Farmers’ Perception on Forest Degradation in Eastern and Northern Regions of Ghana: Implication for Developing Sustainable Forest Management Strategy

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Abstract

Background

Ghana's forest land is under threat of degradation. Even though forest degradation is reported as serious environmental problem, the nature and extent of farmers’ perception on forest degradation has not been adequately reported. In this study, we have attempted to examine farmers’ perception on forest degradation in the study villages from the Eastern and Northern Regions of Ghana and imply for developing forest management strategy.

Results

In both regions study villages, farmers’ socioeconomic, farm and institutional attributes varied significantly among the farmers in which this could influence their perception on forest degradation. In this study, the main direct causes of forest degradation were perceived by most farmers’ (> 90%) as high firewood and charcoal demand and wildfire/bush fire. Similarly, poverty and population pressures were perceived by significantly higher proportions of the farmers as the major indirect causes of forest degradation. In study regions, significantly higher proportions of the respondents (97%) perceived that there is no forest near to their residence or farmland in 2017. This study showed that significantly higher proportions of the framers perceived that many plant species (e.g., Mahogany (Khaya ivorensis)) and animal species (e.g., Leopard (Panthera pardus)) were disappeared due to forest degradation. In this study, the majority of the respondents also identified other forest degradation indicators such as temperature increased and rainfall irregularity. The most frequently noted strategy to reduce forest degradation that perceived by significantly higher proportions of the respondents (95.6%) were strengthening and enforcement of forest rules and strategies. The binary logistic analysis result indicated that age, education, farming experience and income were the determinant variables common in both study villages that influenced significantly farmers’ perception on forest degradation.

Conclusion

This study shows that significantly higher proportions of the farmers well perceived the causes, indicators and consequences of forest degradation in their village. The perception of farmers on forest degradation can support for decision-making while suggested suitable forest management strategy for their village condition such as introduction of environmental regulations and rules, strengthening farmer-extension system, energy options to replace firewood and charcoal and massive reforestation and afforestation programmes.

Introduction

Land degradation due to forest degradation is a serious global problem. At global scale, agriculture is considered as the main driver for 80% of the existing land degradation (FAO 2011; FAO 2015; Nkonya et al. 2016). According to Nkonya et al. (2016), degraded land covers about 30% of the total global land
area and about 3 billion people are reside in the degraded lands. The largest share (22%) of the total global cost of land degradation (300 billion USD) is accounted for Sub-Saharan Africa (SSA) which is a region that experienced severe land degradation for the past many decades (Nkonya et al. 2016). Existing reports have shown that Africa total forest area has declined linearly from year to year, that is, from 705 million ha in 1990 to 624 million ha in 2015 (FAO 2015; Zewdu and Beyene 2018). In this paper, a new national definition of forest has been adopted as it is defined as land with minimum area of one hectare, minimum canopy cover of 15%, and with trees that have the potential to reach a minimum height of 5 m at maturity stage (Forest Commission, FC 2015).

Forest land degradation is more severe in Africa than any other continent as the majority of the peoples’ livelihood is highly dependent on natural resources. Mining, infrastructure and urban expansion, firewood collection, charcoal production, expansion of agricultural land, illegal logging, hunting, uncontrolled fire and overgrazing are reported as the important drivers of forest landscape degradation in several developing countries in SSA.

About 35% of Ghana's land is under threat of desertication, especially in the Upper East, Upper West and Northern Regions of the country (Nsiah 1994; Agyemang 2012; Adanu et al. 2013). Rapid environmental changes have also reported since the last three decades in Ghana in general and in the Eastern Region of Ghana in particular (Amanor 1997; Odoom 2005; Asiedu-Amoako et al. 2016). As a result, Ghana's natural resources such as forest, upon which the country's population main economic livelihood depend, are being depleted at an alarming rate. For example, more than 50% of the original forest area has been converted to agricultural land in which this resulted in an average forest land lost of 2.1% per year in Ghana (Odoom 2005; Tufuor 2012; FC 2015; Asiedu-Amoako et al. 2016). Such forest degradation has resulted in critical shortage of wood, poor soil fertility and agricultural productivity, water pollution, loss of habitat and biodiversity, enhances global warming, and reduces surface water availability as most water bodies dried up. This indicates that forested areas are subjected to severe degradation, owing to the complex natural, anthropogenic, socio-economic as well as policy-related factors that leads to complete disappearance of trees and animal species in various areas (Amanor 1997; Asiedu-Amoako et al. 2016; International Union for Conservation of Nature, IUCN 2017; Duguma et al. 2019).

The effects of forest degradation have reported by several researchers as constantly threatening Ghana's GDP growth at present and more severely in the future (World Bank 2006; Adanu et al. 2013; Duguma et al. 2019). Consequently, challenges related to forest degradation have attracted several international actors to support for the on-going efforts to save forests and manage its landscape. For example, the United Nations Millennium Development Goals (United Nations, UN 2000), and the United Nations Framework Convention on Climate Change (UNFCCC), have emphasized forest conservation as part of achieving sustainable development. Such efforts have been reinforced through the new global development agenda such as the Sustainable Development Goals (Goal 15) (Duguma et al. 2019), and the Aichi targets (Convention on Biological Diversity, CBD 2011). The rational is that forest resources have great socio-economic and ecological importance not only in the SSA countries such as Ghana but also globally as this plays a significant role in livelihood diversification, wood and food security, species
habitat, animal feeds, human health, maintain biodiversity, carbon dynamics and environmental conservation (Sharma et al. 1994; Teketay 2004; Agyemang 2012; Kissinger et al. 2012; Bisaro et al. 2014; Duguma et al. 2019).

