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ASSESSING FARMERS' PERCEPTION AND ADOPTION OF SUSTAINABLE LAND MANAGEMENT PRACTICES IN INTEGRATED LANDSCAPE MANAGEMENT: A CASE STUDY IN TALENSI DISTRICT OF THE GHANA SUSTAINABLE LAND AND WATER MANAGEMENT PROJECT

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ABSTRACT

Since the 1980's, the government of Ghana has implemented various land management projects to address land degradation and improve the livelihoods of people in the Upper East region. Despite these interventions, the Upper East region remains the most degraded and the poorest region in Ghana, partly due to the sectoral approach employed in the implementation of these projects. As a result, the government of Ghana in 2010 adopted the integrated landscape management approach for the Ghana Sustainable Land and Water Management Project. This study aimed to shed light on the socio-economic and ecological impacts of the Ghana Sustainable Land and Water Management Project from the farmers' perspective, and to highlight farmers' reasons for the adopted and non-adopted technologies. The study was conducted in Talensi district, of Upper East region of Ghana. The study sampled 20 farmers from two communities (Yameriga and Pwalugu). Semi-structured interviews were used to collect data from the participants. Enhancement in crop yields and farm incomes, increased women's participation in decision making and women's access to resources, and job opportunities were the socio-economic benefits respondents indicated from the project, whilst soil fertility and soil moisture improvement, reduction in soil erosion, and reduction in number of bushfire cases were the ecological impacts of the project highlighted by the respondents. The respondents generally preferred the agronomic technologies (cereal-legume associations and composting) which have ''short-term returns'' and require less or no annual maintenance labour. Private benefits the respondents perceived to derive from the technologies, and poor farmland conditions appeared to be the reasons why the respondents have adopted some technologies. Limited farmland was the reason the respondents cited for not practicing certain technologies.

Key Words: Farmers' perception, sustainable land management technologies, Ghana

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1. INTRODUCTION

Increasing food production to meet the needs of the growing global population while enhancing landscape ecological functions to optimize the limited land potential is a major problem facing the world currently (Godfray et al. 2010; Motavalli et al. 2013; Mancosu et al. 2015). The problem has become more prominent in Africa, the continent with the fastest growing population in the world, where the livelihoods of most of the population depend directly on agricultural activities and ecosystem services (Hartemink 2007; Liniger et al. 2011; Maisharou et al. 2015). In Ghana, the problem is most pronounced in the savannah agro-ecological zone, particularly in the Upper East Region (Armah et al. 2011; Aniah et al. 2019).

In response to this problem, and the recognized negative effects of land and water degradation on the environment and livelihoods in the Talensi District of Ghana's Upper East Region, the Ghanaian government through the Ghana Sustainable Land and Water Project has been introducing and implementing various land and water management technologies over the past 10 years, with funding from the Global Environment Facility (GEF) (Lovei et al. 2017). A holistic approach to land and water management has been adopted by the Ghana Sustainable Land and Water Management Project to combine soft and physical investments in selected communities to incorporate land and water management practices on communal and farmer-owned plots (Verheijen 2016; Lovei et al. 2017). On the ground, the bottom-up planning approach method has been adopted by the project to engage communities in helping smallholder farmers identify agricultural and environmental related challenges, as well as easy-to-implement land management technologies to address those challenges (Lovei et al. 2017). The project provides input incentives to support the farmers to implement their selected land management technologies on individual farmlands or communal land (Lovei et al. 2017). At the institutional level, the project employs an integrated landscape approach by forming a multi-agency project core team comprised of the Environmental Protection Agency (EPA), the Ministry of Food and Agriculture (MoFA), the Forest Service Division (FSD), and the Wildlife Division; who are responsible for technical execution under the supervision of the Ministry of Environment Science, Technology, and Innovation (MESTI) (Verheijen 2016; Lovei et al. 2017).

The aim of this study was to shed light on the socio-economic and ecological impacts of the Ghana Sustainable Land and Water Management Project (GSLWMP) from the farmers' perspective, and to highlight farmers' reasons for both the adopted and non-adopted technologies. The study is presented in five sections. Section 1 provides the background of the research, the definition of key terms, the problem statement, justification of the study, main and specific objectives, research questions, and contextual framework to allow readers get a better understanding of the topic. The methods employed for the study are outlined in section 2. Section 3 presents the results of the study. The discussion of the results is presented in section 4. Finally, the conclusions of the findings and recommendations on the study are made in section 5.

1.1 Definition of key terms

The concept *Sustainable Land Management* refers to the use of land and water management technologies to optimize the economic and social benefits from the land resources (soil, water, vegetation, and animal) while improving the ecosystem functions of the landscape (FAO 2017).

The concept *Integrated Landscape Management* refers to the multisectoral collaboration among relevant stakeholders to achieve their interests within the landscape through integration and intensification of a mosaic of land management practices to optimize ecosystem functions in the landscape (Scherr et al. 2013).

The term *Perception* is the way things are recognized, regarded, understood, and interpreted by man's cognitive contact with the environment (Qiong 2017). *Farmers' perception* in the context of this study refers to their believes, understanding, opinions, and knowledge.

In the context of this study, the term *Adoption* refers to the acceptance and continuous use of sustainable land management technologies by farmers after project support. While the term *intensity of adoption* refers to the number of different technologies used by a farmer (Mengistu & Assefa 2020).

1.2 Research problem

Understanding the local communities or farmers' perceived socio-economic, and ecological benefits of the Ghana Sustainable Land and Water Management Project interventions as well as the farmers' reasons for adopted and non-adopted technologies is crucial for improving the management of the project and scaling-up the project technologies. However, there are limited empirical studies on the project to bridge this knowledge gaps. The purpose of the study was therefore to increase the understanding of the farmers' perceived impacts of the project interventions, and farmers' reasons for the adopted technologies and non-adopted technologies that the project seeks to promote.

