British Journal of Environmental Studies
ISSN: 000-0000
DOI: 10.32996/bjes
Journal Homepage: www.al-kindipublisher.com/index.php/bjes

BJES
AL-KINDI CENTER FOR RESEARCH AND DEVELOPMENT

| RESEARCH ARTICLE

Agricultural and Extension Education for Sustainability Approach

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| ABSTRACT
The study analyzed the emerging land rights and the extent of the relationship between agricultural and extension education and soil conservation practices. A survey of 376 household heads randomly sampled respondents was administered using a well-structured questionnaire. Results from correlation analysis revealed that the relationship between "agricultural and extension education" and the soil conservation variables "mulching, zero tillage, and the use of crop residues or household refuse" was positive, moderate in strength, and statistically significant. However, the relationship between "agricultural and extension education" and "slash and burn agriculture" was negative, moderate in strength, and statistically significant. The results from the linear probability model show that the coefficients of "Agricultural and Extension education" are statistically significant at a 1% level of significance for all the model specifications except the case where "organic fertilizer" is used as the dependent variable. Specifically, the results indicate that Agricultural and Extension education increases the probability of farmers practising mulching, use of crop or household residues, and zero tillage by 59.4, 16.1, and 33.6 percentage points, respectively. Also, Agricultural and Extension Education decreases the probability of farmers practising slash and burn agriculture by about 16.2 percentage points. Agricultural and Extension education increases the probability of farmers practising at least two of the soil conservations by 25 percentage points, while it increases the probability of farmers practising at least three of those soil conservations by 5.5 percentage points. Based on the results, we propose the Agricultural and Extension Education for Sustainability approach. This approach consists of knowledge, skills, motivation, awareness, concern, responsibility, and action. Therefore, policies geared towards agricultural and extension services should be highly prioritized.

| KEYWORDS

Agricultural and extension education, land tenure system, soil conservation, land investment, sustainability.

| ARTICLE DOI: 10.32996/bjes.2022.2.1.2

1. Introduction

Development often aims at providing greater freedom, opportunity, and improved well-being to humanity by increasing access and availability to services such as food, water, energy, transportation, and economic opportunities (George, 2019; Sen, 2014). However, in the drive to meet legitimate consumption demands, long-term impacts on the economy, human populations, health, and ecological systems are often overlooked or inadequately considered (Adu, Puthenkalam, & Antwi, 2021; Puthenkalam, 2013).

Agricultural-led and industrial-led growth theories and their relationship with the environment have led to human-induced environmental change, causing 29% of total carbon dioxide emission, according to the IPCC (2019). An expansion on the interplay of agricultural-led and industrial-centred theories and their relationship with the environment has resulted in land degradation, therefore casting doubts on sustainable development. Despite the increase in environmental awareness, land degradation continues to deny farmers improved well-being.

The implementation of the various development theories seems to have a piece of inimical news for agricultural sustainability (Otsuka & Place, 2014). Farmers have instead, being left in extreme poverty, while the implementation of these agricultural-led and industrial-centred theories had little for agricultural development leading to land degradation, high rural poverty, and these threaten prospects, thereby casting doubts on sustainable development. As a result of the human desire to develop, the land surface has been modified to meet the constant developmental needs; these human activities have affected over 70% of the ice-free land surface globally (Arneth et al., 2019).

Lands in Ghana are characterized by a dual overlapping legal system, namely, customary and statutory systems. But the most lands are held informally under the customary land tenure systems. The dual legal system could be traced back to 1894 when the Aborigine's Rights Protection Society came into existence in Ghana to resist the Crown Lands Bill from the British that sought to take over the land and mineral rights from the indigenous people (Anaafo, 2015). The result is the dual legal system and administration of land in the country. The existing land-tenure system is known to be a breeder of land degradation, hence the need to analyze the emerging land rights and the relationship between agricultural and extension education and soil conservation practices (Walmsley, Azadi, Tomeckova, & Sklenicka, 2020).

Due to the limits to climate change mitigation and adaptation, a possible way to achieve agricultural sustainability from the agricultural and environmental point of view could be through agricultural and extension education. An appreciable environmental knowledge among the older and younger generations has been recorded (Adu et al., 2021). It is expected that farmers employ the best agronomic practice to ensure environmental sustainability. Despite the increase in environmental awareness, farmers continue to achieve lower yields per hectare, while bottlenecks imposed by the existing land-tenure system also impede agricultural development (Anderson, Bayer, & Edwards, 2020). It is in this light that a sustainability approach to agricultural development is paramount. This paper, besides analyzing the emerging land rights to save and restore degraded land to achieve sustainability, an analysis of agricultural and extension education provided by the Ministry of Food and Agriculture as a form of environmental education and its relationship with soil conservation practices are also analyzed.

The rest of the paper is organized as follows; section 2 explains the evolution of agricultural-led theories of development beginning from the 1950s to the present. It continues with a further review of the conceptual and theoretical foundation of population, the land tenure system, agricultural intensification, and land degradation. The section ends with literature on agricultural and extension education for sustainable development. Sections 3 and 4 looks at the methodology, results, and discussions.

2. Literature Review

2.1 Evolution of agricultural-led theories of development

2.1.1 Agricultural development of the 1950s to 1970s

Farming, the backbone of the rural communities/economy globally, has undergone a series of development processes since the 1950s. The development of the new and modern industrial sector at the expense of traditional agriculture saw the latter sector with negligible prospects for increased productivity. It played a passive role in the entire process of economic growth and development (Kalantari, Tahir, Joni, & Aminuldin, 2018; Ranis, 2012). The modernization of the industrial sector was envisaged to include large plantation commercial farms besides the manufacturing sector. Large farms were believed to be much higher in productivity than small-scale native farms due to the efficient use of resources and modern technologies. Thus, large-scale agriculture enjoys economies of scale in agriculture (Adamopoulos & Restuccia, 2014).

Smallholder farmers started receiving recognition for their significant role in the economic growth and development of a country in the 1960s through the publications of Schultz (1964), especially in his book entitled "Transforming Traditional Agriculture." Thus, the first move was to recognize the small-scale farmer as a stakeholder in the economic development in the early to mid-1960s (Diao, McMillan, & Rodrik, 2019). The researches established the relationship between agriculture and non-agriculture and how agricultural growth serves as a source of income and livelihood. Other benefits from this sector include foreign exchange earnings, serving as labor and capital resources for the industrial sector.

Firstly, the linkage between agricultural, rural, and urban economies was given importance (Ahmed, Asghar, Malik, & Nawaz, 2020). The size distribution of farms and the uni-model lessons from Africa, Latin America, and East Asia later became a concern (Adamopoulos & Restuccia, 2014). Higher productivity from smallholder farmers is considered a step to poverty alleviation and structural transformation (Rada & Fuglie, 2019). Secondly, smallholder farmers were recognized as being able to achieve higher productivity than large-scale farmers. During that time, the inverse relationship between farm size and productivity per hectare was widely observed, as observed today in most developing countries (Rada & Fuglie, 2019). The inverse relationship between farm size and productivity indicates that small farms are more efficient than large farms. Such a relationship was found in Asia and shows not only inefficiency but also inequity of land allocation as land is not transferred from large, wealthy, and inefficient farmers to small, weak, and efficient farmers (Larson, Muraoka, & Otsuka, 2016). The inverse relationship became stronger because smaller farmers relied mainly on family labor, which was in abundance during the 1970s (Otsuka & Larson, 2015). Therefore, they had a comparative advantage over larger farms, which depended on hired labor and other expensive machinery. High monitoring costs associated with hired labor in the spatially agricultural environment increased the expenses of large-scale farmers, whiles small farmers succeeded irrespective of the high price of fertilizer and improved seeds(Takahashi, 2017). There were no scale economies in agriculture in the 1970s, even for those large farmers (Tomich, Kilby, & Johnston, 2018). Furthermore, Schultz pushed for a new revolution in the agricultural sector, which could propel higher productivity through technological change. They stressed the need to have educated rural workers to help achieve higher productivity and improve well-being.

