another crop”. A 48-year old famer at KasenaNanakan West

The implication of the above narration is that land constraints hinder the adoption of crop rotation. This means that farmers need to be sensitised more to understand the economic benefits of crop rotation.

Following weather advice

Farming practices are carried out according to rainfall seasons. Failure to carry out a particular practice at the right time may result in crop failure. Due to climate change, the rainfall patterns have changed and farmers have to become flexible to the period of farming practice in order to get good harvest. The meteorological department in collaboration with MOFA is educating farmers on specific periods to undertake farming practice in order to maximise use of the recent erratic rainfalls. A perusal of Table 4.5 revealed that adoption of weather advice is poor among farmers, as only a few (8) representing 2.7% have adopted weather advice. This implies that most of the farmers carry out the various practices based on their own decisions, and this likely to affect their farm output. Therefore, sensitisation of farmers needs to be intensified in order to change their behaviour.

Planting early maturing varieties

Research efforts have been made to shorten or reduce the duration of some crops in order to reduce the adverse effect of shortening rainfall seasons as an adatation strategy. As such, a number of early maturing crop varieties have been developed and transmitted to farmers through MOFA and other development projects and interventions. The study therefore wanted to ascertain from respondents the extent of adoption of early maturing varieties. As seen in the Table 4.5%, only 20 out of the 300 respondents have adopted planting early maturing crops. The low adoption according to the farmers during a focus group discussion can be attributed to lack of money to purchase seeds. Others argued that they do not have access to them when they need them. Also, private seed companies and vendors should be supported by MOFA and other developmwnt partners such as NGOs to set up outlets and vending points in the various operational areas to ensure easy access, availability and prompt delivery of seed to farmers.

Planting cover crops

Cover crops such as mucuna (Pic 4.3 prevent water run-off and fix nutrients in the soil. As such, MOFA has been educating farmers on the need to adopt it and intercrop it with cereal crops or use it in crop rotation. From the study (Table 4.5) it can be seen that only a few (44) representing 14.6% of the respondents have adopted cover crops. During a focus group discussion respondents shed light on why the adoption of cover crops is low.

"The mucuna is really helping us a lot. If you are able to sacrifice and plant the mucuna and later plant maize, it helps to increase your yield. But the problem is that we are sometimes constrained with land" A 55-year old farmer at Tanpufongsong in the Kasena-Nankana district.

"Mucuna is good. When you plant in your farm it even helps to control weeds. But sometimes the seeds not are easy to get."

The implication is that availability of land and seeds affects the level of adoption of cover crops. This calls for seed producers and companies with vending centers in the various communities to ensure prompt and quick delivery of seeds. Also, private seed companies and vendors should be supported to set up outlets and vending points in the various operational areas to ensure easy access, availability and prompt delivery of seed to farmers. Furthermore, high performing farms can serve as source of seed to other farmers in the various communities hence reducing additional cost of transporting seed from cities to rural areas.

Pic 4.3: A mucuna farm of 55-year old farmer at Tanpufongsong in the Kasena-Nankana district

Crop residue management

After harvesting produce, some farmers usually burn the crop residue to prepare the land for the next planting season. According to research, such type of burning kills soil microrganisms and destroying the surface organic matter.When crop residues are allowed to decay, they release nutrients, which increases the fertility of the soil.Due to the benefits of allowing crop residues to decompose in soils, MOFA has been educating farmers over the years on the usefulness of this practice. The study therefore conducted a survey to establish the extent of adoption of this soil fertility management practice by the farmers through crop residue composting.As can be seen from Table 4.5,the crop residue composting practice was adopted by as low as 1.5%of the respondents. The low rate of adoption is surprising because the technology does not incur extra cost. This compelled the study find out why farmers are not adopting the technology during focus group discussions. Respondents explained as follows:"When you leave the residue at times it makes land preparation difficult". Another respondent also opined " I always tell my family not burn them, but women sometimes gather them and use as firewood"

Mulching

Mulching refers to the practice whereby farmers put grass around plants in order to conserve moisture around the plant. Mulching is one of the very old technologies disseminated MOFA over the past two decades. Due to climate change,farmlands are increasingly becoming dry and there is the need to adopt water conservation mechanisms including mulching. The data in Table 4.5 shows that the practice is not widespread, as only 3% of the respondents adopted mulching.

