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Research Article

Indigenous knowledge systems for land condition assessment and sustainable land management in the Talensi District, Ghana

Latif Iddrisu Nasare[1], Latifa Abdul Rahman[2], Francis Diawuo Darko[3*]

[1] Department of Environment and Sustainability Sciences, University for Development Studies, Tamale, Ghana
[2] Department of Forestry and Forest Resources Management, University for Development Studies, Tamale, Ghana
[3] College of Humanities, Arts and Social Sciences, Flinders University, Adelaide, Australia

[*]corresponding author: dark0018@flinders.edu.au

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Abstract

The quest for sustainable land management has led to the development of modern technologies for land condition assessment and management, but these approaches have often failed in rural contexts due to their high complexity and incompatibility with the socio-economic conditions of land users. Although indigenous systems are known to be accessible, compatible, and economically affordable for rural farmers, less is known about indigenous technologies for the assessment of the land condition and sustainable land management. The present study identified indigenous indicators for the assessment of land degradation and examined indigenous practices for sustainable land management in the Talensi district of the Upper East region of Ghana. The study employed a qualitative approach in which interviews were conducted with sixty farmers in three selected communities of the Talensi district. Generally, land degradation was observed by respondents in the form of soil degradation or loss of vegetative cover. Among indigenous indicators of land degradation, soil erosion emerged as the most frequent indicator (75%), while the proliferation of mining pits (10%) was the least observed indicator. Indigenous practices for sustainable land management in the district include stone bunding, contour ploughing and zero tillage. The most used soil fertility improvement practice identified was crop rotation (47%) while the application of compost/manure occurred as the least (18%) practice. The study recommends that the Ministry of Food and Agriculture incorporate indigenous knowledge and technologies into land management programmes.

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Introduction

Land degradation has emerged as a global threat that directly affects agricultural productivity and livelihoods (Wang et al., 2020). Degradation is caused by a variety of ecological processes, which can result in irreversible loss of cropland, forest cover, or a state of desertification that requires human intervention to recover (Reynolds et al., 2011). Although land degradation occurs in many terrestrial biomes around the world, the impact of degradation is most severe in developing countries that rely heavily on natural resources and land-based livelihoods for survival (Nkonya et al., 2016; Ayuk et al., 2017). In developing countries, the rural poor rely on the land for food, fibre, and other ecosystem goods (Nachtergaele et al., 2010), therefore land degradation has both direct and indirect impacts on human welfare. Hence, the Sustainable Development Goals of the United Nations- SDG-15 seek to protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, stop and reverse land degradation and halt biodiversity loss (Gupta and Vegelin, 2016).

In Ghana, crop productivity is estimated to be on the decline due to the prevalence of erosion and depletion of soil nutrients (Ayuk et al., 2017). Land degradation is prevalent in the Upper East region of Ghana, which coincidentally is among the poorest regions of the country (Adwubi et al., 2009; Ashaley, 2012). Previous studies have demonstrated the impact of erosion on soil health and the siltation of water bodies in the Talensi district due to anthropogenic disturbances (Adwubi et al., 2009). This has been exacerbated by illegal gold mining activities in some parts of the district (Ashaley, 2012). These activities have reduced the capacity of the land to support plant and animal biota in an area already constrained by topography and climate (Issahaku et al., 2016; Fagariba et al., 2018). The prevalence of land degradation in the Talensi district has necessitated efforts to restore degraded lands for enhanced crop production and biodiversity conservation. This has led to the introduction of many externally funded sustainable land management projects, including the Farmer-Managed Natural Regeneration (FMNR) project by World Vision (Amenuveve, 2019), and the Sustainable Land and Water Resources Management Project (World Bank, 2014).