Since forest degradation is a serious social, economic and environmental problem, understanding farmers’ perception on the drivers and indicators of forest degradation is fundamental for developing appropriate policies and strategies. However, the nature and extent of farmers’ perception on forest degradation have not yet been sufficiently understood in the Ghana conditions as both the causes and effects of degradation are time and site-specific (Santibañez and Santibañez 2007; Mertz et al. 2009; Hosonuma et al. 2012; Kiage 2013; Duguma et al. 2019).

In addition, quantifying the scale of the problem is difficult as forest degradation have complex causes, occurs in different forms and with varying intensity, and is perceived differently by different actors. As a result, many technological and institutional innovations that can reduce forest degradation have been developed and introduced; and yet, such innovations do not generally appear to be successful to achieve the intended targets (Biot et al. 1995; Wennink et al. 2000; Douthwaite et al. 2002; Adjei-Nsiah et al. 2004; Saïdou et al. 2004; Meijaard et al. 2031). Some of the main reasons for unsuccessful introduction of intervention against forest degradation could be related to lack of assessment tools, proposed unsuitable techniques to local conditions, limited availability and accessibility of inputs, lack of market access, inappropriate land tenure system and lack of participation of farmers on technology selection and evaluation (Richards 1985; Leach and Fairhead 2000; Duguma et al. 2019).

Forest degradation has been assessed through different scientific methodologies. These include: satellite remote sensing and geographic information system (GIS) through land use and land cover change analysis (e.g., Lillesand and Kiefer 1994; Prakash and Gupta 1998; Al-Quraishi et al. 2004; Braimoh and Vlek 2005; Jansen et al. 2008), ecological assessment tools (e.g., Moges and Holden 2007; Stringer and Reed 2007; Reed et al 2008; Duguma et al. 2019; Tesfahunegn 2019), and measurement of soil properties (e.g., Reed et al. 2008; Tesfahunegn et al. 2011). Previous reports have also appreciated the two approaches (scientific and local knowledge) as both complement to each other to provide comprehensive assessment tool for forest degradation (e.g., Reed et al. 2008; Kusimi and Yiran 2011; Duguma et al. 2019). Other reports have reported that understanding the depth of local knowledge on forest degradation can support to fully realize local capacity on how to respond more quickly to changes and challenges of degradation than the scientific techniques listed on the above (e.g., Dolisca et al. 2006; Moges and Holden 2007; Stringer and Reed 2007; Bugri 2008; Aniah et al. 2013; Tesfahunegn 2019). However, scientific reports about farmers’ perception on forest degradation have been given little attention by researchers and decision makers in the conditions of Ghana.

Despite of the limitations in the existing literature, local people such as farmers have significant knowledge on forest degradation indicators and consequences in which they acquired from the past field experiences and tested for many generations lived close to the land. Understanding farmers’ perception means understanding local realities, which is a crucial concept and ground for successful designing and
introducing appropriate development efforts (WinklerPrins 2003; Teketay 2004; Kusimi and Yiran 2011; Tesfahunegn 2019). To design more appropriate landscape resources management and facilitate quick communication with farmers, there is a need to understand farmers’ perception on indicators and determinant factors of forest degradation in order develop possible coping strategies (Brouwers 1993; Sandor and Furbee 1996; Dolisca et al. 2006; Kusimi and Yiran 2011; IUCN 2017; Duguma et al. 2019). However, there have been inadequate scientific report on how the local people in general and the farmers in particular perceive the causes and effects of forest degradation. The objectives of this study were to examine farmers’ perception on causes, indicators and consequences of forest degradation and analyze the determinant factors for farmers being perceived forest degradation in the conditions of the Eastern and Northern Regions of Ghana.

**Materials And Methods**

**Study area description**

This study was done from Jan 2017 to June 2017 in two villages selected from the Eastern and Northern Regions of Ghana (Fig. 1). The Eastern Region is one of the ten administrative regions in Ghana and lies between latitudes 60° North and 70° North. This region covers an area of 8.1% of Ghana's total landform. It is the third most populous region, after Ashanti and Greater Accra. The Eastern Region has generally two main vegetation zones, namely, the Tropical forest zone (60%), and the Guinea savannah zone (40%) (https://en.wikipedia.org/wiki/Eastern_Region_(Ghana)). The Eastern Region was selected purposively as the study area because the existing reports have indicated that natural resources such as forest are being rapidly degraded. The Eastern Region also captures variability in altitude, soil productivity, cropping systems, livestock systems, forest and other land use types that affect forest degradation status. There are few studies about the problem of forest degradation even though it has been increased rapidly for many decades in the Eastern Region of Ghana (e.g., Amanor 1997; Asiedu-Amoako et al. 2016). The few studies have focused on forest degradation using experts and leaders knowledge in which this indicates that there is still information gap in capturing local people (farmers) understanding towards forest degradation in the region. Hence, the main research question that was addressed during this study is that, “How do farmers perceive on the causes, trends, effects and determinant factors of the rapid forest degradation at their locality? To address this question in this study, one village, namely, Brepaw Kpeti was purposively selected from the Upper Manya district in the Eastern Region of Ghana. Access to transportation for the researchers and presence of rapid forest degradation indicators were used to select the study village purposively. The Brepaw Kpeti village is located at N 06°24′39″ and W 000°06′26″ and has an average altitude of 450 meter above sea level. In this village, annual rainfall and temperature ranges between 900 and 1500 mm, and 26 and 32°C, respectively (District Bureau of Agriculture, Unpublished Report).

The Northern Region of Ghana is another study area of this research. This region is much drier and has degraded forest land than the Eastern Region of Ghana due to its proximity to the Sahel and the Sahara. The vegetation predominantly consisted of grassland, especially savanna with clusters of drought-
resistant trees such as *acacias* or *baobabs*. In the study village of *Nyankpala* from the Northern Region of Ghana, an annual rainfall and temperatures ranges between 750 and 1050 mm, and 14 and 40°C, respectively. The study village of *Nyankpala* was purposively selected from *Tolon district* after discussed with the extension staffs on the basis of the points such as access to transportation for frequent field visit and presence of forest degradation indicators. The mean elevation of *Nyankpala* village is 183 meter above sea level, and the village is located at N 09°24’ and W 000°60’. In this region, more than 75% of the economically active population are involved in agricultural activities (https://en.wikipedia.org/wiki/Northern_Region_(Ghana)).