2.1.2 The "second agricultural paradigm shift" of the 1970s to 1990s

As part of the second attempt to get the agricultural sector developed and expanded, the theories and patterns of the structural change model became known and gained ground in the 1970s. The second paradigm shift was initially designed to guide the development of the industrial sector but, Hayami and Ruttan (1970) argued for a shift away from "industrial fundamentalism" to emphasize growth related to agricultural production in the economic development of a country in the 1970s. In making an argument for the induced-innovation hypothesis, they argued that developed nations relied on technologies that reflect the relative resource scarcities and market prices in the labor-abundant agricultural economy (Boianovsky, 2018). Given this, an attempt to develop agriculture in developing countries requires a deliberate innovation in this sector. They called for a shift from the traditional methods in farming to the application of science and technology.

During this period, development partners in developing countries shifted attention to integrated rural development projects (Williams & Karen, 2019). With the focus on the rural poor, much of the investment was made in the provision of credit, financing agricultural research and extension services, provision of water resources, roads, education, and health sectors (Stads & Sène, 2019). The approach had three aims viz: ensuring an increase in income for improved livelihood, increasing access to public social service, and promoting inclusiveness of affected people in the implementation and formulation of development strategies, policies, and programs. This initiative resulted in massive food production, poverty reduction, and increased economic growth (Mirzabaev et al., 2015).

The success of the green revolution in Asia was not without a high use of pesticides and chemical fertilizers. The nitrogen component of the fertilizer played an essential role in the success story, but this component is the primary environmental pollutant. Lakes and water pollution from leached fertilizers depletes oxygen in the water bodies causing a depletion of fish species and larger invertebrates (Canter, 2019).

The second 'paradigm shift' that occurred in the 1980s and 1990s changed rural development from a top-down to a more community-based participatory approach that seeks to empower rural folks to take their destiny into their own hands (Snapp, DeDecker, & Davis, 2019). There was an increasing acknowledgement for the inclusion of indigenous technical knowledge and the necessity to build the ability of the poor to contribute to finding solutions to their challenges (Puthenkalam, 2016). The coming on board of a participatory approach to agricultural development gave rise to other forms of participation such as rapid participatory appraisal (RPA), participatory rural appraisal (PRA), and the participatory learning and action (PLA) techniques in the 1990s (Swathi Lekshmi & Vipinkumar, 2013).

The Structural Adjustment Program (SAP) introduced by the Bretton Woods institutions saw a massive withdrawal of government interventions from large-scale state management and administration of the agricultural sector and the diversification of state enterprises. The agricultural sector suffered from the removal of subsidies on agricultural inputs; farmers could no longer buy fertilizers and other farming inputs (Weeks, 2016). Land degradation became evident as farmers could no longer afford to replenish the lost nutrient through fertilizer usage or make other forms of land investment to save the degraded land (Reed, 2019). A move that obviously might have reduced their environmental well-being. The policy response from the agricultural sector saw an expansion but a damaging effect on forests and the environment (Lall, Navaretti, Teitel, & Wignaraja, 2016).

2.1.3 Agricultural development as poverty reduction strategies in the 2000s to 2020s

The Structural Adjustment Program (SAP), introduced by the two Bretton Woods institutions: International Monetary Fund and the World Bank, was nothing more than a re-introduction of the Import Substitution Industrialization (ISI) strategy under a different name (Badiane & Makombe, 2015). Through this came the Poverty Reduction Strategy Paper (PRSP) (Quadri, 2018). The PRSP approach seeks to achieve macroeconomic and social programs to promote economic growth, development, reduce inequality and poverty in line with the MDGs launched in 2000. This time, the IMF and the World Bank encouraged low-income countries to be at the forefront in policy formulation, strategizing, and implementation through a participatory approach (Handa et al., 2018).

As part of the strategies to implement the PRSP and to strengthen the partnership between the government and private sector, most governments choose to focus on the provision of public goods while the private sector focuses on agricultural service delivery. In assessing the PRSP's effectiveness in reducing poverty, promoting agriculture, and protecting the environment, it was found out that the ineffective agriculture policies of the SAP were maintained, rendering the PRSP approach ineffective to achieve its targeted objectives. However, there was increased attention to environmental sustainability (Adu et al., 2021; Puthenkalam, 2016).

The main criticisms levelled against previous agricultural policies in developing countries, especially the SAPs and the PRSPs, have been the fact that it is externally-driven, broad-based participation rather than a country-led strategy rendering them ineffective. Based on this, the African Union (AU), in 2002, mapped its development agenda leading to the adoption of the New Partnership for Africa's Development (NEPAD) that puts agriculture as the primary focus to achieving Africa's development agenda (Raji, 2015).

The Comprehensive Africa Agriculture Development Program (CAADP) -a guiding framework- to achieve poverty reduction and economic growth through agricultural-led growth was endorsed by the leaders of the Africa Union known as the AU Maputo Declaration on Agriculture and Food Security in Africa (Kolavalli, Flaherty, Al-Hassan, & Baah, 2010). The declaration forms part of Africa's agenda 2063 contains several vital decisions on agriculture. Prominent among them is the allocation of at least 10% of each African country's national budget to the development of agriculture and rural development. This could help achieve at least a 6% annual agricultural growth rate within five years of implementation and end hunger by 2025 (Kolavalli et al., 2010).

Despite the fact that all the efforts to develop the agricultural sector as a means of lifting, the millions who depend on agriculture seem to have fallen on a rock (Smillie, 2019). Reports from the Intergovernmental Panel on Climate Change (IPCC) point to some damning revelations about the contribution of agriculture and its related activities to climate change and vice versa. According to the technical summary of the IPCC's special report on Climate Change and Land, the 1.3 billion to 3.2 billion affected by land degradation lives in poverty in most developing countries. Interestingly, agriculture, forestry, and other anthropogenic factors were responsible for around 13% of carbon dioxide, 44% of methane, and 82% of nitrous oxide emissions globally during 2007-2016, accounting for 23% (12.0 +/- 3.0 $GtCO_2e$ yr-1) of total net anthropogenic emissions of GHGs.[1] (Arneth et al., 2019).

The lack of synchronization between the supply of soil nitrogen and the demand for crop nitrogen is a major contributing factor to climate change as approximately 50% of the nitrogen applied to agricultural lands is not consumed by the crop (Webber et al., 2015). On this note, the efforts made to revive and use the agriculture sector to lift millions out of poverty have not yielded the desired results.

2.2 Population, land tenure, agricultural intensification, and land degradation

2.2.1 Increasing population and agricultural production

An essay on the "principle of population" by Malthus (1872) started the debate of both the consequences and the solution of an increasing population. Malthus believes that by nature, human food production increases in a slow arithmetical proportion. In contrast, man increases in a quick geometrical proportion unless man does something deliberately or nature strikes to stop humankind. Malthus, in his observation, said that an increase in food production could improve people's well-being. But the improved well-being is temporal because, is later eroded by an increase in population growth, which in turn restores the original per capita production level (Ashraf & Galor, 2011).