Land condition assessment is a prerequisite for the implementation of land management interventions. These diagnoses have often relied on modern technologies such as laboratory testing of soil properties, Land use and Landcover change detection using Geographic Information Systems (GIS), and remote sensing techniques, vegetation inventory among others (Al-Quraishi et al., 2004; Reed et al., 2008). Aside from the limitations of their diagnostic accuracies (Stringer and Reed, 2007; Tittonel, 2013), diagnostic results are complex and cannot be interpreted by rural people. This makes them prohibitively expensive and incompatible with farmers' sociocultural beliefs. Although land degradation is a physical process, there is a need to understand the institutional, socioeconomic, political, and cultural contexts of the land user for sustainable land management (Kusimi and Yiran, 2011; Tittonel, 2013). It is therefore essential to identify existing indigenous knowledge systems available for communities to realise their capacity to monitor and respond to land degradation challenges (Stringer and Reed, 2007; Kusimi and Yiran, 2011). Available evidence demonstrates the integration of indigenous knowledge systems with scientific knowledge helps in developing sustainable natural resource management practices that are compatible with the local environment (Stringer and Reed, 2007; Reed et al., 2008; Hessel et al., 2009; Kusimi and Yiran, 2011; Imoro et al., 2021). This study assessed indigenous knowledge systems for the assessment of land conditions and sustainable land management in the Talensi district. The study specifically identified indigenous indicators used in assessing land degradation and examined indigenous technologies used in sustainable land use management. This study consisted of five sections. After the introductory section, a brief review of literature on indigenous knowledge and sustainable land management is presented in Section 2. Section 3 presents a description of the study area and methods used for the study, Sections 4 and 5 comprise the findings and discussion and conclusion, respectively.

Indigenous knowledge systems and sustainable land management practices

Indigenous Knowledge System (IKS) refers to the knowledge and knowledge systems associated with a particular culture that is acquired by native people through a combination of experiences, informal experimentation, and intimate knowledge of the culture's environment. This type of knowledge is also referred to as local knowledge, folk knowledge, people's knowledge, traditional wisdom, and traditional science (Senanayake, 2006). Unlike the modern scientific knowledge system (MSKS), which is based entirely on scientific research and can only be acquired through well-executed academic research, IKS serves as the foundation upon which local communities make well-being-related decisions (Tharakan, 2017). The use of indigenous knowledge covers a wide range of people’s lives including utilisation and management of natural resources, agriculture, health care, and education (Tharakan, 2017). Many aid projects face difficulties in implementing new technologies, resulting in limited success stories, due to the introduction of new technologies that are incompatible with the indigenous knowledge and techniques of the targeted group. Indigenous knowledge is essential to sustainable development on a local level and, therefore, critical to be incorporated into the decision-making process of small-scale farmers.

Traditional agricultural practices evolved from human adaptation to the production conditions of their environment, such as land degradation. Several practices have been used by indigenous people to cope with the changing land characteristics, which, to date, continue to support land management and development. For instance, farmers have over the years intercropped many species of crops on a piece of land instantaneously. Intercropping is a very productive way of enhancing land quality (Hu et al., 2017) because crop species have varied adaptations to climatic conditions eliminating total crop failure (Hosen et al., 2020). Intercropping with legumes improves soil’s physical and chemical properties (Singh and Singh, 2017; Daryanto et al., 2020). Another indigenous technology for sustainable land management is crop rotation. It is a historical practice of times past that involves the cultivation of different crops on the same piece of land in alternating patterns (Dury et al., 2012). Crop rotation is important in sustainable land management systems since it boosts soil fertility and breaks pest and disease cycles that reduce pathogen burden. Legumes in crop rotation systems also contribute to nitrogen fixation as well as soil moisture conservation (Imoro et al., 2021).

Agroforestry is yet another indigenous practice for sustainable land management among local communities. The planting of trees together with crops and animals is a historic agricultural practice among indigenous communities where multipurpose trees of medicinal and economic importance are retained and managed on croplands for positive interactions between different components (Nair et al., 2010). In contemporary terms, agroforestry is a climate-smart practice with the potential to increase crop productivity and mitigate climate change (Coulibaly et al., 2017). In the global south, rural people in regions of Sub-Saharan Africa have over time used agroforestry to sustain agricultural productivity and livelihoods (Meijer et al., 2015). In Central and West Africa, cocoa agroforestry is an old technique to combine forest components with crops to sustain food systems and improve soil fertility (Imoro et al., 2021). In Ghana, cashew agroforestry is also gaining ground as a viable economic activity among women (Diawuo et al., 2019). Considering the value of indigenous knowledge systems in the development of sustainable land and livelihoods, its incorporation into the production of agricultural knowledge needs to be rapid. It remains that the importance of IKS to the growth and survival of communities cannot be overstated, as it is critical to developing the capacity of communities to address their challenges sustainably.