Row planting

According to MOFA, row planting makes it easy for weeding and other practices such as fertilization to take place. It also allows plants to grow well due to less competition for nutrients between the crops and weeds and less insect infestation. The extent of row planting by the farmers was therefore examined during the study. Table 4.5 shows that 3.3 percent of the respondents adopted row planting. The implication is that the adoption level was poor. In explaining the reasons for the low adoption rate, the respondents argued that the practice is a waste of time. The following view of a 45 year-old farmer in Yagba-Kubori encapsulates the sentiments of the respondents: "I'm farming about 4 acres of land. How can I plant them in row? The most important thing is that you need to make sure that there is enough space in between the crops. We used to do it when we were being supported by a project". This implies that farmers need to be sensitised more on the importance of planting crops in rows, since it appears they will only do it when they are compelled under support projects, probably because they want to benefit from the projects.

Zai

Zai is a technology recently introduced into the country from Burkina Faso, which is used as an effective strategy to conserve both water and nutrients in the soil. It is a land preparation practice whereby farmers dig areas of their farmland where crops are to be planted to about 15 centimetres, and manure put in before crops are planted

(Pic 4.5). As seen in Table 4.5, only 2% of the respondents have adopted Zai. This implies that the technology adoption is not yet widespread. The very low adoption can partially be understood because the technology at the moment is concentrated in the upper East region. During focus group sessions, respondents were asked about their experiences on the use of Zai and why most farmers do not adopt it considering that the practice has several advantages. Some respondents shed light on their experience as:"The practice is very good, but it is labour intensive. It's not easy to dig the small pits especially when you have a large farm.This drudgery is time consuming and energy sapping so most people do not even try it although they know it's beneficial".

"When you do it rainfall cannot wash your manure away, but my family size is small and I cannot mobilize enough labour to support me"

Due to the fact that the practice of Zai is labour intensive, and with scarcity of labour in the rural areas, MOFA and development partners need to assist local artisans to develop the appropriate small farm machinery to aid the construction of Zai.

Pic 4.4: A typical zai constructed by a farmer in the Kasena-Nankana West district

4.5.3 Impacts of SLWM technologies

The study found that the impacts of SLWM technologies on farmers are enormous. The following were captured from respondents during survey and focus group discussions:

- Increased crop yield
- Prevented water and manure run-off on farms
- Provided animal fodder for animal feed,so animals no longer go far in search of food and therefore do not get lost or stolen
- Improved soil fertility due to retention of crop nutrients and erosion prevention leading to moisture retention
- Land is wet, fertile and sustained
- Food security ensuring enough food to feed family than before and suffering is reduced
- Better food nutrition
- Marketable excess food to sell to cater for needs
- Poverty is reduced
- Reduced environmental destruction from strong winds, as trees serve as windbreaks and low incidences of bush fires

During focus group discussions, some of the respondents shed light on their motivation to sustain adoption of SLWM technologies:

"Its the best gift I have received on my farming so far since I started farming. I really appreciate it".

"Mangoes are growing and children will enjoy the fruits, and at the same time yield will increase. So how can I think of stopping"

"It really helps in solving our problem with regards to soil fertility at the area. I will continue since it gives good yield"

The implication is that farmers are appreciating the benefits of SLWM technologies to their livelihood. Therefore, MOFA and its development partners need to look into the challenges hindering them of the technologies in order to enhance adoption.