**Sampling technique and sample size**

In this study, the village *Brepaw Kpeti* from the Eastern Region and *Nyankpala* village from the Northern Region were purposively selected. The rational used during the villages selection included: access to transportation for site visiting, village known for its poor agricultural practices, and sever vegetation degradation in progress, and presence of high indicators of land degradation (biodiversity loss, soil degradation). The selection of the villages was done in consultation with the extension staffs in the district Bureau of Agriculture and farmers contact persons in the villages.

In addition, field reconnaissance survey was conducted to check the suitability of the selected villages and so verified the information acquired from extension staffs and farmers contact persons. From each of the study villages total population, sample of farmer household heads were selected using systematic random sampling at 95% confidence level or 5% of margin of error. A total of 130 household heads farmers, i.e., 70 farmers from the village *Brepaw Kpeti* in the Eastern Region and 60 farmers from the *Nyankpala* village in the Northern Region of Ghana were interviewed. Such sample size was determined using Asmamaw (2011) formula from a total population of 85 farmer household heads in *Brepaw Kpeti* village; and 71 household heads from the *Nyankpala* village.

**Data collection and procedures**

Two sources of data, that are, primarily and secondary data were collected. The primarily data were collected using field observation/measurements, group discussions and semi-structured questionnaire interviews. Available secondary data such as climate/weather, soil, land use types, agricultural practices, demography were collected from secondary sources. Detail procedures of primarily data collection are shown below.

**Field observation and group discussion**

At field and landscape levels of different indicators of forest and its degradation such as plantations, protected areas, tree species, gullies, rills, soil depth, were observed by the team consisting of one researcher, one extension staff, and two farmers contact persons. The field observation and questionnaire surveys were complemented by the group discussions that included two village leaders, two extension staffs, three farmers and one district agricultural official. All the group members were selected
purposively, except the three farmers who were randomly selected to participate in the discussion. Several discussions (upto three times) were conducted in order to get clear information about the causes and effects of forest degradation and farmers perception in the study villages. Such discussions were also used as a means to crosscheck data collected about farmers’ perception on forest degradation using the formal interviews.

**Semi-structured questionnaire**

Semi-structured questionnaire was developed with due attention to the two main sections: (1) household socioeconomic, farm and institutional attributes, and (2) farmers perceptions on causes, trends and indicators of forest degradation. The questionnaire was pre-tested on randomly selected 12 farmers from each of the study villages. The questionnaire interviews were administered by employing two enumerators in each village, with close follow-up from the first author. Orientations were given to both enumerators to translate the questionnaire in English into local language while they interviewed for farmers household heads. In the Eastern Region, the farmers spoke the local language *Krobo* whereas in the Northern Region they spoke *Dagban*. Religion of all respondents in the Eastern Region was Christian and that of the Northern Region was Muslims.

**Data analysis**

Data were analysed using SPSS version 20 software. Descriptive, non-parametric (e.g., chi-square test), T-test and econometric analyses were used. The chi-square test was used to assess the significance of the proportion of the respondents’ response at the probability level (P) ≤ 0.05. The T-test was used to statically test continuous variables. Binary logistic regression was used to analyse the casual-effects of the explanatory variables on the dependent variable at P ≤ 0.05. The logistic model was selected because it is more computationally easier and interpretable than the other models such as probit model (Long 1997; Tesfahunegn et al. 2016). The dependent variable is farmers’ perceived forest degradation as a problem; if a farmer perceived forest is being degraded the value is 1, otherwise 0. Where 1 indicates the presence and 0 for the absence of that attribute. The independent variables included: age, gender, education, family size, education, literacy ratio (illiterate/literate), dependency ratio (dependents/productive), number of livestock, farm size, land tenure, farming experience, off-farm activities, income, access to extension services, access to information (media, radio), access to credit, slope of farm land, and arable land distance from forest and main road. The hypothesised relationship of such variables with the dependent variables was determined from literature and the researchers’ judgment as it shown in sub-section 2.4.1.

Multicollinearity among explanatory variables was tested separately for continuous and dummy/discrete variables before conducted the analysis using the binary logistic regression. Variance Inflation Factor (VIF) was used to detect multi-collinearity among continuous independent variables whereas Contingency Coefficient (CC) was used for dummy or discrete variables. As a rule of thumb, if the VIF of the association among the variables exceeds 10; there is multi-colinearity problem and should be excluded the non-significant variables from the analysis (Greene 2000; Wooldridge 2000; O’brien 2007). The CC
values are between 0 and 1; in which zero indicates no association between variables while values close to 1 indicates high degree of association between variables. The association is said to be high when the value of CC exceeds 0.75 (Greene 2000; Wooldridge 2000). Analysis results showed that the values of VIF and CC for the independent variables were within the lower level of association (data not shown) which indicates that there is no serious problem of multi-collinearity effect among most of the explanatory variables. Multi-collinearity was only detected between education and literacy ratio, and gender and sex ratio in which the literacy ratio and sex ratio were excluded from the analysis.

Description of variables

The dependent variable is farmers perceived forest degradation as a problem. The following independent variables are expected to affect the dependent variable as described their hypothetical effects.

Age: This refers to the number of years the head of the household acquired farming experiences. Thus, it is hypothesized that older farmers have adequate experiences and higher likelihood of perceiving forest degradation and so influences positively their perception (Bogale 2011). Age is a continuous variable.

Gender: This refers to the sex of the head of the household and so believed to affect perception on forest degradation. Both men and women headed households have different access to information and experiences and so perceived differently about forest degradation. Thus, being a male headed household influences positively perception on forest degradation (Tesfahunegn 2019). This is a dummy variable as 1 for male headed and 0 for female headed.