1.3 Justification

Until 2019, when new regions were created in Ghana, the Upper East region was the smallest, most densely populated (number of people per unit land area), and the poorest region in Ghana (Ashaley 2012). The region is characterized by the Guinea and the Sudan savannahs. The climatic condition of the region includes erratic rainfall, floods, and prolonged spells of drought. Agriculture (crop and livestock production) and small-scale mining are the main sources of livelihood for the inhabitants of the region. In such a densely populated region where the inhabitants rely mainly on such a fragile ecosystem for their livelihoods, land and environmental degradation are prominent, posing a serious threat to the sustainability of their livelihoods and the land resources. This has resulted in a rise in poverty levels among the people of Upper East region, and land degradation such as soil fertility decline, soil erosion, siltation of rivers, and desertification (Ashaley 2012). Activities resulting in the fast degradation of the land in the region include continuous farming on one piece of land, bush burning, over grazing, small scale mining, indiscriminate tree felling for charcoal production and fuel wood (Ashaley 2012).

Since the 1980's, the government of Ghana has been implementing various land management projects and programmes to address land degradation and improve the livelihoods of people in the Upper East region (Benneh & Agyepong 1990). Key amongst these projects include; the Ghana Environmental Resource Management Project (GERMP) which was implemented between 1993 and 1998 (World Bank Group 1992), Northern Savannah Biodiversity Conservation Project (NSBCP) implemented from 2002 to 2008 (GEF 2002), Sustainable Land Management for Mitigating Land Degradation, Enhancing

Agricultural Biodiversity and Reducing Poverty Project (SLaM) was implemented between 2004 and 2012 (UNDP 2007), and Ghana Environmental Management Project (GEMP) implemented from 2008 to 2015 (USAID 2017). Despite all these interventions, the Upper East region remains the most degraded and poorest region in Ghana (Ashaley 2012), partly due to the sectoral approach employed in the implementation of these projects, as well as the behaviour and attitude of the farmers (Benneh & Agyepong 1990). Since Ghana Sustainable Land and Water Management Project (GSLWMP) adopted the integrated landscape management approach, this study considered it an ideal project for the case study. Similarly, the Talensi district having benefited from most of the land management projects and located within the White Volta River watershed was also selected for the case study. Though the study was conducted in Yameriga and Pwalugu which are all located within the White Volta River watershed, the outcome of the study could be useful in a broader context.

Information on the impacts the Ghana Sustainable Land and Water Management at the community level might motivate the government and donors to invest more in upscaling and intensifying the adoption of the technologies. Knowledge on SLM technologies adopted by farmers and their reasons for adoption and non-adoption might assist institutions to improve on strategies being used to promote the technologies. The study will also motivate and broaden the knowledge of the researchers to promote the upscaling and intensify the adoption of sustainable land and water management technologies. Finally, the study might contribute to meeting some of the Sustainable Development Goals; such as poverty alleviation (Goal 1), sustainable agriculture and food security (Goal 2), women empowerment and gender equality (Goal 5), climate change mitigation and adaptation (Goal 13), and sustainable use of terrestrial ecosystem (Goal 15).

1.4 Aim and objectives of the study

The main aim of this study was to examine how farmers' in the Talensi district perceived impacts of the Ghana Sustainable Land and Water Management Project interventions as well as the farmers' reasons for both adopting and not adopting the technologies the project seeks to promote.

The specific objectives of the study were:

- To assess the perceived ecological and socio-economic impacts of the Ghana Sustainable Land Water Management Project interventions in Talensi district.
- To examine the adoption of the project technologies in the Talensi district.
- To explore Talensi district farmers' reasons for adopting and not adopting technologies

1.5 Research questions

The following questions were addressed to achieve the objective of the study:

1. What are the socio-economic benefits farmers associate with the project interventions?
2. What are the perceived ecological impacts of the project interventions?
3. What are the technologies adopted by farmers?
4. What is the intensity of adoption of the technologies practiced by farmers?
5. Is gender playing a role in the adoption of the technologies?

6. Are farmers’ perception of ecological problems playing a role in the adoption of the technologies?
7. What are the farmers’ reasons for adoption and non-adoption of the technologies?

1.6 Contextual framework

Despite continuous efforts to spread and intensify land management technologies to address land degradation issues and enhance ecological functions for improvement of ecosystem services that support life on earth, the adoption of the technologies is still alarmingly low (Liniger et al. 2011). The socio-economic, and environmental or ecological benefits that local communities or farmers perceive to derive from land management technologies have been identified as one of the key factors influencing the adoption of the technologies (Moges & Taye 2017). That is, for farmers or local communities to adopt and invest in sustainable land and water management technologies, they must first perceive it as beneficial to their lives. For example, Wairiu (2017) reported that farmers have adopted and invested in lime and mucuna legumes in Pacific Island Countries due to recorded significant increase in their yields. Similarly, some farmers in Kahramanmaras province of Turkey continue to burn their crop residues after harvest despite the negative ecological impacts because they believe burnt fields require less time and labour to cultivate crops (Tatlıdil et al. 2009).

Motavalli et al. (2013) noted that to enhance social acceptability of land management practices, key attention should be given to the differences in local communities’ perceptions, priorities, and demands. Salaisook et al. (2020) emphasised that farmers' preferences, priorities, and opinions, as opposed to resource accessibility and farmer characteristics, heavily influence the adoption and intensification of sustainable land management technologies. For instance, farmers whose cultivated fields are characterized by steep slopes, and obvious soil erosions and decline in soil fertility, adopt and invest in physical sustainable land management practices like stone bunds which require high upfront costs (labour and time) and high maintenance costs every year (Adimassu et al. 2016). Understanding farmers or local communities' awareness of land degradation problems, their priorities and preferences, as well as the perceived benefits of an implemented land management project or programme, is therefore critical for enhancing the adoption and scaling-up land management technologies (Liniger et al. 2011; Mengistu & Assefa 2020).