Materials and Methods

Study area

The research was conducted in the Talensi District of Upper East Region, Ghana (Figure 1). The district lies between latitude 10º15' and 10º60' North of the equator and longitude 0º31' and 1º05' West of the Greenwich meridian, with a land area of 838.4 km^2. The population of the district is 81,194 representing 7.8% of the total population of the Upper East region. The district is known to be agrarian with an estimated 90.7% of the population engaged in agriculture. Agriculture is generally characterised by the cultivation of annual crops and the rearing of animals on subsistence basis. The topography of the area is characterised by isolated rocky outcrops and highland slopes with relatively undulating lowlands that are gently sloped.

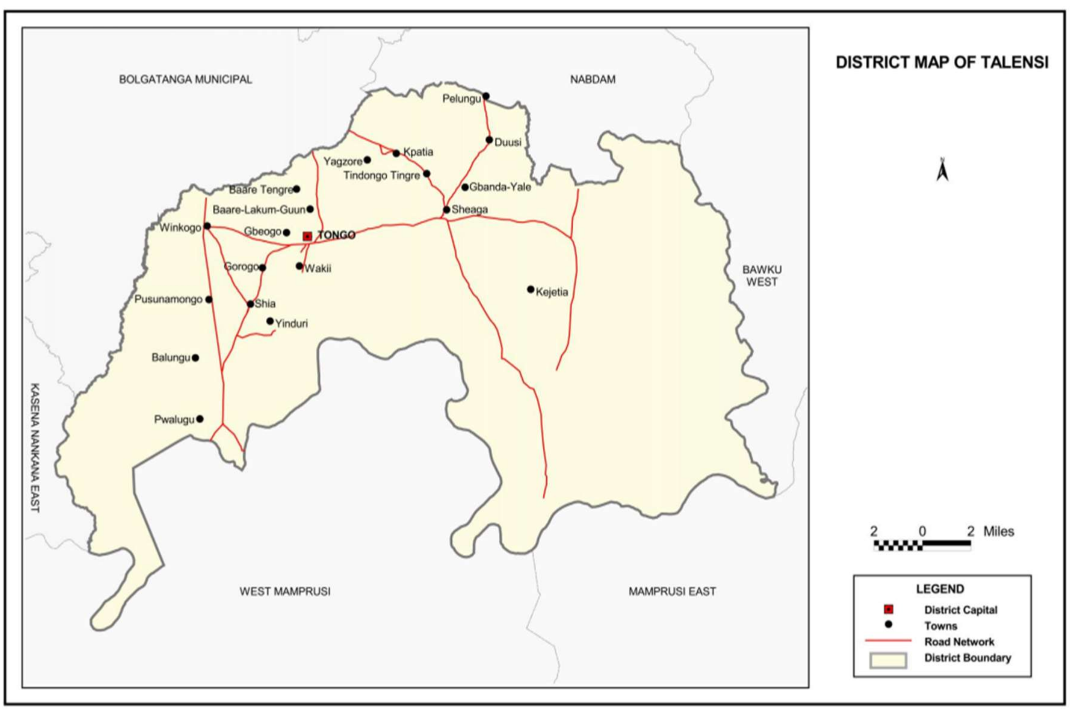

Figure 1. Map of Talensi District. Source: GSS (2014).

The soils are primarily composed of granite rocks characterised by shallow soils with low levels of organic matter. However, sandy loam soils occur in valleys and low land areas. The district lies within the Guinea Savannah woodland characterised by sparse short deciduous trees dotted within grass-dominant landscapes. Common tree species in the area include *Vitellaria paradoxa* (Shea), *Parkia biglobosa*

(Dawadawa), *Adansonia digitata* (Baobab) and *Faidherbia albida* (Acacia), among others (GSS, 2014). The area records an average annual rainfall of 950 mm per annum with a single maximum rainfall pattern where rains are recorded from May to October. Mean monthly temperatures range from 12 to 45 ºC.