4.5.4 Summary of Reasons why farmers do not adopt SLWM technologies

The study sought to establish the reasons why farmers do not adopt the SLWM technologies despite proven successes of some of the technologies. The views of respondents captured are:

- Farmers expect immediate benefits from the SLWM technologies
- Poor water availability in some areas affects the adoption of tree growing technologies.
- Complexity of some of the SLWM technologies
- Cost of technologies deters some of the farmers from adopting SLWM
- Farmers perceive writing of proposals to qualify for access to funds serves as a demotivation to some community members.
- Few community members benefit from SLWM support
- Poor timing in accessing inputs and other services
- Processes of selection of beneficiaries for SLWM support is less participatory
- Livestock destroy tree seedlings
- Lack of knowledge about the technologies
- Lack adequate labour
- No added value

4.5.5 Duration of practice of SLWM technologies

The study sought to find out about the duration of practice of SLWM technologies. As seen in Table 4.5, the majority representing 89.7% practiced SLWM for less than 5 years. Only a few of the respondents representing 3.8% practiced SLWM up to 7 years. The finding is not surprising because although SLWM technologies have been in place for over a decade, the subject matter hadnot received much support until recently (GEMP and GSLWMP).

Table 4.5 Duration of practice of technologies

Years	Frequency	Percent
1-2	121	41.7
3-4	139	48
5-6	19	6.5
7-8	7	2.4
Above 9	4	1.4
Total	**290**	**100**

4.6 Capacity of MOFA to Promote SLWM technologies

MOFA is the main government agency supporting agricultural activities in Ghana. Their ability to promote SLWM technologies for improved uptake by farmers depends on their capacity to operate. To assess the capacity of MOFA to perform these functions, the study undertook a survey by administering a questionnaire to MOFA staff. The findings reveal serious capacity gaps, which are contributing greatly to the low adoption level of farmers, and if immediate solutions are not found by the government to address challenges, many of the agriculture programmes risk collapsing.

4.6.1 Personnel and Logistics

Human resources and logistics are key in the running of every organization. Therefore, the study examined whether MOFA has adequate staff to carry out these SLWM activities, as well as the necessary logistics such as vehicles and motorcycles to carry out their extension activities. Table 4.6 presents the personnel and logistics situation of MOFA in the study districts.

Table 4.6: Personnel and logistics study districts

Location	**Number of AEAs**		**Number of Vehicles**		**Number of motorbikes**	
	Required	Available	Required	Available	Required	Available
Northern region						
West Mamprusi	22	8	2	1	16	7
Yagba-Kubori	20	7	2	0	20	5
Upper East						
Bawku West	24	6	2	0	24	5
Kasena-Nankana West	24	7	2	0	24	1
Upper West						
Wa East	17	7	2	0	17	5
Sisala East	15	4	2	0	21	5

As seen in the Table 4.6, MOFA is seriously understaffed, with most districts having less than a quarter of the required staff strength. In the Northern region, only 8 out 22 and 7 out of 20 staff are available in the West Mamprusi and Yagba-Kuboridistricts respectively. Also in the Upper East region only 6 out of 24 and 7 out of 24 personnel required Agricultural Extension Agents (AEAs) were available in the Bawku West and Kasena-Nankana districts respectively. While in the Upper West region only 7 out of 17 and 4 out of 15 AEAs required were available in the Wa East and Sisala East districts respectively to fulfil their mandates.

Analysing Table 4.5 further, it can be seen that in Northern region there was no vehicle in theYagba-Kubori district to undertake their extension activities, while the West Mamprusi district,which is very expansive had one vehicle instead of 2 needed for effective performance of their assignments. In the Upper East Region and Upper West region none of the district surveyed had a working vehicle to be used for work.

The above situation was not too different with regard to the availability of motorcycles, which are used by extension agents to reach out to rural farmers. In the

Northern region, 7 out of 16 and 5 out of 20 motorcycles were available in the West Mamprusi and Yagba-Kuboridistricts respectively. In the Upper East region, 5 out of 24 and 1 out of 24 motorcycles were available in Bawku West and Kasena-Nankana districts respectively. With respect to the Upper West region, 5 out of 17 and 5 out of 21 required motorcycles were available in the Wa East and Sisala East districts respectively.