Sustainable land management practices have many ecological and socio-economic benefits. Various studies, for example, have found that adopting sustainable land management practices and participating in land management projects has reduced soil erosion, increased biodiversity, reduced bushfire cases, improved river catchment protection, improved soil fertility, increased crop yields, reduced conflict over resources, increased women's participation in decision making, and built community institutions (Branca et al. 2013; Motavalli et al. 2013; Almagro et al. 2016; Wairiu 2017; Ebabu et al. 2019; Adam et al. 2020; Salaisook et al. 2020)**.** Key sustainable land management technologies being used by farmers include; not burning crop residues after harvest, minimum tillage, mulching, contour farming, rotations and intercropping with nitrogen fixing crops, compost utilization, and tree growing (Tatlıdil et al. 2009; Adimassu et al. 2016; Dallimer et al. 2018; Zeweld et al. 2018; Salaisook et al. 2020; Kansanga et al. 2021).

2. METHODS

2.1 Study area

The study was carried out in Yameriga and Pwalugu communities in Talensi District of Upper East Region of Ghana (Fig. 1). The two communities are located within the White Volta River watershed.

Talensi District lies between latitudes 10^o 15'N and 10^o 60'N, and between longitudes 0^o 31'W and 1^o 05'W with land area of 838.4 km^2 (GSS 2014). It shares boundaries with the Bolgatanga Municipality and Nabdam District to the north, the East and West Mamprusi Districts (both in the North-East Region) to the south, the Bawku West District to the east, and the Kassena-Nankana East Municipality to the west.

According to the Ghana 2010 population and housing census, the Talensi district had a population of about 81,200 comprising of 49% males and 51% females (GSS 2014). Approximately 96% of the households in the district were engaged in crop cultivation (GSS 2014).

The vegetation is Guinea Savannah, characterised by low density woodland of drought and fire resistant short, sparse trees with ground flora of perennial grasses such as *Andropogon gayanus*, and bare to severely eroded rocky land. Shea (*Vitellaria paradoxa*), locust (‘dawadawa’) (*Parkia biglobosa*), kapok (*Ceiba pentandra*), and baobab (*Adansonia digitata*) are the most prevalent economic trees in the district (GSS 2014).

The district has gentle slopes ranging from 1^o to 5^o gradient with some scattered rock-outcrop formations on the range of hills referred to as Tongo hills which have upland slopes of about 10^o (GSS 2014). The soil of the district is mostly produced by granite rock, characterized by shallow and poor soil fertility, and largely coarse in texture. The district is drained by the White Volta and its tributaries.

The climatic regime of the district is semi-arid characterised by minimum temperature of 12^oC in December and maximum temperature of 45^oC in March and April, and a mono-modal erratic rainy season lasting from approximately May to October, and dry season that extends from October to April (GSS 2014). The district's average annual rainfall is 95 mm, with a range of 88mm to 110 mm.

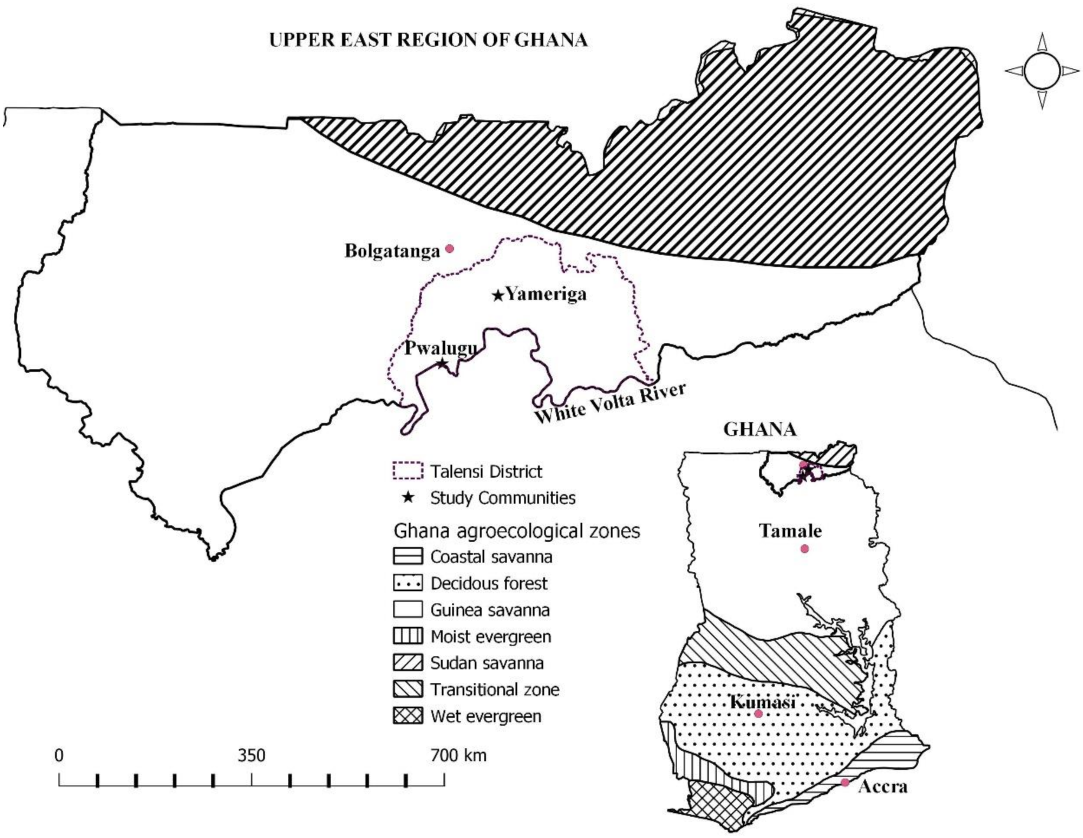

Figure 1. Map of Upper East Region of Ghana showing the Talensi District, and the Guinea and Sudan Savannah Ecological Zone. (Source: Modified from Dickson and Benneh, 1995).