On the other hand, human beings tend to utilize abundance (in food production) to increase their population instead of maintaining their high standard of living. This has become known as the Malthusian trap (Madsen, Robertson, & Ye, 2019). Malthusian theory of population and the graphical representation of Malthus basic theory is presented in figures 1 and 2.

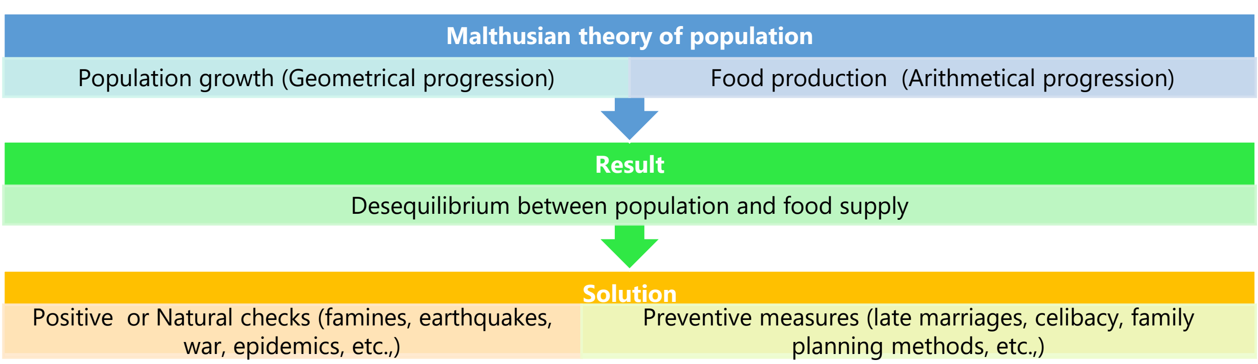

Figure 1: The Malthusian theory of population
Source: created by the author based on Malthus theory of population

[1] This assessment only includes CO_2, CH_4, and N_2

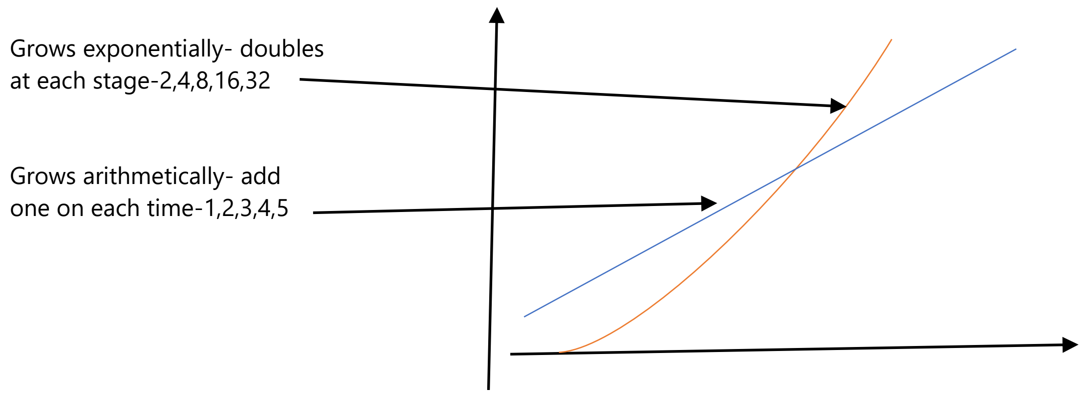

Figure 2: The Malthus basic theory
Source: created by the author based on Malthus theory of population

Though Malthus did not provide a calculation for the geometric population growth and the arithmetic food growth, some experts have pointed out that the growth rates are not consistent with his theory (Madsen et al., 2019). It is, however, worth noting that the world's population has increased by 148% in the space of 57 years between 1960 and 2017, while cereal production has also increased by 296% from 1961 to 2016, as shown in figure 3 and 4, respectively. The doom prediction by Malthus did not materialize because, in Western Europe, there was an increase in population but not as predicted by Malthus; however, food production increased due to technological advancements (Madsen et al., 2019).

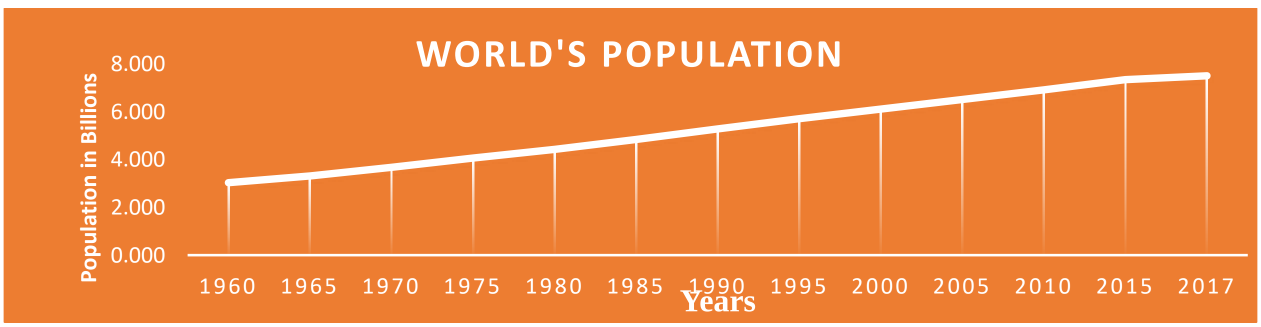

Figure 3: Trends in the World's population, 1960-2017.
Source: Created by the author using World Bank data

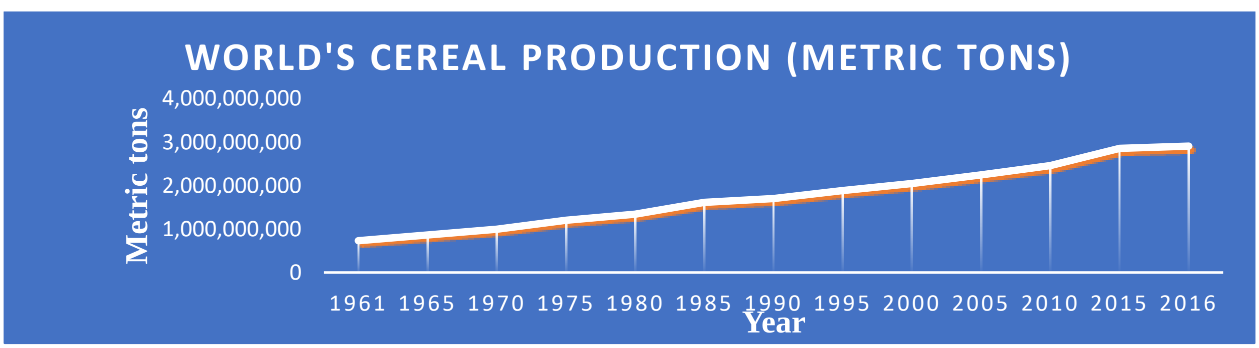

Figure 4: World's Cereal production (metric tons), 1961-2016.
Source: Created by the author using World Bank data

In developed countries, the food production growth rate has been higher than the rate of population growth, but this is not the case in less developed countries (Pawlak & Kołodziejczak, 2020). 25% of the USA's population depended on agriculture during the 1930s, but as of today, less than 2% of the population work in this sector (Hausman, Rhode, & Wieland, 2020). In developing countries, limited land availability due to population growth is mediating the increase in poverty. Arable land has expanded by about 20% in some Sub-Saharan Africa (SSA) countries, but arable land per person in SSA has declined (Otsuka & Place, 2014).