Educational level: This increases the ability of household heads to perceive forest degradation. Thus, it is hypothesized that as the education level of farmers increases it influences positively their perception on forest degradation (Bogale 2011; Al-Subaiee 2016). It is a dummy variable with 1 for literate, otherwise 0 for illiterate.

Family size: Bigger family size could harmonize and share forest degradation related activities and experiences from the field and thus affects positively the perception on the problem of forest degradation (Bogale 2011; Tesfahunegn 2019). It is a continuous variable.

Farming experience: This is the number of years the head of the family fully involved on the farming. Such experiences influence positively farmers’ perception on forest degradation. It is a continuous variable (Bogale 2011; Tesfahunegn 2019).

Total livestock owned: The number of livestock owned is one of the key factors to influence natural resources and thereby influences positively farmer perception on forest degradation (Bogale 2011; Al-Subaiee 2016). It is a continuous variable.

Farmland size: A farmer having larger land size could associate with forest land as such land is found from a forest area and so this increases perception on forest degradation. Farmland size is thus
hypothesized to influence positively farmers’ perception on forest degradation (Bogale 2011; Al-Subaiee 2016). It is a continuous variable.

**Field slope:** Steep field slope increases the effects of erosion under poor vegetation cover and it is hypothesized to be positively associated with perception on forest degradation (Bogale 2011; Al-Subaiee 2016). It is a dummy variable with 1 for steep, otherwise 0 for flat slope.

**Land tenure (secured):** A farmer having a tenured land is hypothesized to influence positively perception on forest degradation because such farmer practices interventions considering the degradation severity (Alemneh et al. 1997; Tenge et al. 2004). It is a dummy variable with 1 for a tenured farmer land, otherwise 0.

**Total income:** This refers to the farm income of a household head in the form of monetary terms from agriculture. Tesfahunegn (2019) indicated that higher income positively affects the perception of farmers on land degradation as extra income helps farmers to practice suitable agricultural technologies. It is a continuous variable.

**Off-farm activities (non-farm income):** A farmer headed household mainly involves on off-farm activities may not perceive forest degradation. Thus, this variable is hypothesized to influence negatively farmers’ perception on degradation (Tenge et al. 2004). It is a dummy variable with 1 for a farmer who involved on off-farm activities, 0 otherwise.

**Forest distance from home:** Farmers live in the vicinity of forest can determine the type and quantity of harvest being used from forest land and this influences positively perception on forest degradation (Bogale 2011; Koenig et al. 2011). This is a continuous variable in km.

**Location of farmland:** The distance of farmland from forest area is an important factor for farmers’ perception on forest degradation. As the distance of farmland increases or far away from the forest it influences negatively for farmer perception on forest degradation and vice versa if it is near to their farmland (Bogale 2011). This is a continuous variable in km.

**Access to extension service:** Access to extension service by farmers is fundamental to receiving information and technology that influences perception on degradation. This study is thus hypothesized that extension service plays an important positive role for farmers’ perception on forest degradation (Gould et al. 1989). This is a dummy variable with 1 if access to extension services, 0 otherwise.

**Access to credit/ association:** Access to credit/ association that supports agricultural inputs such as fertilizer, improved seeds, seedlings etc., is more likely to influence farmers understanding on the status of forest degradation. Thus, this variable is hypothesized to influence positively farmers’ perception on forest degradation (Lundgren and Lundgren 1983). This is a dummy variable with 1 if access to credit/ association, 0 otherwise.
Results And Discussion

Farmers' socioeconomic, farm and institutional attributes: Qualitative results

The qualitative results about farmers (respondents) socioeconomic, farm and institutional attributes are shown for the study villages from the Eastern and Northern Region of Ghana in Tables 1a and b, respectively. These tables show that except for the farmland slope and access to association in the Eastern Region, and off-farm activity and access to extension service in the Northern Region, the chi-square test showed significant differences in the proportions of the respondents that support for a given attribute. For example, in the study village from the Eastern Region of Ghana, the male headed households (91.4%) were significantly higher than that of the female headed farmers who involved in the interview. In the study village from this region, significantly higher proportions (78.6%) of the respondents were married. In the Eastern Region, significantly lower (25.7%) proportions of the respondents were illiterate and the remaining were literate (Table 1a). The majority of the farmers (55.6%) in the study village in the Eastern Region were possessed flat to gentle farmlands. In this region, significantly higher proportions (91.4%) of the interviewed farmers had a feeling of land security and so did not rent out any part of their land. In this region study village, 90% of the interviewed farmers’ main occupation was agriculture. However, about 92.9% of the respondents were involved on off-farm activities in the Eastern Region study village. In this Region, the respondents who accessed services such as extension, credit, media (radio), and membership to association were 60.0, 17.1, 64.3 and 58.6%, respectively. This indicates that the proportions of farmers' who have access to credit (17.15) are reported to be lower than those who had access.