2.2 Research design

The study adopted a qualitative research approach. It was employed to describe and attempt to understand the participants' perspectives through their knowledge, behaviour, believes, and opinions (Mack et al. 2005). This method was employed for this study because it focuses on seeking deeper understanding of the aspect of reality such as perceptions, behaviours and attitudes that cannot be easily quantified (Queirós et al. 2017).

2.3 Research sample and data collection

The study sampled 20 farmers from two communities, Yameriga and Pwalugu, in the Talensi district. This is the number of interviews that was considered realistic given the time and resource constraints. The two communities were selected based on their active participation in the Ghana Sustainable Land and Water Management Project. The sampling frame was all the farmers who participated in the project in the two communities. To achieve gender representativeness of the sample, the sampling was stratified using the gender of the farmers. Five (5) males and five (5) females were then sampled from each community.

Semi-structured interviews were conducted with the selected participants to collect the data. The goal of this research approach is to acquire a diverse range of perspectives on the research topic. This method provides flexibility when it comes to probing answers. It is perfect for gathering information on people's knowledge, experiences, and perspectives (Mack et al. 2005).

The interview questions were prepared in English. The interviews, however, were conducted in the local language (Gurenne) of the participants by three officers from the Environmental Protection Agency of the Upper East Regional Office, and one officer from the Talensi District Department of Agriculture. The interviewers wrote the responses of the participants on a separate sheet of paper as well as recording the responses with audio recorders. Photographs of various land management technologies being implemented by the farmers in the two communities were also taken by the interviewers using digital camera. Coordinates of the two communities were taken using hand-held global positioning system (GPS). The field activities (the interviews, photos and GPS coordinates taken) in the two communities were carried out on the 8th, 9th, 12th, and 13th of July 2021. All the 20 famers (10 males and 10 females) interviewed were easily identified and consented to the interview. The interviewers were able to take photos of all the fields of the respondents in the Yameriga community, but photos of only one respondent's field in the Pwalugu community were taken due to far distances of their fields from the community and time constraint.

2.4 Data analysis

The audio recordings were transcribed and compared to the interviewers' field writings. This harmonisation was done to guarantee the reliability of the responses. Upward coding was used to code the data, which means that all common responses were allocated to one attribute, and specific level of themes based on the research questions were given as follows: 1) perceived ecological impacts of the project, 2) socio-economic impacts farmers associate to the project, 3) technologies adopted by the farmers, and 4) intensity of adoption of the technologies. The data was analysed using a descriptive statistic and supported with quotations from the farmers. The research results are presented in tables, with means and frequencies used to discuss the findings.

2.5 Ethical considerations

Ethical concerns are critical in all research. However, due to the in-depth interview of qualitative research process, applications of appropriate ethical standards become more salient (Arifin 2018). The researcher's and interviewers' cultural competency, self-awareness of ethical issues in research, and collaborative commitment to the participants are critical for vigilant ethical conduct in qualitative research (Ponterotto 2010). The study therefore ensured that officers assisting in the data collections were well versed in the cultural and traditional values in the study area. To balance the potential ethical risks and the benefits of the study, particular attention was given to the flexibility of the interview process, informed consent, voluntary participation, and anonymity.

3. RESULTS

3.1 Demographic background of respondents

Table 1 below presents the demographic characteristics of the respondents. The average age of the respondents is 46.5 years while the minimum and maximum age of the respondents are 31 and 70 years, respectively. Out of the 20 farmers interviewed from the two communities (Yameriga and Pwalugu), 10 were males and 10 were females. The majority (14) of the respondents had been farming during their entire working age and have had no formal education. Two (2) of the respondents had basic education and four (4) had middle school/J.H.S education, however, farming has been their main occupation.

There is one major farming season in the area, which is the main rainy season (July – September). The major crops cultivated by farmers in the area are cereals, legumes, and vegetables. The cereals include sorghum (*Sorghum bicolor*), maize (*Zea mays*), and millet (*Panicum miliaceum*), while the legumes include groundnut (*Arachis hypogaea*), cowpea (*Vigna unguiculata*), and soybean (*Glycine max*). The vegetables include tomato (*Solanum lycopersicum*), pepper (*Capsicum*), and okra (*Abelmoschus esculentus*). All the men (10) interviewed owned their cultivated lands while the women (10) were non-owner of their cultivated lands. According to culture and traditions of the area, lands are owned by the men, however, women may have user right on either family land or their husbands' land. Six (6) of the women indicated they were farming on their husbands' land, while the remaining four (4) were widows, farming on the land of their late husbands.

Table 1. Respondents' demographic characteristics.