The expansion of arable land in SSA is due to the conversion of forest land and woodland (Adu, Tetteh, Puthenkalam, & Antwi, 2020). Forest cover has decreased significantly in the last three decades (Adu et al., 2020). Place et al. (2017) pointed out that there is increasing competition for land use, including cropland, and this has been cited as a major deforestation driver; therefore, efforts to protect and conserve the remaining forest reserve should be made. To respond to this threat, many researchers have argued for an increase in productivity on existing lands to meet the growing population without expanding cropland (Shah & Wu, 2019).

The FAO (2012) estimates that Africa still has significant forest land (about 70% of total land) for agricultural purposes (Alexandratos & Bruinsma, 2012). But in some African countries like Mali, Niger, and Burkina Faso, cultivated land has exceeded 50% of the total land between 1990 and 2009. Amid the increase, the FAO predicts a modest expansion of 50 million hectares by 2050 (Otsuka & Place, 2014). The increase in population has reduced the total land available per person for cultivation purposes; not only has the land been infertile, but also fallow periods have been reduced in SSA (Mechiche-Alami & Abdi, 2020).

Studies have found that only half of the nutrients consumed by the crops are replaced. Annually, African croplands suffer the most, with 85% of croplands experiencing soil nutrient mining rates of more than 30 kilograms per hectare (Henao & Baanante, 2006). When soil is highly degraded, replenishing it with chemical fertilizer can become ineffective (Ladha et al., 2016). As a result of land/soil degradation, Africa in the latter part of the twentieth century lost 25% of food productivity to degeneration (Oldeman, 1998; Senjobi, Ande, & Ogunkunle, 2013). With the increasing population, loss of forest, changing pattern of land use, lower productivity, and increasing emission of greenhouse gases, it has become obvious that an increase in productivity per hectare is the way forward. But, the land tenure system continues to be a hindrance to agricultural activities and soil conservation thereby, depriving them of environmental well-being. The employment of agricultural and extension education could help to address the issues raised.

2.2.2 Land tenure system, agricultural intensification, and land degradation.

In the traditional African customary land tenure system, the land is owned collectively by the community (under the custodian of a Chief), lineage, or extended family or clan (under the leadership of a family head) but changes to land ownership have begun to appear (Sargeson, 2018). We examine the three major land tenure systems, viz., customary, leasehold, and freehold. In Ghana, under the customary land tenure system, lands are owned by skins/stools, families, and clans where clan elders, family heads exercise authority over the land. In some instances, the authority would be in the hand of an administrative chief. Land ownership may be obtained by inheritance, marriage, gift, or sale (Yeboah & Shaw, 2013). Under the freehold tenure, lands are owned by individuals or subgroups, but at the same time, the said land is owned by the community. The land is inheritable, and the owner possesses the right to lease and sell the title; however, this type of land has generated conflicts. Under the leasehold, individuals have the right to own titles over a specific period. Mostly, the community or clan leases land to individuals or a subgroup for an agreed amount of money for the right. The lessor has the right to possess the said land after the expiry of the agreed period (Lambrecht & Asare, 2016). Land Title Law of 1986 came to enhance land security, but the problem persists.

In defence of the -theories and pattern of structural change model, Boserup (2011) and Glover, Sumberg, Ton, Andersson, and Badstue (2019) made a strong argument in favour of a new and emerging agricultural system from the land-using system to the land-saving farming system due to the effects of the increasing population density. Boserup's theory is quite different from the Malthus theory; the population growth is independent of food supply, and the increased population causes increasing agricultural output through technological advancement (Boserup, 2011). The base of the Boserupean theory is "necessity is the mother of invention." Boserup's theory was extended by Hayami and Ruttan (1971), while Boserup discusses induced technological change. Hayami and Ruttan (1971) discussed not only the induced technological change but also the induced institutional change to support the new farming system. The induced innovation has become necessary due to the land tenure system that hinders the new and emerging farming system. This kind of change did not happen in the traditional African setup due to the rigidity of the land tenure system. In this sense, little is done to develop the labor-intensive agricultural sector and transform the land-using system into a land-saving farming system leading to low land investment. The low land investment and unmanaged lands are known to be a net source of methane (CH_4), accounting for 441% for the periods 2006-2017 for the methane emissions caused by anthropogenic forces (Arneth et al., 2019).

The induced innovation has become more necessary in developing countries especially, African countries, because it fits better in the contemporary densely populated African society where much pressure on the limited resources has resulted in soil degradation. Given this, deprived environmental well-being is inevitable. To reduce or reverse the soil degradation situation, achieve agricultural intensification and higher output, agricultural and extension education should be prioritized. Tree planting is considered to be a long-term investment, and an effective way of securing tenure and improving environmental well-being as its practice helps to conserve water in the soil and improves its richness (Lin, Qu, Liu, & Yao, 2020). But despite these, if the land tenure system remains as it has been then, there is the likelihood that these efforts would be in vain. The old land tenure system is a major factor contributing to the poor harvest and land degradation, hence, preventing a green revolution take-off.

2.3 Agricultural and extension education for sustainable development

Efforts to stimulate economic growth in developing countries through agricultural development have seen a rise and fall of different policies by the Bretton Woods institutions over the last 60 years (Tiwari, 2018). Agricultural and extension education as part of the agricultural development strategies has the educational tool but, it has been affected by many factors, including external financing (Bank, 2018). Agricultural and extension education was hit after the failure of the Bretton Woods institutions-led agricultural and industrial policies in the 1970s and 1980s (Jackson & Jabbie, 2020). As a result, most state-run agricultural and extension education which supports smallholder farmers was abandoned, while large-scale farmers received massive support (Bank, 2018). Producer organizations, farmer-based groups, and state institutions responsible for agricultural development have recently developed an interest in agriculture and extension education to achieve sustainable development where environmental sustainability is emphasized (Baig, Pulhin, El-Juhany, & Straquadine, 2019). Such an approach could play a significant role in revitalizing agriculture and extension education with the potential of increasing crop productivity, farmers' revenue, farmers' environmental awareness, and reversing and restoring degraded lands.

Recently, global environmental issues have received attention due to the increase in global problems relating to pollution, depletion of natural resources, land degradation, and climate change. Other environmental challenges such as acid rain, urban sprawl, waste disposal have affected nature and humankind (Antwi et al., 2017). The desire to develop in all dimensions of life characterized by the exploitation of natural resources has led to severe environmental degradation (Adu et al., 2020). The quest for development has modified the land surface in the last 10,000 years; forest land has been reduced whiles cropland and residential area have increased to meet the increasing demand of the growing population (Adu et al., 2021).

The IPCC’s (2019) report indicates that 70% of the world’s landscape has been affected by human activities and agricultural intensification; these activities generated land degradation (Shukla et al., 2019). Data from the World Bank (2019) indicates that crop production increased by 240% between 1961 and 2017. Agricultural, forestry, and other related land use activities together emit around 13% of carbon dioxide, 44% of methane, and 82% of nitrous oxide during the 2007-2016 period representing a total of 23% of all greenhouse emissions caused by anthropogenic factors (Shukla et al., 2019).

Land-related adaptation and mitigation strategies continue to change to deal with the dynamics of climate change. There are limits to these measures and hence, the need to ignite and revitalize environmentalism in the older generation to reduce activities that increase the emission of greenhouse gases and pollute the environment. It could be achieved by the creation of awareness through the various sources of environmental information transmission systems, especially through agricultural and extension education.