Some MOFA staff shed further light on the challenges with regard to logistics during key informant intervies as follows:

"As for logistics we don't have to talk about it. Can you imagine that since 2012 our district doesn't have a vehicle? I was on my way to visit some communities with the director to monitor things with the director. The director uses motorbike just like any other staff. The agricultural projects in the districts concentrate more on their staff without little regard for MOFA staff. The decentralization programmeis going to even make matters worse" Deputy district director/SLWM desk officer in Upper East Region

This assertion shows how seriously incapacitated MOFA is in both personnel and logistics,which are critically needed for any effective extension service to occur. The government in collaboration with development partners need to look into this issue in order to immediately provide support to the districts to facilitate effective extension services.

4.6.2 Training gap

MOFA AEAs are supposed to be adequately trained on SLWM technologies in order to effectively impart knowledge to farmers. The review of some secondary data and information from the study team's interaction revealed that some MOFA staff have not received training on the SLWM technologies. On the extent of knowledge of MOFA staff on SLWM technologies, the study found that some of the MOFA staff were not adequately trained on some of the technologies. During key informant interviews, some of the AEAs confessed that they lacked adequate understanding of the technologies they are carrying to farmers. One AEA's narrative is encapsulated in the following:

"One has to be hard working to learn things on your own because some of the things we do are just from our own effort. It puts pressure on supervisors. No proper capacity building for our staff. The other serious thing is that all those who were trained are all gone"- SLWM desk officer in upper East region. This statement by a MoFA AEA indicates that MOFA management needs to always ensure that they provide adequate training for their staff anytime a new technology is being introduced.

4.6.3 Challenges facing the dissemination of SLWM technologies by MoFA

Challenges hindering the implementation and adoption of SLWM technologies include:

- Farmers are impatient to wait for the benefits of the technologies
- The project structure also affects the dissemination of MOFA. This is because MOFA did not have the full mandate to handle the SLWM projects, as the two main SLWM projects (GEMP and GSLWMP) have been managed by MEST.
- Limited provision of materials for SLWM implementation by community members
- Inputs for SLWM technologies from the projects not received on time
- Farmers do not access tractor services on time due to limited tractors and its implements.

5. 0 Conclusions and Policy Recommendations

5.1 Conclusions

The study established that the awareness of SLWM technologies is quite high among respondents. However, there were generally low levels of uptake across all the technologies identified in the three regions of the north. Motivation plays a key role in facilitating farmers' adoption of technology, as farmers with support or access to resources influence their adoption levels.

SLWM technologies are making great impacts on the lives of poor rural farmers through increases in crop yield, prevention of water and manure run-off on farms, reduction in lost of livestock due to readily available feed,conservation of fertility and water, enough food to feed the family, reduction in poverty, increases environmental consciousness, reduction in bushfire destruction, improvement in rainfall among other.

It became clear that only a few people in the communities are benefiting from SLWM technologies. However, SLWM technologies need to be replicated across all farmers in order to scale up the expected results. Some farmers expressed their willingness to adopt SLWM technologies, but complained about the challenge they face regarding limitation of membership of SLWM projects. It is therefore necessary to expand SLWM projects to cover a wider scope.

SLWM is of critical importance because the issue of climate change and climate variability has become a global affair. The smallholder farmers are the worse affected by the adverse effects of climate change. The review of agricultural policy strategies revealed inadequate capturing of SLWM issues, which is critical for its promotion among farmers. For instance, interventions such as AgSSIP, FASDEP I, FASDEP II, as well as METASIP did not sufficiently capture SLWM issues.

Personnel and logistics are key in the successful delivery of technologies. However, the situation of these important requirements was not appealing to the ear, as study observed insufficient AEAs in all the three districts studied. Moreover, basic logistics such as vehicles and motorcycles were seriously insufficient, and this was seriously hindering the activities of extension.

5.2 Policy recommendations

The following policy recommendationsare being proposed for consideration by MOFA and its development partners.