Respondents' demographic characteristics	**Frequency**
Age (years)	
31 – 40	6
41 – 50	8
>51	6
Average age = 47 years	
Sex	
Male	10
Female	10
Education	
Non- formal	14
Basic	2
Middle school/ J. H. S	4
Farming experience (years)	
< 10	6
10 – 20	9
21 – 30	2
31 – 40	3
Land ownership status	
Owner of farmland	10
Non-owner of land	10

3.2 Farmers' perceived ecological problems

Each of the 20 farmers interviewed mentioned low yields, pests, and overgrazing by nomadic herdsmen as some of their farming problems (Table 2). Soil fertility decline was also mentioned by the majority (18) of the respondents as a problem on their cultivated lands. Bushfire was identified by 16 of the respondents as one of their ecological problems. While all the 10 respondents from Yameriga community perceived soil erosion as a problem on their cultivated land, only two (2) farmers from Pwalugu community perceived soil as a problem. A female farmer from Yameriga emphasised that "*due to the stony and slopy nature of our land here, the topsoil is washed away"*. Extinction of plants species was the ecological problem mentioned by the fewest number of respondents, only four (4), aged between 53 to 70 years mentioned it as problem. Although rainstorm and drought/erratic rainfall are more of a climatic problem than ecological problem, all the 20 farmers mentioned these when asked of their major ecological problems.

Table 2. Farmers perceived ecological problems in Talensi District.

Perceived ecological problems	Frequency
Soil erosion	12
Bushfires	16
Drying up of water bodies	15
Low/poor crop yields	20
Soil fertility decline	18
Low livestock feed	10
Extinction of plants/animals	4
Increased bare patches of land	15
Diseases/pests to crops	20
Overgrazing	20
Drought/Erratic rainfall	20
Rainstorm	20

3.3 Perceived ecological impacts of GSLWMP interventions

All the 20 farmers (Table 3) interviewed believe the Ghana Sustainable Land and Water Management Project (GSLWMP) has contributed to soil fertility improvement on their cultivated land. A higher number (18) of the respondents mentioned that there has been significant reduction of bushfire cases because of the GSLWMP. A farmer from Yameriga community stated that:

> *Aside the sensitisation and awareness raising on bushfires, the GSLWMP has formed well trained fire volunteer squad to control wildfire from nearby communities, so we have not been experiencing bushfires in this community for the past five years.*

Majority (15) of the respondents mentioned increase soil moisture as another impact they have realised from the implementation of the GSLWP technologies. All the farmers (10) interviewed from Yameriga community emphasised that the implementation of technologies like stone bund has significantly reduced soil erosions on their fields.

Table 3. Farmers' perception of the ecological impacts of GSLWMP interventions in Talensi.

Perceived ecological impacts of project interventions	Frequency
Biodiversity enhancement (plants and animals' species)	13
Increase soil moisture	15
Reduction in rate of indiscriminate tree felling	9
Reduction in number of bushfire cases	18
Reduced soil erosion	13
Enhanced protection of river catchment	12
Improvement in soil fertility on farm	20

3.4 Socio-economic benefits farmers derived from GSLWMP interventions

Table 4 below presents the socio-economic benefits farmers have realised from the GSLWMP interventions. Each of the farmers interviewed was quick to mention that because of the project, their crop yields and farm incomes have enhanced. Emphasising this benefit one farmer said that:

> *I have learned better ways of farming such as strip cropping, compost preparation and utilisation, cereal-legume rotation which improve crop yield. Any time I sell my surplus food produce, I earn income which supports my children's schooling.*

Most of the women interviewed pointed out that due to non-burning of the shea-nut trees, their shea-butter production work they do during the farming off-season is sustainable now because of availability of the shea-nuts. One of the farmers stated that:

> *Because of the annual burning of our shea-nut trees has stopped for some years now, we collect a lot of shea-nuts now than before which is boosting our shea-butter production and improving our income.*

Almost all the farmers (19) interviewed said the project has created job opportunities in the area. One of the respondents noted that:

> *In addition to the sensitization and the technologies introduced, the project also supported us with ploughing services, and inputs such as improved seeds, and tree seedlings. This encouraged many people particularly the youth to involve in farming and has stopped most of them from migrating to the Southern part of Ghana*.

Women's involvement in decision making and equal access to project resources (farm inputs) were the benefits each of the women interviewed pointed out. One of the women stated that:

> *We women were unable to compete with the men in affording ploughing services and farm inputs, but the project ploughed for everyone and gave us input too. I was also a member of the community watershed management committee.*

Some of the farmers also mentioned availability of livestock feed (grass and shrubs) as a benefit, which they believe is because of the non-bush burning. One of the farmers highlighted this benefit stating that *"with no bushfires in this community, trees, shrubs, and grasses are growing well so our livestock do not go far places in search of feed, and risk being stolen".*

On how the project has influenced their lives as participants, majority of the farmers (16) indicated that sensitisation and demonstration programmes have enhanced their knowledge in good farming practices. One famer for instance stated that:

> *We inherited the stone bunds from our parents because our land is full of stones, however, the project has taught us how to use 'A-frame level' for determining the contours to shape the stone bunds*.

Another important socio-economic benefit most of the farmers mentioned was the availability of special grass locally called ‘thatch’ which the local inhabitants use to roof their houses. One of the farmers, for instance, explained that:

> *Also, through SLWMP fire management techniques such as fire belt creation, fires don’t burn away our local grass called ‘thatch’ which we harvest for roofing our homes if one cannot afford to buy roofing sheets.*

Table 4. Socio-economic benefits famers associate to GSLWMP interventions in Talensi.

Socio-economic impacts	**Frequency**
Enhances crop yield and farm income	20
Reduces conflict over resources (water, forest)	8
Build community institutions (WSM committee for resource conservation)	13
Increased women’s participation in decision making	16
Enhanced livestock feed (grass, fodder)	11
Provision of potable water (borehole and well)	11
Create job opportunity	19

3.5 SLWM technologies adopted by farmers

Table 5 shows sustainable land and water management technologies practiced by the farmers. Interestingly, all the farmers interviewed mentioned compost preparation and utilisation, cereal-legume rotation, cereal-legume strip cropping, tree growing/agroforestry, and fire management as one of the technologies they are practicing (Figure 2). However, during the photograph taking of some of the practices on the farmers’ fields by the interviewers, they observed that most of the trees planted by the farmers are around their houses.