Table 1a. Qualitative results of farmers socioeconomic, farm and institutional attributes in Eastern Region, Ghana (n =70).
| Attribute              | Value | Attribute              | Value |
|------------------------|-------|------------------------|-------|
| Gender                 | **    | Main occupation        | **    |
| Male                   | 64 (91.4) | Agriculture          | 63 (90.0) |
| Female                 | 6 (8.6)  | Daily laborer          | 2 (2.9)  |
| Martial status         | **    | Petty trading          | 5 (7.1)  |
| Married (live together)| 55 (78.6) | Off-fam activity     | **    |
| Divorced               | 4 (5.7)  | Yes                    | 65 (92.9) |
| Widowed                | 11 (15.7) | No                     | 5 (7.1)  |
| Education              | **    | Access to extension service | **    |
| Illiterate             | 18 (25.7) | Yes                   | 42 (60.0) |
| Informal education     | 3 (4.3)   | No                     | 28 (40.0) |
| Primarily education (upto Junior high school) | 28 (40.0) | Access to credit  | **    |
| Secondary education (senior high school) | 19 (21.1) | Yes                   | 12 (17.1) |
| College                | 2 (2.9)   | No                     | 58 (82.9) |
| Farmland slope         | ns     | Access to radio        | *      |
| Flat to gentle         | 39 (55.7) | Yes                   | 45 (64.3) |
| Gentle to steep        | 31 (44.3) | No                    | 25 (35.7) |
| Land tenure feeling    | **    | Access to local association | ns    |
| Yes                    | 64 (91.4) | Yes                   | 41 (58.6) |
| No                     | 6 (8.6)   | No                     | 29 (41.4) |
| Rented out land        | **    | Own land               |       |
| Yes                    | 6 (8.6)   | Yes                   | 65 (92.9) |
| No                     | 64 (91.4) | No                    | 5 (7.1)  |

Values in parentheses are percentages; ** and *, significant at $P \leq 0.01$ and $P \leq 0.05$, respectively; ns, non-significant at $P > 0.05$

Source: Own Survey Data (2017).

In the study village from the Northern Region of Ghana, the numbers of male and female household head farmers’ respondents were 95.0 and 5.0%, respectively. In this region, significantly higher proportions (91.7%) of the respondents were married. This proportion is higher than the respondents in the study
village from the Eastern Region (78.6%). In the Northern Region, the proportions of farmers in the different education status varied significantly, with the higher proportions of respondents were illiterate (76.7%) (Table 1b). In this Region, about 66.7% of the farmer respondents' possessed flat to gentle slope farmland. In the Northern Region study village, 98.3% of the respondents had the feeling of land tenured. All of the respondents were engaged on agriculture as their main occupation. However, the majority of the farmers did not have access to extension (53.3%) and credit (96.7%) services in the Northern Region study village. In this Region, about 64.3% of the farmers accessed to radio, but 85% of them were not participated in any membership of development association at their locality (Table 1b).

Table 1b. Qualitative results of farmers socioeconomic, farm and institutional attributes in Northern Region, Ghana (n =60).
| Attribute                      | value | Attribute                      | value |
|-------------------------------|-------|-------------------------------|-------|
| **Gender**                    | **    | **Main occupation**           | **    |
| Male                          | 57 (95.0) | Agriculture                   | 60 (100) |
| Female                        | 3 (5.0)  | Daily labor                   | 5 (8.3)  |
| **Martial status**            | **    | Petty trading                 |       |
| Married (live together)       | 55 (91.7) | Other sources such as driver | 15 (25.0) |
| Divorced                      | 3 (5.0)  | Off-farm activity             |       |
| Widowed                       | 2 (3.3)  | Yes                           | 34 (56.7) |
| single                        | 0 (0)    | No                            | 26 (43.3) |
| **Education**                 | **    | **Access to extension service | ns     |
| Illiterate                    | 46 (76.7) | Yes                           | 28 (46.7) |
| Informal education            | 8 (13.3) | No                            | 32 (53.3) |
| Primarily education (upto Junior high school) | 4 (6.7)  | Access to credit              | **    |
| Secondary education (senior high school) | 0 (0)     | Yes                           | 2 (3.3)  |
| College                       | 2 (3.3)  | No                            | 58 (96.7) |
| **Farmland slope**           | *      | **Access to radio**           | *      |
| Flat to gentle                | 40 (66.7) | Yes                           | 45 (64.3) |
| Gentle to steep               | 20 (33.3) | No                            | 25 (35.7) |
| **Land tenure feeling**       | **    | **Access to local association | **    |
| Yes                           | 59 (98.3) | Yes                           | 9 (15.0)  |
| No                            | 1 (1.7)   | No                            | 51 (85.0)  |

Values in parentheses are percentages; ** and *, significant at $P \leq 0.01$ and $P \leq 0.05$, respectively; ns, non-significant at $P > 0.05$.

Source: Own Survey Data (2017).

Consistent to the present results of the farmers qualitative attributes that vary significant, previous reports have indicated that socioeconomic attributes (e.g., gender, education, marital status, occupation),
Farm characteristics such as slope of farmland, land tenure, and institutional factors (e.g., access to extension services, credit, association) are reported to influence for farmers perception on forest degradation. For example, if education level of farmers’ increases, it influences positively their perception on forest degradation (Hassan et al. 2002; Bogale 2011; Koenig et al. 2011; Al-Subaiee 2016; Tesfahunegn 2019). Existing literature have also reported that variations in socioeconomic characteristics of local farmers could be significantly influenced their needs for extension services and thereby on perception level of forest degradation (e.g., Van den Ban and Hawkins 1996; Bogale 2011; Koenig et al. 2011; Al-Subaiee 2016).

**Farmers socioeconomic, farm and institutional attributes: Quantitative results**

In the study village from the Eastern Region of Ghana, the farmer respondents’ age, total family size, and farming experiences ranged from 31 to 79 years, 3 to 16, and 13 to 55 years, respectively. The household head total livestock possession in number varied significantly from 0 to 64. In the Eastern Region, almost all the farmer respondents were dependent on rain-fed agriculture and there was no any respondent who practiced irrigation agriculture (Table 2a). The household farmers total farmland size that included owned land, rented and inherited land ranged from 0.61 to 15.4 ha. However, the farmland size owned by a household head ranged between 0.0 and 6.27 ha, with a mean farmland size of 1.13 ha. This mean farmland size is lower than the report by Peprah et al. (2016) who reported that more than 70% of the farmers in Ghana cultivated less than 3 ha of land.