Rural dwellers’ livelihood depends mainly on farming; it is the main link between the rural dwellers and land. A study to examine farmers’ environmental awareness and attitude towards environmental degradation found that perception of the seriousness of environmental degradation had a positive influence on their awareness, concern, and attitude toward environmental degradation (Wu & Mweemba, 2010). Therefore, the greater the level of environmental consciousness among the farmers, the higher their involvement in land management activities. It also enhances their capacity to decide to improve and reverse land degradation (Wu & Mweemba, 2010). Thus, agricultural and extension education could have a positive impact on the restoration of degraded land, which could lead to environmental sustainability. In achieving sustainable environmental practices in the agriculture sector, this research looks at the relationship between agricultural and extension education and the various forms of soil and anti-soil conservation practices.

3. Methodology

3.1 Correlation of soil conservation practices and agricultural and extension education

To establish a link between agricultural and extension education and soil conservation practices that could ensure sustainability, we do a correlation analysis. The correlation coefficient is a statistical measure of the strength of the relationship between the relative movements of two variables. The values range between -1 and 1. Existing correlation coefficients are Pearson, Spearman, and Kendall. The coefficient shows the strength of the correlation. A positive correlation between two variables means they increase at the same time. On the other hand, a negative correlation means as one variable increases, the other variable decreases.

CORRELATION COEFFICIENT	POSITIVE CORRELATION	NEGATIVE CORRELATION
Strong correlation	>0.7	>-0.7
Moderate correlation	< 0.5 – 0.7 >	< -0.5 – -0.7 >
Weak correlation	< 0.4 – 0.00 >	< - 0.4 – 0.0 >
No correlation	0	0

3.2 Linear Probability Model (LPM) estimates of soil conservation practices

The variables used in the model specification includes mulching, zero tillage, use of crop or household residues, organic fertilizer, and slash and burn farming as dependent variables. Agricultural and extension education, age, gender, level of formal education, years of farming experience, marital status, religious denomination, ethnicity, municipality, and income are variables used as covariates. The dependent variables take the value of 1 if the farmers practice any of the measures and 0 otherwise. For example, mulching is a dummy variable that takes the value of 1 if a farmer practices mulching and 0 otherwise. Similar variable creation is done for zero tillage, use of crop or household residues, organic fertilizer, and slash and burn agriculture. OLS equation (1) for each dependent variable was calculated as follows:

$$y_i = \beta_0 + \beta_1 AgrExt_i + \beta X_i + u_i \tag{1}$$

Where y_i is a dummy variable equal to 1 if farmer i practices mulching or zero tillage, use of crop or household residues, organic fertilizer, and slash and burn agriculture, and 0 otherwise. Also, $AgrExt_i$ is a dummy variable equal to 1 if farmer i receives agricultural and extension education, and 0 otherwise. X_i is a vector of control variables that includes age, gender, level of education, years of farming experience, marital status, religious denomination, ethnicity, and income of a farmer while u_i is the error term. The parameter of interest is β_1 .

3.2.1 Linear Probability Model of Soil Conservation practices Dependent/outcome variables

Mulching: Is a dummy variable equal to 1 if farmer i practices mulching and 0 otherwise. Mulching the soil surface with a layer of plant residue is an effective method of conserving water and soil (Adekalu et al., 2007). A positive relationship was expected to exist between good soil moisture and crop yield because water is required by the plant for nutrient absorption and photosynthesis to ensure proper plant growth. However, soil exposed to the sun could impact negatively crop yield.

Zero tillage: Zero tillage variable is a dummy that takes the value 1 if the cocoa/maize farmer practices zero tillage in his/her farm, and 0 otherwise. Zero tillage practices decrease the amount of soil erosion; therefore, it is expected to increase crop productivity (Randrianjafizanaka et al., 2018).

Use of crop or household residues: Use of crop or household residues is a dummy variable equals 1 if farmer i use a crop of household residues as manure in his/her farm and 0 otherwise.

Organic fertilizer: The organic fertilizer variable is a dummy that takes the value 1 if the cocoa/maize farmer applied organic fertilizer to his/her farm and otherwise takes the value 0. Intensive cultivation of cocoa and maize on a piece of land is known to result in a decline in soil fertility due to soil nutrient mining, slash and burn agriculture (Tetteh et al., 2018). Therefore, the application of organic fertilizer other than chemical fertilizer to such soils can replenish the depleted soil nutrients and could reverse and restore degraded land, and hence, increase cocoa and maize output and yield.

Slash and burn agriculture: The slash & burn agriculture variable is dummy as any farmer who practices slash and burns agriculture takes the value of 1 and 0 if otherwise. A negative relationship is expected between this variable and soil conservation practices as slash and burn agriculture often leads to loss of soil organic matter and breeds land degradation (Kukla et al., 2019).

3.2.2 Explanatory/independent/control variables

Agricultural and extension education: Is a dummy variable equal to 1 if farmer i receives agricultural extension education, and 0 otherwise. The frequency of agricultural and extension education by an agricultural extension officer increases the exposure of a farmer to extension information of degraded land restoration, adoption of new and improved production practices. They are more likely to be convinced to adopt environmentally friendly technologies to increase yield during the agricultural and extension education seminars and training programs.

Age: Equals 1 if farmers' age is 18 to 40 years; 2 if farmers' age is 41 to 60 years; 3 if farmers' age is 61 to 80 years; 4 if farmers' age is 81 years and over.

Gender: This is a dummy variable equal to 1 if the farmer is a male and 0 if a female. It is expected that females become more knowledgeable than males due to their active engagement in household-oriented pro-environmental activities.

Level of education: Equals to 1 if farmer has no education; 2 if farmer has a primary education; 3 if farmer has Junior High School education; 4 if farmer has Senior High School education; 5 if farmer has tertiary education. The study predicts a positive relationship between this variable and soil conservation practices since an educated farmer can evaluate the soil conservation practices and make informed technical and economical choices to increase investment in land aimed at reversing and restoring degraded land.

Years of farming experience: Equals 1 if the farmers' years of farming experience is between 1 month to 10 years; 2 if the farmers' years of farming experience is 11 to 20 years; 3 if the farmers' years of farming experience is 11 to 30 years; 4 if the farmers' age is 31 years and over.

Marital status: Equals 1 if the farmer is single; 2 if the farmer is monogamously married; 3 if the farmer is polygamously married; 4 if the farmer is a widow; 5 if the farmer is separated/divorced; 6 if the farmer is none of the above.

Ethnicity: Equals to 1 if the farmer does not belong to any ethnic group; 2 if the farmer belongs to the Akan ethnic group; 3 if the farmer belongs to the Ewe ethnic group; 4 if the farmer belongs to the Ga-Dangme ethnic group; 5 if the farmer belongs to the Dagbani ethnic group; 6 if the farmer belongs to the Frafra/Grusi ethnic group; 7 if the farmer belongs to the Nzema ethnic group; 8 if the farmer belongs to the Wali/Dagari ethnic group; 9 if others.

Religious denomination: Equals to 1 if the farmer has no religion; 2 if the farmer belongs to the Orthodox; 3 if the farmer belongs to the Protestants; 4 if the farmer belongs to the Pentecostals; 5 if the farmer belongs to Charismatic; 6 if the farmer belongs to other Christians sects; 7 if the farmer belongs to the Islamic religion; 8 if the farmer belongs to the Traditional religion; 9 if others.

Municipality: This is a dummy variable equal to 1 if the farmer is from Abuakwa North municipality and 0 otherwise.

Income: Equals to 1 if a farmer's annual income is below the lower poverty line of GH¢982.2 ($258.47); 2 if a farmer's yearly income is below the upper poverty line of GH¢1,760.8 ($463.37) using the exchange rate of $1 = GH¢ 3.8 (January 2016) per adult equivalent per year; 3 if a farmer's annual income is above the upper poverty line.