Figure 2. Agroforestry field at Yameriga (left). Five-year-old eucalyptus tree plantation at Yameriga (right). (Photos: R. Pondorh, 8 July 2021).

Pits or furrow around plants/crops (Zai pits) was mentioned by 15 of the respondents as one of their favourite technologies (Figure 3). All the 10 farmers interviewed from Yameriga stated they are practicing earth/stone bunding, and only four (4) from Pwalugu indicated that they practice earth/stone bunding (Figure 3). Fodder bank establishment, and land rotation were the technologies least practiced by the farmers.

 

Figure 3. Stone bunded field at Yameriga (left). A farmer digging ‘zai’ pits for planting at Yameriga (right). (Photos: R. Pondorh, 8 July 2021).

On why they prefer these technologies, most of them indicated that the compost utilisation, cereal-legume rotation, cereal-legume strip cropping enhance the fertility of the soil and increase crop yields. For instance, a female farmer stated that:

> *Composting and cereal-legume rotation have increased my yields; I do not need to buy inorganic fertilizers which are normally expensive and not environmentally friendly.*

She further explained that:

> *Sometimes I pay nomadic herdsman to keep his cattle on my farm during dry season and move them away at planting season; the cattle droppings improve the fertility of my land and increase my yields.*

Similarly, another farmer indicated that:

> *I am practicing cereal-legume rotation, cereal-legume strip cropping, and composting because they give me good yields.*

Almost all the farmers interviewed indicated that trees serve as wind break that protect their buildings against heavy rainstorms. For example, one of the famers explained that:

> *Tree planting beautifies the environment and serve us wind breaks and it helps because Pwalugu is always very windy during the beginning of the rainy seasons.*

Similarly, another farmer stated that:

> *The tree planting also has several importance including serving as windbreaks, food/fruit trees, and shade.*

Some of the farmers also mentioned that they are practicing the farm management techniques because grasses their livestock feed on, and those they use to roof their local houses, grow well without bushfires. The farmers practicing the stone/earth bunding noted that they cannot do away with the technology because it is very effective in controlling soil erosion and retaining water in the soil. A farmer stated that:

> *For us here in Yameriga, as you can see it around yourself, every farmer here is doing stone bunding that is the only way we can retain water in the soil considering the sloppy nature of our lands*.

The reason farmers gave for not establishing fodder banks and practicing land rotation was limited cultivated land. Interestingly, a 52-year-old male farmer pointed out that he does not practice cereal-legume intercrop because it does not give him good yields. The farmer noted that *"I do not practice cereal-legume intercrop because, it does not give me the same level of yield as strip cropping or legume-cereal rotation gives me".*

With regards to how farming in the area will be like in the future, 11 of the respondents mentioned that with the technologies they are practicing, there will be good yields in future as it is now. Four (4) of the respondents simply said they did not know how the farming will be like in the future. Five (5) of the respondents also said the farming could be good and even better if they manage the land well but could also be bad if the land is not properly managed.

Table 5. GSLWMP technologies practiced by farmers in Talensi District.

SLM technologies practiced	**Frequency**
Compost preparation and utilization	20
Cereal-legume rotation	15
Cereal-legume intercrop/mix	19
Cereal-legume strip cropping	20
Tree growing/Agroforestry	20
Fodder bank establishment	3
Fire management techniques	20
Land rotation or improved fallowing	2
Earth/stone bunding	14
Pits or furrow around plants/crops (Zai pits)	15

3.6 Distributions of intensity of adoption of sustainable land management technologies

Each of the 20 farmers interviewed is practicing at least a combination of six (6) out of the 10 technologies the Ghana Sustainable Land and Water Management Project introduced on their farmlands (Table 6). Only one farmer (male) from Yameriga is practicing a combination of all ten technologies on his farmland. On average, the farmers interviewed are practicing a combination of seven (7) out of the 10 technologies on an average land of 4.81 acres.

Table 6. Distributions of intensity of adoption of GSLWMP technologies in Talensi.

Intensity (number) of adoption of SLM technologies	**Frequency**	**Males**	**Females**
6	4	1	3
7	7	5	2
8	7	3	4
9	1	0	1
10	1	1	0

4. DISCUSSION

This discussion presents the synthesis of the results based on the research questions. The section is organised by stating the research question and synthesizing the results to address the stated question.

What are the socio-economic benefits farmers associate to the project interventions?

With regards to socio-economic benefits, farmers associate to GSLWMP interventions, the responses suggest the GSLWMP has contributed to increase in yields of the respondents. This finding supports the claim by Branca et al. (2013) and Wairiu (2017) that implementation of sustainable land management technologies increases yields of farmers. Since the subsistence of the local communities depends largely on their annual crop yields, this finding is encouraging because it will motivate farmers to invest in those technologies they believe are contributing to the increase in the yield and sustain their continuous use. Increased women's participation in decision making was another important benefit the respondents acknowledged. This is an interesting finding considering the tradition and cultural values as well as the differentiated roles men and women play in the area. This implies that sustainable land management might contribute to women's empowerment, and shape gender roles towards increased gender equality as suggested by Doss and Morris (2001). It also appears that the project support (inputs and the ploughing services) has established most of the respondents in farming and minimised rural urban migration.

What are the perceived ecological impacts of the project interventions?

The perceived ecological impacts of the GSLWMP interventions by the respondents were presented in Table 3. It appears there were variations in responses of the two communities in terms of the ecological benefits they have perceived from the project. That is, while famers in Yameriga community emphasised that reduction in soil erosion is a key ecological impact of the project interventions, the farmers in Pwalugu community seemed silent on this impact. It therefore appears that the land conditions or the landscape characterises of the farms are playing a major role in farmers' perceived impacts of the interventions as reported by Adimassu et al. (2016). That is, farmers who apply SLM technologies on more degraded land conditions are more likely to perceive the benefits of the interventions than those who apply it on less degraded lands. This finding should, however, be interpreted with caution, because the Yameriga community appears to be more active in farming and depend largely on the land for their livelihoods, if not their responses might have been different. This implies that if GSLWMP or similar projects target communities who are into active farming and with poor land conditions, the farmers are likely to succeed in promoting the adoption of the technologies because the farmers might see the impacts of the project and invest in the technologies.