According to the respondents, the average monthly income of a household head farmer in the Eastern Region of Ghana study village was reported between 30 and 1450 Ghana cedis (7.50 to 363 US Dollar) (Table 2a). In this region, the farmers reported that maize yield varied between 0.25 and 5 tons ha\(^{-1}\), with mean value of 1.5 tons ha\(^{-1}\), which is lower than the estimated achievable potential yield of 6.0 tons ha\(^{-1}\) reported for the Ghana conditions (Ministry of Food and Agriculture, MoFA 2016; Scheiterle and Bimer 2018). In addition, the amount of chemical fertilizer (e.g., NPK and sulphate ammonia fertilizers) used by the farmers varied significantly between 0 and 250 kg ha\(^{-1}\), with a mean value of 100 kg ha\(^{-1}\) in the study village from the Eastern Region of Ghana. The time of fertilizer application reported by the respondents varied from 4 to 5 weeks after planting time. About 65% of the respondents used manure as soil management practice just at planting time or before planting time in the Northern Region whereas all of the respondents in the Eastern Region of Ghana did not use manure at their farmland (Tables 2a and b). Such quantitative attributes variability of the farmers in the Eastern Region indicates that there are differences in farmers’ level of perception on forest degradation.

**Table 2a.** Quantitative results of farmers’ socioeconomic, farm and institutional attributes in Eastern Region, Ghana.
| Parameters                                      | n  | Minimum | Maximum | Mean  | SD   | T-Test |
|------------------------------------------------|----|---------|---------|-------|------|--------|
| Age (years)                                    | 70 | 31      | 79.0    | 52.5  | 12.2 | **     |
| Total family size (number)                     | 70 | 3.0     | 16.0    | 10.2  | 7.55 | **     |
| Farming experience (years)                     | 70 | 13.0    | 55.0    | 27.4  | 12.9 | **     |
| Total number of livestock                      | 70 | 0.0     | 64.0    | 25.3  | 14.7 | **     |
| Total farmland size (ha)                       | 70 | 0.61    | 15.4    | 3.25  | 2.42 | **     |
| Farmland size owned by HH (ha)                 | 70 | 0.00    | 6.27    | 1.13  | 1.37 | **     |
| Farmland size inherited (ha)                   | 70 | 0.00    | 13.4    | 1.96  | 2.41 | **     |
| Farmland rented (ha)                           | 70 | 0.00    | 1.62    | 0.17  | 0.40 | **     |
| Irrigated land size (ha)                       | 70 | 0.00    | 0.00    | 0.00  | 0.00 | ns     |
| Ave. monthly income from Agriculture (cedis)   | 70 | 113     | 1450    | 562   | 82.0 | **     |
| Ave. monthly income from off-farm (cedis)      | 70 | 0.00    | 1200    | 398   | 390  | **     |
| Farm distance from main road (km)              | 70 | 0.10    | 7.00    | 1.60  | 1.50 | **     |
| Main road distance from home (km)              | 70 | 0.10    | 6.00    | 1.00  | 1.00 | **     |
| Maize yield in bag per acre (tons ha⁻¹)        | 70 | 0.25    | 5.00    | 1.50  | 0.94 | **     |
| Maize- NPK Fertilizer rate applied (kg ha⁻¹)   | 70 | 0.00    | 250     | 75    | 35   | **     |
| Maize- Sulphate ammonia rate applied (kg ha⁻¹) | 70 | 0.00    | 250     | 100   | 49   | *      |
| Maize- Manure/compost rate applied (tons ha⁻¹) | 70 | 0.00    | 1.25    | 0.750 | 0.25 | ns     |
| Maize- Urea rate applied (kg ha⁻¹)             | 70 | 0.00    | 250     | 100   | 25   | *      |
| Time of NPK application (weeks after planting = WAP) | 27 | 0.00    | 6.00    | 3.17  | 1.71 | **     |
| Time of urea application (WAP)                 | 16 | 0.00    | 7.00    | 4.53  | 2.38 | **     |
| Time of sulphate ammonia application (WAP)     | 10 | 0.00    | 7.00    | 4.90  | 1.97 | **     |

n, number of respondents; SD, standard deviation; manure/compost is applied at 0 WAP which is at planting time.

** and *, significant at P ≤ 0.01 and P ≤ 0.05, respectively; ns, non-significant at P > 0.05.
During the study period, the average conversion rate of 1 US Dollar = 4.00 cedis, which is the currency of Ghana was used.

Source: Own Survey Data (2017).

In the study village from the Northern Region of Ghana, age of the respondents varied significantly from 25 to 65 years, total family size from 2 to 19 and farming experiences from 10 to 50 years. The total family size in this region study village was higher than that of the village in the Eastern Region of Ghana. This could be due to all of the respondents’ religion is Muslim in which a husband can have more than one wife in the Northern Region. The total livestock per household head farmer varied significantly from 0 to 60; and the total farm land size from 0.61 to 14.2 ha, with a mean value of 2.97 ha. This mean value is nearly similar to the report by Peprah et al. (2016) who reported that more than 70% of the farmers in Ghana could cultivate about 3 ha of land. In the Northern Region, there were some farmers who practiced irrigation upto 2.50 ha of land, but there were many farmer respondents who did not practice irrigation at all in this region.

The minimum and maximum income from agriculture and off-farm activities in the study village in the Northern Region of Ghana is shown in Table 2b. The average monthly income from agriculture was reported from the study village in the Northern Region of Ghana by the majority of farmers to be 459 cedis (115 US Dollar). Table 2b also shows the variability in the respondents’ perception on grain yield of the different crops, fertilizer rates and time of fertilizer application in the Northern Region. According to the farmers (100% of the respondents about maize and 75% of them about rice), the mean yield of the main crop (maize) and rice in the Northern Region was reported to be 1.20 and 1.40 tons ha\(^{-1}\), respectively. The mean yield of maize reported at farmers field (1.2 tons ha\(^{-1}\)) is below the national yield (1.7 tons ha\(^{-1}\)) (Ragasa 2013) and is also below the attainable potential yield from research sites as reported between 4 and 6.0 tons ha\(^{-1}\) in Ghana (Chapoto and Ragasa 2013; MoFA 2016; Scheiterle and Birner 2018).