The Talensi District is located in northern Ghana's environmentally vulnerable dryland area where climate change and rapid population growth, have gradually eroded livelihood security and increased the vulnerability of the population to poverty. Mean annual rainfall has decreased in recent decades coupled with reduced forest cover and soil fertility. This sometimes results in regional food shortages but, over the years, the people have used indigenous land management practices to adapt to depleting arable land conditions. This makes the district a good case for studying indigenous knowledge-based systems for sustainable land management.

Research design

The study employed an exploratory research design to enable the attainment of new insights and the discovery of new ideas (Hair et al., 2003). The use of this design was to explore knowledge, indicators of land degradation, and sustainable land management practices in the Talensi district. The exploratory design allowed for full interaction with the study participants. Purposive sampling was used to select three communities, Zoog, Wuug, and Goriko for the study. Additionally, sixty respondents were purposively selected to collect information-rich, quality, and reliable data. The participants were selected via snowballing with the help of community leaders. The study focused on farmers who are 50 years and older and had lived in the area for not less than 30 years. The age limit allowed the study to engage with local people capable of giving an in-depth explanation of environmental and land degradation incidents in the area (Kusimi and Yiran, 2011). In other words, the age limit helped to select participants who could comparatively explain the observed environmental changes over the past 30 years. According to Bryman (2012), purposive sampling focuses on the selection of participants with adequate knowledge and understanding of the objectives of the study.

A semi-structured interview was used to collect data on the farmers' knowledge and indicators of land degradation and management. The interview questionnaire was categorised into two sections: section A and section B. Section A collected information on participants' demographic and land use characteristics such as educational background, agricultural land-use systems, number of years of farming, and the type of crops cultivated. Section B focused in asking the farmers about indigenous indicators of land degradation and practices for sustainable land management. The Nvivo qualitative data analysis software was used to thematically analyse the field data collected. Thematic analysis is necessary for identifying, analysing, and reporting patterns in information (Braun and Clarke, 2006). The identified themes were put in tables and the percentage of frequencies developed. The analysed data were presented mainly in tables and textually with quotations.

Results

The majority (53%) of the respondents were males, and more than half (67%) of all responding households were headed by males (Table 1). Among male respondents, two-thirds (72.5%) were household heads, but only 27.5% of female respondents were household heads. Respondents had varying household sizes, but the dominant household size ranged from 11 to 15 people. In terms of education, 80% of respondents had no formal education while 20% had some level of formal education. The marital status of respondents revealed, 83% were married, 13% were widowed, and 2% were either divorced or never married. The results revealed a common agricultural land use system in which all respondents combined crop production with animal rearing.

Table 1. Demographic characteristics of respondents.

Variable	**Frequency**	**Percentage (%)**
Sex		
Male	32	53
Female	28	47
Total	60	100
Household Size		
1-5	10	16.7
6-10	16	26.7
11-15	26	43.3
>15	8	13.3
Total	60	100
Household Headship		
Yes	40	66.7 (Males- 72.5; Females- 27.5)
No	20	33.3 (Males- 15; Females- 85)

The crops cultivated in the area include maize, millet, sorghum, rice, soya bean, groundnut, Bambara groundnut, and pepper. Cattle, sheep, goats, and poultry were the most common animals reared by farmers.

Indigenous knowledge systems for land condition assessment

All respondents answered affirmatively that the conditions of the land on which they farm have changed over the past 30 years. The occurrence of soil erosion was the most widely used indicator of land degradation, whereas the proliferation of mining pits is the least used indicator for the assessment of land degradation (Table 2).

Table 2. Indicators and causes of land degradation.

Land Degradation Indicator	Causes
Soil Erosion	High rainfall intensity, ploughing along the slope
Bare Land	Overgrazing, deforestation, bush burning
Low soil fertility	Continuous cropping
Proliferation of Mining Pits	Indiscriminate mining activities, mining on agricultural lands

Interviews with the respondents revealed that soil erosion is mainly caused by high intensity of rainfall and ploughing along slopes. It was found that a small incidence of rainfall washes away the topsoil due to the lack of vegetation cover. According to a 65-year-old maize farmer, soil erosion is the worst form of land degradation.