What are the technologies adopted by farmers?

The responses suggest that most of the respondents are practicing the agronomic technologies (cereal-legume associations and composting) which have ”short-term returns” and require little or no annual maintenance labour as reported by Adimassu et al. (2016) and Dallimer et al. (2018). However, it seems the respondents who prioritise farming as an important component of their livelihoods had, in addition to the agronomic practices adopted the physical SLM technologies (stone/earth bunding). This finding supports assertions by Adimassu et al. (2016) and Salaisook et al. (2020) that farmers who prioritise farming and consider it as an important component of their livelihoods might invest their time and resources in physical SLM technologies. This implies that the respondents' major livelihood activities play a key role in the adoption of SLM technologies. That is, local communities who are actively engaged in farming would like to optimise the productivity of their farmland and are likely to accept and adopt new SLM technologies. Contrary to Adimassu et al. (2016) assertion that ''long-term return'' SLM practices like tree growing are less adopted by farmers, the responses from the interviews appear to differ, as it appears tree growing is highly practiced by the respondents. However, it was observed that most of these trees were planted around homes not on their farmlands, per se. This could be explained by the perceived benefits from trees (windbreaks and shade) the respondents sought to derive from the trees. This implies that it is not the "long-term return" that is the reason for less adoption of tree growing but rather the benefits the farmers perceived to derive from the trees. Therefore, if farmers are well sensitised on the ecological benefits of trees to land fertility improvement and are introduced to trees that would enhance the productivity of their crops, the farmers are likely to adopt the tree growing practice on their farmlands.

What are the farmers' reasons for the technologies adopted and non-adopted technologies?

With regards to the respondents' reasons for practicing the agronomic technologies (cereal-legume associations and composting), it appears they have adopted those technologies because they believed they enhance the fertility of their farmlands and contribute to increasing yields in short time, as suggested by Wairiu (2017). Similarly, the respondents indicated that they were growing trees because trees serve as wind breaks, provide shade and fruits. These outcomes imply that for farmers to adopt any land management technology, they should first perceive it as beneficial to their livelihoods. For the respondents practicing physical SLM technologies (stone/earth bunds) they believe that, because of the sloping nature of their fields, it is nearly impossible to farm without the bunds. This finding agrees with the assertion of Adimassu et al. (2016) that farmers whose fields are characterised by slopes and obvious soil erosion adopt physical SLM technologies. On the other hand, limited farmlands appear to be a reason for the inability of some of the respondents to practice some technologies like cereal-legume rotation and fodder bank establishment. This result also agrees with Adimassu et al. (2016), who asserted that farm plot size affect the adoption of SLM practices. This implies that when farmers are introduced to several technologies, they are likely not to adopt all the technologies but prioritise the technologies they perceived to be beneficial. Generally, most of the reasons for the adoption of the technologies concerned the respondents' opinions, believes, priorities, and farm conditions.

Are farmers perceived ecological problems playing a role in the adoption and intensity of adoption of the technologies?

When the respondents practicing only the agronomic technologies (cereal - legume crop association) were compared to the respondents practicing both the physical SLM technologies (stone/earth bund) and the agronomic practices, it appears they differed only in terms of their land conditions. That is, the respondents who indicated that their fields are sloping, and hence are at risk of soil erosion, seem to practice both the physical and the agronomic technologies. This outcome corresponds to the assertion of Salaisook et al.

(2020), that farmers with sloping and obvious soil erosion-prone lands appear to adopt physical SLM technologies. With regards to tree growing, it appears the respondents opted to grow trees to serve as wind breaks and shade for their compounds.

What is the intensity of adoption of the technologies practiced by farmers?

The responses suggest that each of the respondents is practicing a combination of at least six (6) of the technologies. This result suggests that farmers might adopt SLM technologies in combination to maximise their perceived benefits as emphasised by Zeweld et al. (2018). This outcome is encouraging as it seems to suggest that the integrated landscape management approach adopted by the GSSLMP is effective. This outcome supports the assertion of Adimassu et al. (2016) that adoption of sustainable land management technologies relies greatly on effective collaboration of relevant institution to provide technical supports to the farmers. When the intensity of adoption of the respondents that have formal education was compared with those with non-formal education, it appeared there was no variation.

Is gender playing a role in the adoption of the technologies?

When the number of female respondents practicing both the agronomic SLM technologies and the physical technologies were compared with the male respondents practicing both technologies, it appears there was not much variation between the males and females. Similarly, in terms of intensity of adoption, it seems there is not much variation between the male and female respondents. This could be attributed to the active involvement of women in the decision making, and women's' increased access to resources as stated by this female respondent:

> *We women were unable to compete with the men in affording ploughing services and farm inputs, but the project ploughed for everyone and gave us input too. I was also a member of the community watershed management committee.*

This implies that if women are actively involved in land management decision making and are given equal access to resources as the men, gender will not play a role in the adoption of sustainable land management technologies as emphasised by Doss and Morris (2001)**,** Nyasimi and Huyer (2017), and Zeweld et al. (2018)**.**

5. CONCLUSION AND RECOMMENDATIONS

The main objective of this study was to examine farmers' perceived impacts of the Ghana Sustainable Land and Water Management Project interventions as well as the farmers' reasons for the adopted technologies and non-adopted technologies that the project seeks to promote in Talensi District, Upper East region of Ghana. The findings shows that the farmers interviewed recognised both the socio-economic and ecological impacts of the project. With regards to the socio-economic impacts, the following key impacts were attributed to the project by the respondents; enhancement in crop yields and farm incomes, increased women's participation in decision making and women's access to resources and job opportunities. On the ecological impacts, the respondents highlighted soil fertility and soil moisture improvement, reduction in soil erosion, and reduction in number of bushfire cases.