Farmers confirmed that such lower yield could be associated with the low rate of fertilizer application coupled with climate effects in Ghana in which this is consistent with the report described by previous papers (e. g., Ragasa et al. 2013; Tanko et al. 2016; Scheiterle and Birner 2018; Scheiterle et al. 2019). A lower grain yield could be associated with poor soil and crop management practices in Ethiopia (Tesfahunegn et al., 2016). Existing literature also showed that the inorganic fertilizers are applied to nearly one half of the area planted with maize in Ghana (Ragasa et al. 2013; Scheiterle and Birner 2018). The quantitative attributes of farmers such as age, farming experience, land size, income, fertilizer rate and application time, low crop yield could have significant contribution to perceive or not on forest degradation because the same attributes are directly or indirectly influenced forest land.

**Table 2b.** Quantitative results of farmers’ socioeconomic, farm and institutional attributes in Northern Region, Ghana.
| Parameters                                              | n   | Minimum | Maximum | Mean | SD  | T-test |
|---------------------------------------------------------|-----|---------|---------|------|-----|--------|
| Age (years)                                             | 60  | 25.0    | 65.0    | 46   | 9.70| **     |
| Total family size (number)                              | 60  | 2.00    | 19.0    | 8    | 3.60| **     |
| Farming experience (years)                              | 60  | 10.0    | 50.0    | 29   | 10.1| **     |
| Total number of livestock                               | 60  | 0.00    | 60.0    | 22   | 15.7| **     |
| Total farmland size (ha)                                | 60  | 0.61    | 14.2    | 2.97 | 2.32| **     |
| Farmland size owned by household head (ha)              | 60  | 0.00    | 6.10    | 0.43 | 1.21| **     |
| Farmland size inherited (ha)                            | 60  | 0.00    | 11.3    | 2.02 | 1.88| **     |
| Farmland rented (ha)                                    | 60  | 0.00    | 14.2    | 0.55 | 2.02| *      |
| Irrigated land size (ha)                                | 60  | 0.00    | 2.50    | 0.04 | 0.32| **     |
| Ave. monthly income from Agriculture (cedis)            | 60  | 105     | 1380    | 459.0| 351 | **     |
| Ave. monthly off-farm income (cedis)                    | 60  | 0.00    | 1000    | 398.0| 227 | **     |
| Farm distance from main road (km)                       | 60  | 0.50    | 15.0    | 3.65 | 3.64| **     |
| Main road distance from home (km)                       | 60  | 0.50    | 6.00    | 1.27 | 1.06| **     |
| Maize yield (tons ha⁻¹)                                 | 60  | 0.50    | 4.00    | 1.20 | 0.29| *      |
| Rice yield (tons ha⁻¹)                                  | 45  | 0.52    | 5.50    | 1.40 | 1.10| *      |
| Sorghum yield (tons ha⁻¹)                               | 3   | 0.29    | 0.75    | 0.50 | 0.18| ns     |
| Groundnut yield (tons ha⁻¹)                             | 24  | 0.75    | 2.50    | 1.50 | 0.56| *      |
| Cassava yield (tons ha⁻¹)                               | 6   | 0.98    | 3.70    | 2.50 | 1.12| **     |
| Pepper yield (tons ha⁻¹)                                | 5   | 0.50    | 5.60    | 3.40 | 1.37| *      |
| Soya bean yield (tons ha⁻¹)                             | 6   | 0.49    | 1.71    | 0.88 | 0.64| *      |
| Maize- NPK Fertilizer rate applied (kg ha⁻¹)             | 60  | 0.00    | 250     | 225  | 85  | **     |
| Maize- Sulphate ammonia rate applied (kg ha⁻¹)           | 60  | 0.00    | 250     | 85   | 70  | **     |
| Maize-Manure/compost rate applied (tons ha⁻¹)            | 60  | 0.00    | 10.0    | 4.0  | 2.20| *      |
| Maize- Urea rate of applied (kg ha⁻¹)                   | 60  | 0.00    | 0.00    | 0.00 | 0.00| ns     |
### Table 3

| Parameter | n | Mean1 | SD1 | Mean2 | SD2 | Significance |
|-----------|---|-------|-----|-------|-----|--------------|
| Time of NPK use to maize (WAP) | 59 | 2.00 | 6.00 | 3.20 | 0.56 | ** |
| Time of sulphate ammonia application to maize (WAP) | 37 | 5.00 | 8.00 | 6.40 | 0.79 | ** |
| Time of manure/compost application to maize (WAP) | 39 | 0.00 | 0.00 | 0.00 | 0.00 | ns |
| Rice- NPK fertilizer rate applied (kg ha⁻¹) | 42 | 0.00 | 3.00 | 1.55 | 0.75 | ** |
| Rice- Sulphate ammonia rate applied (kg ha⁻¹) | 40 | 0.00 | 3.00 | 0.59 | 0.67 | ** |
| Rice- Urea rate of applied (kg ha⁻¹) | 41 | 0.00 | 100 | 17 | 8.00 | ** |
| Time of NPK application to rice (WAP) | 37 | 2.00 | 6.00 | 3.62 | 0.79 | ** |
| Time of ammonia application to rice (WAP) | 19 | 8.00 | 8.00 | 7.16 | 1.01 | ** |

n, number of respondents; SD, standard deviation; manure/compost is applied at 0 WAP which is at planting time.

** and *, significant at P ≤ 0.01 and P ≤ 0.05, respectively; ns, non-significant at P > 0.05.

aDuring the study period, the average conversion rate of 1 US Dollar = 4.00 cedis, which is the currency of Ghana was used.

Source: Own Survey Data (2017).