> *Over the past few years, we have experienced dry spells and high intensities of rainfall. Although it does not rain as often and at the time as we want it, when it does rain it is very intense and it washes away the nutrient parts of the soil. This happens because of the little vegetation cover of the land. Sometimes the runoff is so severe that my crops get washed away.*

Another observed indicator of land degradation is bare land. Respondents indicated that most of the areas in their communities have little vegetation cover mainly due to overgrazing, deforestation, and bushfires. Land degradation as evidenced in bare lands was agreed to be largely driven by activities such as bush fires, felling of trees, charcoal production, and unsustainable farming practices. Although the people admitted that their land is savannah grassland with trees sparsely spread across, the few trees have been felled indiscriminately for fuel and other uses (Table 4). *The main tree crop in the area, the shea tree, has been identified as a good material for charcoal production, hence people have just been cutting them down*, this is the experience of a respondent who has observed the loss of tree cover.

Continuous cropping on the same piece of land for several years without allowing the land to naturally rejuvenate and loss of nutrients leads to soil infertility. The study revealed that the nature of the soils in terms of fertility is not the same as what it used to be some 30 or more years ago, and unsustainable farming practices were mentioned as one key cause of this change. A 71-year-old respondent revealed that:

> *Growing up shifting cultivation was the best farming practice. When we farmed on a piece of land for two years, the land was left alone to become bushy again so that it could regain the loss of nutrients. It was the case that when we returned to that farmland after several years, it was always healthy. However, the case is not the same today. Farmers can farm on a piece of land for more than 5 years and when they see that nutrients in the soil are exhausted, they turn to the use of fertilisers.*

Moreover, another observed cause of land degradation in the study area was identified as activities of small-scale mining by individuals.

Indigenous technologies for sustainable land management

Soil erosion

Having identified the land degradation indicators, the study sought to investigate the available local technologies farmers employ for sustainable land management in the district. Stone bunding, contour ploughing/farming, and zero tillage were the dominant indigenous practices used by farmers to mitigate soil erosion (Table 3).

Table 3. Indigenous practices to mitigate soil erosion.

Indigenous SLM Practices	Respondents (%)
Stone Bunding	60
Contour Ploughing	26
Zero Tillage	14
Total	100

Bare land

Indigenous practices used by farmers to mitigate the loss of vegetation that leads to bare land include reforestation, avoiding indiscriminate tree felling, and preventing bushfires. The regulation of indiscriminate tree felling for wood and charcoal (45%) was the most mentioned strategy for protecting the vegetative cover of the land, while the reforestation of the bare land areas was the least mentioned (25%) (Table 4).

Soil fertility improvement practices

The study identified three (3) soil fertility management practices carried out by farmers to improve soil fertility at the farm level. Crop rotation is the most predominant practice (47%), while composting / application of animal droppings was the least practiced (18%) (Table 5).

Table 4. Indigenous practices for mitigating the prevalence of bare land areas.

SLM Practice	Respondents (%)
Reforestation	25
Regulate indiscriminate felling of trees	45
Prevention of bush fires	30
Total	100

Table 5. Indigenous practices for improving soil fertility.

Soil Improvement Practice	Respondents (%)
Crop Rotation	47
Multiple Cropping	35
Compost/Manure	18
Total	100

The study found that farmers alternate the crops they plant on the farmlands every planting season. When asked why, a 65-year-old woman replied in an interview that *"it helps the soil to regain the strength it lost. Last year during the planting season, we cultivated Guinea corn on a two-acre field, but this year we will plant only beans and other vegetables. That is what my parents and those before them did. It is very helpful"*. Across the communities, crop rotation was widely practiced.

Another practice for improving soil fertility is multiple cropping, otherwise known as intercropping. Farmers intercropped different crops on the same piece of land in the same planting season. Sharing the experience of his family, an elderly man, 78-year-old farmer alluded that planting multiple crops on the same land at the same time saves them a lot of stress.