- MOFA with support of Development Partners (DPs) should facilitate the development of a national knowledge database on proven key SLWM technologies, which have achieved results in key agroecological zones across the country.
- SLWM projects should move from pilots to high levels of upscaling in whole communities, since a lot more people have no access to the support of SLWM technologies.
- Major agricultural development projects by both public and private sector should integrate SLWM technologies in their implementation, since SLWM holds a key to future agricultural sustainability.
- MoFA, DPs and the private sector should consider adopting a Public-Private Partnership model in the implementation of SLWM technologies across the country. For instance to ensure availability and easy access to early maturing seed varieties for farmers in the seed sector, PP will give MoFA the facilitative, monitoring and certification role to private seed companies leading to the creation of vendor centers in the communities.
- With the proposed integration of SLWM technologies in all agricultural programmes, MoFA and other agricultural development projects should ensure that all agricultural extension staff are trained in SLWM technologies
- MOFA with support from DPs needs to immediately employ more AEAs and provide basic logistics such as vehicles and motorcycles in order to facilitate extension activities on SLWM technologies. An innovation such as the use of mobile extension service need to employed to reach out to smallholder farmers.

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Appendix 1

Documenting Various Sustainable Land and Water Management (SLWM) Technologies into Forms that can be used for Extension Service Provision: The Northern Ghana experience

Draft Questionnaire for Farmers

Questionnaire No……………………………..……………………………………….

Name of enumerator……………………………………………………………………….

Region/District/Community……………………………………………………………….

Name of respondent……………………………………………………………………….

Section A: Background of Respondent

1. Age……………………..
2. Gender 1. Male [ ] 2. Female [ ]
3. Marital status 1. Married [ ]2. Single [ ] 3. Widowed 4. Divorced [ ] 4. Other…………………...
4. Do you have formal education? 1.Yes [ ] 2.No [ ]
5. If yes, what is your level of education? 1 . Primary [ ] 3 . JHS/Middle [ ]4 . SHS [ ] 5. Tertiary [ ] 6. Arabic school [ ] 7. Others……………………
6. What is your major occupation? 1. Farming [ ] 2. Trader [ ] 3. Artisan [ ] 4. Wage labour [ ] 5. Others, please specify…………………………………
7. What is your household size? 1. Less 3 [ ] 2. 3-5 [ ] 3. 6-8 [ ] 4. 9-12 [ ] 5. Above 12[ ]

Section B: Farming system

8. What type of farming system do you practice? 1. Crops [ ] 2. Livestock [ ] 3. Vegetables [ ] 4. Mixed farming[ ] 5. Aquaculture [ ] 6. Other, specify ………………………………………….

9. What type of crops do you cultivate, average farm size and yield obtained per acre?

Type of crop	**Farm size/acre**	**Total output**		
		2016	**2015**	**2014**
1. Maize				
2. Rice				
3. Groundnut				
4. Sorghum				
5. Cassava				
6. Soybean				
7. Cowpea				
8. Others, specify 9………………………….. 10…………………………. 11…………………………..				

10. What type and number of livestock do you rear?

Type of livestock	**Estimate number reared**		
	2016	**2015**	**2016**
1. Sheep			
2. Goat			
3. Cattle			
4. Pigs			
5. Poultry			
6. Others, specify……… 7……………………….. 8……………………….. 9………………………. 10………………………			

11. What is your source of farm labour 1. Family [ ] 2. Friends [ ] 3. Hired labour [ ] 4. Others, please specify………………………………………..
12. Is your farm produce able to take you year-round? 1. Yes [ ] 2. No [ ]
13. If no, how do you cope when you run out of your food stock?
    ……………………………………………………………………………………
    …………………………………………………………………………………….

Section C: Awareness and uptake level of SLWM

14. Have you heard about SLWM technologies? 1. Yes[ ] 2. No[ ]
15. If yes, what do you know about it?
    ....
    ....

16. Where did you get to know about it? 1. MOFA extension agent [ ] 2. NGOs [ ] 3. Fellow famer [ ] 4. Research institutions [ ]4. Others, please specify…………………………………………………………………….
17. Do you think SLWM technologies are beneficial? 1. Yes [ ] 2. No[ ]
18. Give reasons for your answer in question 17.