4. Results and Discussion

4.1 Land tenure systems by sampled cities, towns, and villages

Table 1 provides a summary of the three-tenure system in Ghana stratified by the sampled cities, towns, and villages. Information on 622 plots was collected, comprising 309 from the Abuakwa North Municipality and 313 from the Abuakwa South Municipality of the Eastern Region of Ghana. Out of the 622 farm plots, 78.46% belong to the customary land tenure, while 11.58% and 9.96% were of the leasehold and freehold land tenure, respectively.

4.2 Land conservation practices under different tenure systems and tenancy

In tables 2 and 3, we present the three customary tenure and the three land tillers under the five soil conservation practices, namely, fertilizer application, mulching, slash and burn, zero tillage, and the use of crop residues or household refuse. In general, the level of replenishing lost nutrients through fertilizer application is very low as only 11.58% of the sample applies fertilizer due to several reasons, top among them is the price and farm size been the most cited reasons in Ghana (Nunoo, Frimpong, & Frimpong, 2014). Mulching is the widest practice, with 65.27% of the 622 plots. Only 0.56% of the 11.58% who applied fertilizer used organic fertilizer compared to 11.01% that used chemical fertilizer.

We stratified the plots by tenure system and tenancy in tables 2 and 3, respectively. We found that the practices of soil conservation are highest among the customary land tenure system than the freehold and leasehold tenure. By stratifying the total number of plots by tenancy, it found that soil conservation is more practiced by landowners than tenants and occupants. However, occupants practice more soil conservation than tenants. Owners are the only land tillers that use organic fertilizer, though very low as only 0.56% uses it.

Among all the five identified soil conservation practices, land-owners with secured land rights are identified as the topmost group of land tillers that conserve or invest in improving their agricultural lands. Landowners with land rights do not fear losing their land at any time; therefore, it is not surprising that they invest in improving the fertility of the soil. For example, out of the 11.58% who applied fertilizer in the last two crop seasons, 7.72% are landowners, compared with 0.64% and 3.22% of tenants and occupants, respectively.

Table 1:Land tenure systems stratified by sampled cities, towns and villages-Plot level.

	Abuakwa North Municipality			
City/Town/Village	Total number of plots	Customary	Leasehold	Freehold
	Number	%	%	%
New Tafo Akyem	52	69.23	17.31	13.46

Kukurantumi	34	70.59	11.76	17.65
Nobi	20	55.00	30.00	15.00
Tontro	32	81.25	18.75	0.00
Old Tafo Akyem	28	78.57	7.14	14.29
Osiem	37	91.89	5.41	2.70
Ettukrom	18	94.44	5.56	0.00
Sokode Juaso/Bediasi	26	100.00	0.00	0.00
Anyinasin/Aboabo	46	65.22	23.91	10.87
Ficher	16	75.00	6.25	18.75
	Abuakwa South Municipality			
Amanfrom	29	75.86	10.35	13.79
Apedwa	50	90.00	4.00	6.00
Apapam	32	93.75	6.25	0.00
Kyebi	45	66.67	15.56	17.77
Asiakwa	42	92.86	0.00	7.14
Segyimase	25	92.00	0.00	8.00
Asafo/Addonkwanta	34	94.12	5.88	0.00
Akwadum	15	20.00	73.33	6.67
Asikam	16	62.50	12.50	25.00
Akooko	25	64.00	4.00	32.00
All plots	622	78.46	11.58	9.96

Source: Author's own from fieldwork (2019).

Table 2: Land conservation practices under different tenure systems-Plot level

Land tenure system	Total number of plots	Fertilizer application		Mulching	Slash and burn	Zero tillage	Use of crop residues or household refuse
		Chemical	Organic				
	%	%	%	%	%	%	%
All plots	622(100%)	11.02	0.56	65.27	57.23	37.78	14.63
Customary	78.46	9.00	0.56	51.93	45.98	30.39	11.09
Leasehold	11.58	1.77	0	7.23	6.60	4.01	1.77
Freehold	9.96	0.80	0	6.11	4.66	3.38	1.77

Source: Author's own from field-work (2019).

Table 3: Tenancy and soil conservation practices-Plot level

Tenancy	Total number of plots	Fertilizer application		Mulching	Slash and burn	Zero tillage	Use of crop residues or household refuse
		Chemical	Organic				
	%	**%**	**%**	**%**	**%**	**%**	**%**
All plots	622	11.02	0.56	65.27	42.77	37.78	14.63
Owners	74.12	7.72	0.56	48.55	31.19	29.42	11.25
Tenants	3.54	0.64	0	1.93	1.29	0.96	0.32
Occupants	22.35	3.22	0	14.79	10.29	7.4	3.05

Source: Author's own from fieldwork (2019).

4.3 Tree planting under different tenure systems

Tree planting is considered to be a long-term investment and an effective way of securing tenure and improving environmental well-being, as this practice helps to conserve water in the soil and improves its richness (Lin et al., 2020). When we stratify the sampled population by the three-land tenure system, agricultural land tillers under the customary tenure turn to plant more trees than the others. Farmers under this system increase their tenure security by planting more timber and other trees than the other tenure systems. From table 4, farmers working under the customary tenure system reveal that 81.04% and 71.41% of them indicated that in the last five years, they had planted timber and other trees, respectively. It is the highest among the three tenures. Freehold tenure is the least among the three who plant trees to increase their land security. Land insecurity among the freehold system discourages them from making a long-term investment through tree planting.

Interestingly, more trees have also been cut down in the last five years. From table 4, 71.85% of the sampled population indicated that they had cut down timber in the previous five years. An indication that the gains from tree planting have been eroded gradually by cutting down trees. In this instance, the agricultural and extension form of environmental education could be used as a special-purpose vehicle to ensure sustainability. A similar incidence in the number of other trees planted and cut down in the last five years is also recorded. Agricultural farmers (tenants, occupants, and owners) under the customary turn to increase their security by planting more trees. 72.55% of trees cut down in the last five years, suggesting that farmers need the education to double the number of trees cut down every year. This will increase their security, but also it prevents water loss from the soil; therefore, reducing soil degradation and increasing environmental well-being through increased productivity.

Table 5 presents tree planting under different tenancies on the plot level. Out of the total timbers planted, 78.21% were planted and owned by land-titled owners because they do not fear that they might lose their lands anytime. Tree planting as a way of conserving and protecting land/soil is less practice by occupants and tenants but more practice by land-titled owners. Owners demonstrate a high sense of care for nature.

Table 4: Tree planting under different tenure systems-Plot level

	Timber trees planted in last five years	Timber trees cut-down in last five years	Other trees planted in last five years	Other trees cut-down in last five years
Total No. of trees	4498	3232	2361	1713
	%	**%**	**%**	**%**
Customary	81.04	86.14	71.41	81.09
Leasehold	14.43	10.21	21.9	14.47
Freehold	4.54	3.03	6.69	4.44

Source: Author's own from field-work (2019)

Table 5: Tree planting under different tenancies-Plot level

Tenancy	Timber planted	Timber cutting	Other trees planted	Other trees cutting
	%	**%**	**%**	**%**
Owners	78.21	75.06	72.34	76.3
Tenants	1.65	1.83	3.14	3.85
Occupants	20.14	22.49	24.52	19.85

Source: Author's own from field-work (2019)

4.4 Structural change and evolving land rights

4.4.1 The emerging individualized land rights

This study found that agricultural lands occupied by tenants are mostly characterized by insecurity. They felt insecure about long-term land rights because of a possible takeover by the owner of the land after the agreed period of cultivation, especially when the terms and references of the tenancy agreement are breached by the tenants. Also, the results show that tenants were the most insecure agricultural land workers among the three types of individuals who till the land. They do not have a land title or certificate, and only 4.55% could either sell or give the land to others without the approval from landowners, extended family members, or local authorities (Refer to table 6).