> *When we make the mounds for the planting of yam, we plant vegetables such as pepper, okro, tomatoes, and beans around the mounds. Since these are early maturing plants, we are able to harvest them early to consume. When there is plentiful harvest, we sell some in the local market. Aside from economic benefits, planting beans on the land with Guinea corn, millet, or maize helps in the growth of nutrients.*

Proliferation of mining pits

Recently, small-scale mining has gained roots in the district, with some illegal small-scale miners leaving traces of unfilled pits. The practice degrades arable lands. Most farmers (75%) indicated that they protect their lands from this practice by preventing illegal mining on their lands. This is done through fighting off illegal miners from the land and submitting petitions to the chiefs in their communities. Those whose lands have already been degraded by mining, backfill mine pits with the hope that the land will recover over time (Table 6).

Table 6. Strategies to address the proliferation of mining pits.

SLM Practice	Respondents (%)
Backfilling of pits with soil	25
Protect farmlands against mining activities	75
Total	100

Discussion

The study found that the majority (53%) of the respondents were males. This is because men are mainly the household heads and major decision-makers in the district, including agricultural-related decisions. This confirms Mensah and Fosu-Mensah (2020) assertion that land preparation and management are male-dominated activities in semi-arid regions of Ghana. The people of Talensi District practice a patrilineal system of inheritance where women can only make claims of farmland through their husbands. The few female-headed households recorded may be as result of the demise or migration of their husbands or the absence of a responsible male adult in the household. Gebre et al. (2021) reported a similar situation in Ethiopia, with a relatively low number of female-headed households. Larger household sizes recorded in this study are an important revelation as large household sizes lead to land fragmentation. Although the large size of the household was not reported by respondents as a possible cause of land degradation, when the size of the household is large, it triggers continuous cropping resulting in land degradation. Kusimi and Yiran (2011) reported that increased pressure on farmlands emanating from the increased population might result in continuous cropping, a precursor of land degradation.

The study revealed that all the respondents combined crop production with animal rearing. This finding is consistent with earlier studies that described farming in the Upper East region as agro-pastoral (Eguavon, 2013; Yembilah and Grant, 2014). The crops cultivated by respondents include maize, millet, sorghum, rice, soya bean, groundnut, Bambara beans, and pepper. All these are traditional crops commonly cultivated in the Upper East region (Villamor and Badmos, 2016). Respondents reared animals such as cattle, sheep, goats, and poultry. These animals are among those common to the Upper East region (Mensah and Fosu-Mensah, 2020).

Indigenous knowledge indicators of land degradation

All the respondents agreed that the quality of land has changed negatively over the last 30 years. Generally, land degradation assessment indicators in the three (3) communities are broadly classified as soil degradation and vegetation/tree depletion. The study revealed soil erosion, low soil fertility, the proliferation of mining pits, and bare lands as the key indigenous indicators of land degradation. A similar study by Kusimi and Yiran (2011) also identified soil degradation and depletion of trees and vegetative cover as the two broad indicators of land degradation in the Bawku East district of the Upper East region, Ghana. The majority (75%) of respondents identified soil erosion as the most crucial land degradation indicator, followed by deforestation (35%). Erosion was also attributed to high rainfall in some seasons where run-off creates gullies on the land.

In addition, bush burning and indiscriminate felling of trees for charcoal production were identified as the causes of vegetation loss leading to the prevalence of bare land areas. Farmers used the prevalence of bare land spots within the landscape as an indicator of land degradation. Indigenous people use the amount of vegetation on the land as a measure of soil functionality. Therefore, bare lands indicate the soil is not capable of supporting plant life hence a degraded state. The proliferation of mining pits as an indicator of land degradation confirms Baddianaah et al. (2022), who reported that illegal mining has become ubiquitous in the Ghanaian community and destroying environmental resources such as land and water due to weakened state regulatory institutions on mining. This finding is consistent with the findings of the World Wildlife Fund (2020) that mining operations, smallholder farming, the felling of trees for commercial purposes, and fuelwood are the main drivers of vegetation loss in Ghana. More than half (67%) of the respondents reported that grazing lands had been specially reduced over the past three decades due to mining and other land use practices. Respondents also indicated that the proliferation of mining pits had reduced the quality of grazing land.