It has been highlighted by this study that the farmers interviewed generally preferred the agronomic technologies (cereal-legume associations and composting) which have ‘‘short-term returns’’ and require less, or no annual maintenance labour as emphasised by Adimassu et al. (2016) and Dallimer et al. (2018)**.** It has been noted from the findings that respondents who perceived that their farmlands were more degraded particularly with obvious soil erosions, and prioritised farming as an important component of their livelihoods appear to adopt physical SLM technologies such as stone/earth bunding and zai as emphasised by Adimassu et al. (2016) and Salaisook et al. (2020). The study noted that the long-term return is not the reason for less adoption of tree growing on farmlands but rather the private benefits the farmers perceived to derive from the trees. Generally, most of the reasons for the adoption of the technologies concerned the respondents’ opinions, believes, priorities, and farmland conditions.

With regards to the intensity of adoption of the technologies, the study shows that each of the respondents is practicing a combination of at least six (6) of the technologies. This finding corroborates the effectiveness of integrated landscape management approach employed by the GSLWMP as emphasised by Zeweld et al. (2018).

It has been noted from the results of the study that the Ghana Sustainable Land and Water Management Project has made some contributions to the Sustainable development Goals such as sustainable agriculture and food security (Goal 2), women empowerment and gender equality (Goal 5), and climate change mitigation and adaptation (Goal 13).

This study has also highlighted that if women are actively involved in land management decision making and are given equal access to resources as the men, gender will not play a role in the adoption of sustainable land management technologies as emphasised by Doss and Morris (2001)**,** Nyasimi and Huyer (2017), and Zeweld et al. (2018)**.** This finding supports Doss and Morris (2001)**,** Nyasimi and Huyer (2017), and Zeweld et al. (2018) claims that sustainable land management promotes women empowerment and bridge gender gaps.

The following recommendations are proposed based on the findings of this study:

1. It has been observed from this study that farmers and communities who rely heavily on farming for their livelihoods and are into active farming with poor land conditions, invest their time and resources in SLM technologies and are ready to learn new methods to improve their productivity. Such communities and farmers should be targeted and considered in the implementation of land management and restoration projects.

2. Since this study has shown that long-term return is not the reason for less adoption of tree growing on farmlands but rather the private benefits the farmers perceived to derive from the trees, farmers should be well educated on the ecological benefits of trees to land fertility improvement and be introduced to trees that would enhance the productivity of their crops.

3. The integrated landscape approach employed by the Ghana Sustainable Land and Water Management Project appears to be effective according to the findings of this study and should be employed by similar projects.

4. Considering the socio-economic impact GSLWMP has made in the study area, there is the need to upscale the project to cover more communities and farmers.

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APPENDICES

Appendix I

Interview guide

Introductory Remarks

I am …………………………………………………………………. a research assistant collecting data on behalf of Emmanuel who is in Iceland for GRO - Land Restoration Training programme and therefore not here to do the research himself, I will send him the data from this interview. He is conducting research on ***farmers' perception and adoption of sustainable land management practices in integrated landscape management: a case study of Ghana sustainable land and water management project, Talensi District, Ghana****. You have been identified to as a key stakeholder as a farmer to provide me with information to accomplish this study. This is therefore to request you to provide information by answering these questions and the information provided to me will be kept anonymous and will be used for this research.*

Background and Socio demographic characteristics

1. Name of Community:
2. What is your age? 18-20☐ 21-30☐ 31-40☐ 41-50☐ 51 and above☐
3. Gender? Male☐ Female☐
4. Marital Status? Single☐ Married☐ Divorced☐ Widow/widower ☐
5. What is your level of education?
6. How long have you been farming?
7. Do you own or rent your cultivated land?

Perception on Ghana Sustainable Land and Water Management Project

8. How were you involved in the Ghana Sustainable Land and Water Management Project?
9. How has the Ghana Sustainable Land and Water Management Project influenced you as a participant?
10. How has the Ghana Sustainable Land and Water Management Project influenced this community?

Adoption of GSLWMP technologies (or knowledge)

11. What were the technologies (or knowledge) introduced by the project?
12. Which of the technologies (or knowledge) are you using on your cultivated land?
13. On how many acres of land are you using this/these technology/ies?
14. Why do you prefer the technologies (s) you are using on your cultivated land?
15. Why are you not using other technologies on your cultivated land?

16. What are the major ecological/environmental problems in this community/cultivated land?
17. What do you think farming on your cultivated land will be like in 15 years?
18. What do you think the environment (vegetation, streams/rivers, fauna) will be like in 15 years?

Appendix II

Acronyms / Abbreviations

EPA	-	Environmental Protection Agency
FSD	-	Forest Service Division
GEF	-	Global Environment Facility
GEMP	-	Ghana Environmental Management Project
GERMP	-	Ghana Environmental Resource Management Project
GPS	-	Global Positioning System
GSLWMP	-	Ghana Sustainable Land and Water Management Project
MESTI	-	Ministry of Environment Science, Technology, and Innovation
MoFA	-	Ministry of Food and Agriculture
NSBCP	-	Northern Savannah Biodiversity Conservation Project
SLaM	-	Sustainable Land Management for Mitigating Land Degradation, Enhancing Agricultural Biodiversity and Reducing Poverty Project
SLM	-	Sustainable Land Management