Despite occupants having over 27% rights to either sell or give lands without permission from extended family or landowners, they feel insecure. This manifests in the right to plant trees, as only 15% could exercise that right. A little over 5% of occupants have a land title or certificate, making them not have full control of the land. They are considered to have a higher uncertainty of land rights in the future. The outcome is a low level of investment in land, leading lower to productivity. Farmers who are unable to break even will certainly not feel encouraged to invest more in the next farming season. A situation that will deprive farmers of multidimensional environmental well-being.

Information contained in table 6 individual owners indicating their rights to sell lands is 82.21% compared to 94.36% of owners who said they have the right to give the land without approval from any quarters. This group of individual land users demonstrates higher security in the land. It is reflected in their rights to either plant timber or other trees, with over 95% exercising/claiming that right. Among those who have the right to either sell or give their land without any family member's consent, it was found that only 30.77% of them do possess land title or certificate bringing to bear the weak land market system. This requires a structural change to reflect the new and emerging individualized land rights to avoid any form of land conflict. Land scarcity has occasioned individualized land rights. The call for an induced-innovation change to guide these new land rights is in order.

The rigidity in the land tenure system is seen among all the three systems, especially among the customary and the leasehold. The effect of the rigidity does not encourage land investment leading to lower productivity. The perception that trees planted by either occupants or tenants do not guarantee their rights to cultivate on the same piece of and in the next agricultural season has an effect on tenure security, agricultural investment, and productivity. A reflection of the land insecurity is also seen in the total number of people with land certificates (just 21.7% of all lands).

Table 6: Land rights by tenancy and land tenure system- Plot level

Tenancy	Total number of plots	Individualized land rights*				
		To sell	To give	Right to plant timber trees	Right to plant other trees	Has land title/ certificate
	Number	%	%	%	%	%
Owners	461	82.21	94.36	95.44	95.66	30.77
Tenants	22	4.55	4.55	9.09	0	0
Occupants	139	27.34	28.78	15.1	26.62	5.04
Land tenure						
Customary	488	67.83	78.28	75.82	78.69	21.72
Leasehold	72	58.33	58.33	55.56	58.33	16.67
Freehold	62	72.58	83.87	85.48	83.87	27.42
All	622	67.2	76.53	74.44	76.85	21.7

Source: Author's own from fieldwork (2019).

*Can sell, give, and plant either timber or other trees without the permission of the extended family, landowners of the land commission.

4.4.2 The induced-innovation change

The rigidity of the land tenure system is considered one of the setbacks in land investment. Unmanaged lands are known to be a net source of methane (CH_4), accounting for 441% for 2006-2017 (Arneth et al., 2019)**.** The call for the induced-technological and the induced-institutional change proposed by Boserup, Hayami, and Ruttan to support the new farming system is long overdue. The emergence of the new individualized land rights needs to be supported as empirical evidence points that they can prevent soil and water deterioration through land investment and planting of both timber and other trees. From the focus group discussion, farmers were unwilling to plant trees due to the bureaucratic system and the monetization of the process involved to secure permission before cutting trees they have planted with their resources. Most of them cut down their trees without sorting for permission from state authority; this is done at night when officials of the forestry commission are not at the post. Re-planting of trees or reforestation has also been discouraged due to the same reasons.

The old system is known to breed soil degradation as tenants, and occupants feel less secure to make any investment to improve, reverse and restore degraded lands. In this instance, it is imperative to welcome the induced innovation that calls for a technological change and an institutional change to encourage land investment and reduce or reverse the soil degradation situation. To achieve this proper land market system must be established to avoid any possible land conflicts. Annual and perennial crop farmers are expected to receive a kind of training to guarantee a minimum revenue from their farm work for survival. But, the traditional extension services though helpful, most farmers do not avail themselves of such training. The next section discusses the link between agricultural and extension education and soil conservation practices to ensure sustainability.

4.5 Analysis of the correlation of soil conservation practices and Agricultural and Extension education

Table 7 presents the correlation results between "agricultural and extension education" and the various soil/land conservation practices. The relationship between "agricultural and extension education" and the soil conservation variable "mulching" was positive, moderate in strength, and statistically significant. Likewise, a similar relationship exists between agricultural and extension education, zero tillage, and the use of crop residues or household refuse. It suggests that farmers who avail themselves of an agricultural and extension education are more likely to practice soil conservation measures to reverse and restore the degraded land. However, the relationship between "agricultural and extension education" and the soil conservation variable "slash and burn" was negative, moderate in strength, and statistically significant. As expected, an educated farmer, either through formal or informal education, is not likely to practice slash and burn agriculture.

There is enough evidence to suggest that a correlation exists between agricultural and extension education and soil/land conservation practices. The results suggest that household heads who avail themselves of agricultural and extension education are expected to practice mulching, zero tillage, and the use of crop residues or household refuse. But, the negative correlation between agricultural and extension education and slash and burn means that as household heads avail themselves for agricultural and extension education practice of slash and burn agriculture will be discouraged and vice versa Intuitively, a household member who receives an environmental education in agricultural and extension education is more likely to avoid the slash and burn type of agriculture.

Among the household heads', the younger ones' do not only show a higher level of agricultural and extension education but also put them into practice. From table 7, 73% of household heads aged between 18 and 40 years have undergone an agricultural and extension education in the 2018/19 farming season. However, the percentage is lower among the older generation as 49% and 44% aged 41-60 and 61+ years respectively had received agricultural and extension education in the last two years.

Table 7: **Household head's age and agricultural and extension education**

Age	Agricultural and extension education (%)
18-40	73.02
41-60	49.36
61+	43.59

Source: Author's own from fieldwork (2019).

4.6 Explanation of the LPM estimates

The results from the Ordinary Least Square (OLS) or Linear Probability Model (LPM) estimates are shown in table 9. It can be seen that the coefficients of "Agricultural and Extension education" are statistically significant at a 1% level of significance for all the model specifications except the case where "organic fertilizer" is used as the dependent variable. Specifically, the results indicate that Agricultural and Extension education increases the probability of farmers practicing mulching, use of crop or household residues, and zero tillage by 59.6, 19.0, and 34.6 percentage points, respectively.

Also, Agricultural and Extension education decreases the probability of farmers practicing slash and burn agriculture by about 16.8 percentage points. Moreover, Agricultural and Extension education increases the probability of farmers practicing at least two of the soil conservations by 27.3 percentage points, while it increases the probability of farmers practicing at least three of those soil conservations by 5.9 percentage points. The use of organic fertilizer as a way of replenishing lost nutrients and land investment is not statistically significant, controlling other demographic factors. It suggests that the use of organic fertilizer does not depend on agricultural and extension education but rather on other factors such as prices and the size of farmland (Nunoo et al., 2014).