    ………………………………………………………………………………

    ……………………………………………………………………………...
19. What types of SLWM technologies do you know?

    1. Planting trees [ ] 2. Bust fire control [ ] 3. Bonding 4. Planting year round green plants [ ]5. Farming across slope 6. Use of compost [ ] 7. Planting drought resistant crops [ ] 8. Fallowing of land [ ] 9. Adhering to weather information advice [ ] 10. Plating early maturing varieties 11. Others,

    specify………………………………………………………………...............
20. Which of the technologies stated in question 19 do you practice?

    ………………………………………………………………………………

    ………………………………………………………………………………

    ………………………………………………………………………………
21. Give reasons:

    a) Why you practice?

    ………………………………………………………………………………

    ……………………………………………………………………………..

    b) Why you do not practice?

    ……………………………………………………………………………
22. Which of the technologies listed in question 20 do you prioritise for use?

    ....

    ....
23. Give reasons why you prioritise technologies listed in question 22.

    ………………………………………………………………………………

    ………………………………………………………………………………
24. How long have you been practicing SLWM technologies? ……………………
25. If you started and stopped, why did you stop?

    ....
26. Do you intend to continue to practice SLWM technologies? 1. Yes [ ] 2. No[ ]
27. Give reasons for your answers in question 26.

    ………………………………………………………………………………

    ………………………………………………………………………………
28. What factors do you think influence your uptake of SLWM technologies? 1. More income 2. Farm size 3. Level of education 4. Exposure 5. Access to information 6. Yield increase 7. Cost reduction 8. Others, please specify

    ……………………………………………………………………....................
29. Do you practice indigenous SLWM technologies? 1. Yes [ ] 2. [ ]

30. If yes in question 29 what are they?

....

....

31. Between the indigenous and modern SLWM which one do you prefer?

    1. Indigenous [ ] 2. Modern [ ]

32. Give reasons for your answer in question 31

    ………………………………………………………………………………

    ………………………………………………………………………………

33. What challenges do you face with regard to the use of SLWM technologies?

    ………………………………………………………………………………

    ……………………………………………………………………………….

34. In your opinion how can SLWM technologies be sustained in your communities?

    ………………………………………………………………………………

    ……………………………………………………………………………….....

Appendix 2

List of enumerators

Region	**District**	**Name of enumerator**
Northern	West Mamprusi	[redacted]
	Mogduri	[redacted]
Upper East	Wa West	[redacted]
	Kasena-Nankana	[redacted]
Upper West	Sisala West	[redacted]
	Wa East	[redacted]

Appendix 3

List of Interviewees

Institution	Name of Interviewee	Schedule
	Northern	
EPA	[redacted]	Regional director
MOFA-Regional directorate		Regional extension officer
MOFA-Mogduri district office	[redacted]	Deputy director and SLWM desk officer
MOFA-West Mamprusi district	[redacted]	Deputy director and SLWM desk officer
IFDC	[redacted]	Progammes director
Organization for Indigenous Initiative and Sustainable Ghana (ORGIIS)	[redacted]	Programmes director
ACDEP	[redacted]	SLWM desk officer
	Upper East	
MOFA-Regional directorate	[redacted]	Ag. Reginal Director of Agric/SLWM desk officer
MOFA-Bawku West district	[redacted] [redacted]	Deputy director and SLWM desk officer District director
West African Science Service Centre on Climate Change Adaptation Land use (WASCAL)	[redacted]	Technical person
EPA	[redacted]	Programmes officer
MOFA-Navrongo Municipal	[redacted]	Deputy director
MOFA-Kasena-Nankana district	[redacted]	Deputy director and SLWM desk officer
Forestry Commission	[redacted]	Assistant Regional director
Wildlife division-Bolga	[redacted]	Assistant director
ORGIIS	[redacted]	Mr.JuliousAwnija
	Upper West Region	
Forestry Commission	[redacted]	Park manager
ProNET-Wa	[redacted]	Programmes director
MOFA-Regional directorate	[redacted]	Regional extension officer
EPA	[redacted]	Regional director