Indigenous practices for sustainable land management

The majority of the farmers (60%) using stone bunding as an erosion control practice confirms earlier assertions that stone bunding is a common technique widely used in controlling soil erosion in West Africa (FarmingFirst.org, 2012). Stone bunds slow water movement, hence allowing water to infiltrate into the soil and spread uniformly over the land. The slowing down of water also allows for a proper build-up of soil layers (FarmingFirst.org, 2012). The application of stone bunding in experimental fields in Ethiopia significantly reduced soil erosion (Gebremichael et al., 2006), demonstrating the efficacy of the practice.

Zero tillage, identified as a sustainable land management practice in this study, has also been reported as an effective soil conservation technique known for the provision of sustained platforms that create soil-water-biological units with close resemblance of natural ecosystems (Gellatly et al., 2011). Zero tillage or no-till farming involves the deliberate practice of leaving residues of harvested crops on the soil surface without any soil disturbance or tillage before planting. Zero tillage improves soil health and reduces the cost of labour in tillage (Creech, 2021). Additionally, ploughing across the slope or contour ploughing identified in this study has previously been reported as an effective way of controlling soil erosion and run-off (Gilley, 2005). The findings of the study suggest that the indigenous land management practices used by farmers in Talensi are similar to those previously reported in other parts of northern Ghana (Osumanu et al., 2016; Peprah, 2018).

Furthermore, three (3) soil fertility improvement practices were identified in the district. All respondents indicated they undertake some form of soil fertility improvement either through crop rotation, multiple cropping or application of compost/animal droppings. Farmers indicated these practices help to avoid soil depletion emanating from continuous cropping since there are no fallow lands to be cleared for new farms anymore. This is contrary to Kusimi and Yiran (2011), who reported that continuous cropping was rampant among farmers in the Bawku East district. The contrasting views in the findings of the two studies could be as a result of differences in study districts and differences in age groups targeted for both studies. Kusimi and Yiran (2011) interviewed farmers aged 35 years and over, while the focus of this study was on farmers aged 50 years and above. Meanwhile, Tenagyei and Osumanu (2021) reported crop rotation to be widely used practice among indigenous farmers in the Upper West Region (UWR) of Ghana. Again, some farmers resort to the application of compost or manure in their bid to improve soil fertility. Zhang et al. (2020) showed that the application of manure, especially from cattle, increase the activities of soil fauna which enhances soil structure. The findings indicate that the production of compost is expensive and difficult, making it the least preferred sustainable land management strategy. This agrees with the findings of Tenagyei and Osumanu (2021) in north-west Ghana, where local farmers cited the high cost of compost production as the reason for the low application. Uzoh et al. (2019) reported that the inclusion of legumes in crop rotation, especially with maize enhances soil nitrogen for maize production.

Conclusion

Land degradation continues to be a major challenge to rural livelihoods in sub-Saharan Africa. Meanwhile, opportunities exist in local agricultural land management practices to reduce the problem and sustain food production. The study sought to investigate indigenous indicators of land degradation and sustainable land management practices used in the Talensi district. The study identified soil erosion, loss of vegetation cover/bare land, the proliferation of mining pits, and low soil fertility as indigenous indicators of land degradation. Adoption of stone bunding, contour ploughing, zero tillage, backfilling of mining pits, and reforestation were recorded as the predominant strategies to mitigate land degradation.

Also, to improve soil fertility, farmers practice crop rotation, multiple cropping, and application of compost/manure. The adoption of these historical farming practices implies that farmers have wealth of indigenous knowledge to assess land conditions for sustainable land management. The findings add to existing evidence in Ghana and across Africa about the wealth of indigenous knowledge and practices that could be integrated into modern practices to fight land degradation in fragile environments. We recommend that local government authorities, Environmental based NGOs, and the Ministry of Food and Agriculture integrates this indigenous knowledge and practice into their programmes for sustainable land management.

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