Table 8: Correlation of agricultural & extension education and soil conservation

		Agricultural & Extension education	**Mulching**	**Slash & burn**	**Zero tillage**	**Use of crop residues or household refuse**
Agricultural & Extension education	Pearson Correlation	-				
	Sig. level (2-tailed)					
Mulching	Pearson Correlation	.562**	-			
	Sig. level (2-tailed)	0.001				

Slash & burn	Pearson Correlation	-.219**	-.152**	-		
	Sig. level (2-tailed)	0.001	0.003			
Zero tillage	Pearson Correlation	.392**	.206**	-.111*	-	
	Sig. level (2-tailed)	0.001	0.001	0.032		
Use of crop residues or household refuse	Pearson Correlation	.289**	.107*	-.149**	.228**	-
	Sig. level (2-tailed)	0.001	0.039	0.004	0.001	

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Source: Created by the author from fieldwork (2019)

***Table 9**: Linear Probability Model (LPM) estimates of soil conservation practices and Agricultural and Extension education*

Variables	Mulching	Crop and household residues	Zero tillage	Organic fertilizer	Slash &burn	At least two	At least three
Agricultural and Extension education	0.596***	0.190***	0.346***	0.0147	-0.168***	0.273***	0.0586***
	(0.0412)	(0.0374)	(0.0487)	(0.00954)	(0.0521)	(0.0467)	(0.0179)
Gender	-0.0527	0.0642	-0.0995	-0.00951	0.113	0.117*	0.0161
	(0.0577)	(0.0501)	(0.0643)	(0.00663)	(0.0687)	(0.0663)	(0.0321)
Age	-0.00516	-0.0123***	-0.00482	-0.000544	0.00738**	-0.00834**	-0.00281*
	(0.00314)	(0.00277)	(0.00325)	(0.000475)	(0.00364)	(0.00330)	(0.00146)
Education	-0.0192	-0.00347	-0.0256	0.00221	-0.00590	-0.0174	-0.00125
	(0.0207)	(0.0198)	(0.0228)	(0.00334)	(0.0252)	(0.0255)	(0.0110)
Years of experience	0.00632*	0.00118	-0.00344	-5.11e-05	0.000632	0.00454	0.00363**
	(0.00324)	(0.00275)	(0.00355)	(0.000746)	(0.00383)	(0.00342)	(0.00157)
Marital Status	-0.0236	-0.00424	0.105**	0.0120	0.0464	0.0740*	-0.00843
	(0.0414)	(0.0349)	(0.0424)	(0.00819)	(0.0518)	(0.0440)	(0.0265)
Religious Denomination	0.0129	0.0140	0.00923	0.00358*	-0.00434	0.0198	-0.00496
	(0.0120)	(0.00975)	(0.0132)	(0.00212)	(0.0149)	(0.0137)	(0.00455)
Ethnicity	-0.00884	-0.00241	0.00104	-0.00405*	0.00189	-0.0138	-0.0074**
	(0.0139)	(0.0137)	(0.0121)	(0.00243)	(0.0148)	(0.0148)	(0.00330)
Municipality	0.207***	0.0459	0.0399	0.000269	0.0870	0.229***	0.0111

	(0.0465)	(0.0428)	(0.0490)	(0.0128)	(0.0548)	(0.0508)	(0.0208)
Income	0.0798**	0.00653	-0.078**	-0.00947	-0.0613	-0.0360	0.0188
	(0.0360)	(0.0318)	(0.0378)	(0.00952)	(0.0457)	(0.0386)	(0.0252)
Constant	0.0543	0.563***	0.863***	0.0295	-0.163	-0.0488	0.0234
	(0.148)	(0.132)	(0.153)	(0.0421)	(0.171)	(0.167)	(0.0633)
Observations	376	376	376	376	376	376	376
R-squared	0.371	0.241	0.222	0.026	0.123	0.145	0.054

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: Author's own from fieldwork (July/August 2019)

4.7 Agricultural and extension education for a sustainability approach

Based on the results from the linear probability model and correlation analysis, we propose the Agricultural and Extension Education for Sustainability approach. This approach consists of knowledge, skills, motivation, awareness, concern, responsibility, and action (refer to figure 5). Agricultural and extension education regards environmental improvement as the ultimate goal of this form of environmental education. This approach limits itself to the acquisition of knowledge, skills, and motivation, developing environmental awareness, concern, responsibility, and action to support the new and emerging individualized land. It has the potential to reverse and restore land degradation. The agricultural and extension education for sustainability incorporates a future perspective as it seeks to deepen the environmental generation theory. It distinguishes this approach from the conventional approach because of its future dimension.

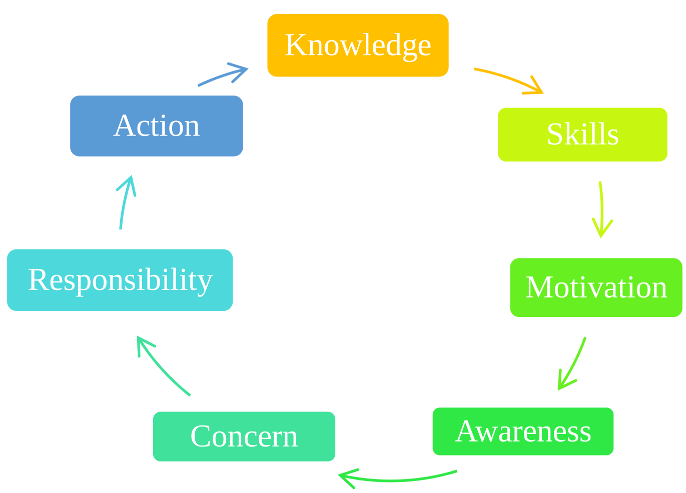

Figure 5: Agricultural and extension education for sustainability approach

5. Conclusion

Soil conservation practices in Ghana are very low as only 0.56% of the 11.58 % of the sampled farmers that applied fertilizer uses organic fertilizer, while mulching is the topmost soil conservation measure practiced in Ghana. Landowners with secured rights to either sell or give their owned lands are on the rise as more and more people felt insecure due to the nature and characteristics of land administration. Tree planting is a long-term investment and an effective way of securing tenure. The results above indicate that the new form of land rights encourages land conservation practice. Agricultural land tillers under the customary tenure turn to plant more trees than the others. Farmers under this system increase their tenure security by planting more timber and other trees than the other tenure systems. Having land rights improve soil conservation practices.

Land tenure systems in Ghana have been a stumbling block to the development of agriculture and are linked to major land conflicts in the country today. The frustrations experienced by both smallholder farmers and large-scale farmers; have been identified due to the structural deficiencies in land administration. With the increase in population and more mouths to be fed, it is difficult for the Ghanaian economy to depend on local agricultural produce without importing foodstuff, especially rice from Asia. The loss of foreign exchange due to importation weakens the country's currency.

The sale of customary, leasehold, and freeholds land under the custodian of chiefs has discouraged investment as most of these lands are sold to more than one person. Most land investors have been discouraged from planting trees and practicing other forms of soil conservation for fear of losing the land anytime.

The current land tenure system impedes socio-economic development and breeds land degradation as most agricultural workers are reluctant to invest in improving the fertility of the soil for increased productivity. The adoption of new technologies in agriculture could achieve its intended purpose if institutions to support emerging agricultural land rights exist.

The relationship between agricultural and extension education and soil conservation was statistically significant. Therefore, there is enough evidence to show that a correlation exists between agricultural and extension education and soil/land conservation. Results from the LPM agricultural and extension education increase the probability of farmers practicing soil conservation practices while it decreases the probability of farmers practicing slash and burn agriculture. Moreover, agricultural and extension education increases the probability of farmers practicing at least two and three of the soil conservations practice.

Against this background, we propose the Agricultural and Extension Education for Sustainability approach. This approach limits itself to the acquisition of knowledge, skills, developing environmental awareness, concern, responsibility, and action to support the new and emerging individualized land rights. It has the potential to reverse land degradation to achieve a higher agricultural yield.

Funding: This research received no external funding.
Conflicts of Interest: The authors declare no conflict of interest.

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