### 3.3. Farmers perception on causes of forest degradation

Significantly higher proportions of the farmer respondents interviewed from both of the study villages were perceived the problem of forest degradation. Most farmers in the study villages also perceived on the different causes of forest degradation (Tables 3a and b). In the Eastern Region study village, the main direct causes of forest degradation were identified by the respondents as higher demand for firewood and charcoal (94.6%) (Figs. 2a and b), wildfire/ bush fire for land clearing (85.7%) (Fig. 2c), and expansion of arable land (84.3%). However, in the Eastern Region, the proportions of respondents who identified the direct causes of forest degradation as free grazing (8.6%) and urban encroachment (38.6%) were significantly lower than those who did not identify them (Table 3a); in which this is contrasted to the report by Aniah et al. (2013) and Bukari et al. (2013) who reported that overgrazing is the main cause for forest degradation by many respondents.

In the Eastern Region of Ghana study village, poverty (92.9) followed by population pressures (82.9%) were identified as the major indirect causes of forest degradation perceived by significantly higher proportions of the respondents. The indirect causes of forest degradation identified as land mismanagement (71.4%) and inadequate policy implementations (62.3%) were also reported by the
The majority of the respondents in this region. Lack of environmental knowledge and landscape technology options were also perceived by the majority of the farmers (62.3%) as indirect causes of forest degradation in the study village in the Eastern Region (Table 3a).

Table 3a. Farmers perception on forest degradation causes and indicators in Eastern Region, Ghana (n = 70).

| Attribute                                           | Respondents                  | \( \chi^2 \) |
|-----------------------------------------------------|------------------------------|--------------|
|                                                     | Yes (%)                       | No (%)       |              |
| Farmers perceived forest degradation                | 67 (95.7)                     | 3 (4.3)      | **           |
| **Direct causes forest degradation**                 |                              |              |              |
| Expansion of arable land                            | 59 (84.3)                     | 11 (15.7)    | **           |
| Free/ over grazing                                  | 6 (8.6)                       | 64 (91.4)    | **           |
| High firewood and charcoal demand                   | 66 (94.6)                     | 4 (5.4)      | **           |
| Illegal logging                                     | 50 (71.4)                     | 20 (28.6)    | **           |
| Urban encroachment                                  | 27 (38.6)                     | 43 (61.4)    | ns           |
| Forest fire                                         | 53 (75.7)                     | 17 (24.3)    | **           |
| Wildfire /bush fire                                 | 60 (85.7)                     | 10 (14.3)    | **           |
| **Indirect causes**                                 |                              |              |              |
| Inadequate environmental policy and its implementation| 44 (62.3)                     | 26 (37.7)    | *            |
| Land mismanagement                                  | 50 (71.4)                     | 20 (28.6)    | **           |
| Insecure land tenure                                | 6 (8.6)                       | 64 (91.4)    | **           |
| Lack of environmental knowledge                     | 44 (62.3)                     | 26 (37.7)    | *            |
| Lack of knowledge on landscape technologies         | 44 (62.3)                     | 26 (37.7)    | *            |
| High population pressure                            | 58 (82.9)                     | 12 (17.1)    | **           |
| High poverty                                        | 65 (92.9)                     | 5 (7.1)      | **           |
| Climate change                                       | 9 (12.9)                      | 61 (87.1)    | **           |

Values in parentheses are percentages of respondents; \( \chi^2 \), chi-square test; ** and *, significant at \( P \leq 0.01 \) and \( P \leq 0.05 \), respectively; ns, non-significant at \( P > 0.05 \)
In the study village Northern Region of Ghana, all of the respondents indicated that high demand for firewood and charcoal production and bush fire were the most important direct causes of forest degradation (Table 3b; Fig 3). These were followed by expansion of arable land (63.3%) and free/over grazing (60.0%). The proportions of respondents who perceived the expansion of arable land, free grazing, high demand for firewood and charcoal and bush fire as the direct causes of forest degradation were significantly higher than those who did not perceive them. According to the significantly higher proportions of the respondents, the indirect causes of forest degradation in the Northern Region of Ghana were mainly related to poverty (98.3%) and population pressure (98.3%) followed by inadequate environmental policy and its implementation (81.7%) and lack of knowledge about environmental technologies (80.0%). All the respondents indicated that land tenure is not an issue to become a cause for forest degradation in the Northern Region study village. The number of respondents who perceived climate change as indirect cause of forest degradation was significantly lower than those they did not perceive it. Fifty percent (50%) of the respondents replied that illegal logging was also perceived as the indirect cause of forest degradation. This indicates that there is no significant difference in the proportion of the respondents who perceived illegal logging as indirect cause as compared to those who did not perceive it.

Table 3b. Farmers perception on forest degradation and its causes in Northern Region, Ghana (n = 60).
| Attribute                                      | Respondents | $\chi^2$ |
|-----------------------------------------------|-------------|---------|
| Farmers perceived forest degradation          |             |         |
| Yes (%)                                       | 59 (98.3)   |         |
| No (%)                                        | 1 (1.7)     | **      |
| Direct causes of forest degradation           |             |         |
| Respondents                                  |             |         |
| Yes (%)                                       |             |         |
| No (%)                                        |             |         |
| Expansion of arable land                     | 38 (63.3)   |         |
| Free/ over grazing                           | 36 (60.0)   |         |
| High firewood and charcoal demand            | 60 (100.0)  | **      |
| Illegal logging                              | 30 (50.0)   |         |
| Urban encroachment                           | 34 (56.7)   |         |
| Forest fire                                  | 9 (15.0)    | **      |
| Wildfire /Bush fire                          | 60 (100.0)  | **      |
| Indirect causes                              |             |         |
| Inadequate environmental policy and its       | 49 (81.7)   |         |
| implementation                                |             | **      |
| Land mismanagement                           | 18 (30.0)   |         |
| Insecure land tenure                         | 0 (0.00)    | **      |
| Lack of environmental knowledge              | 37 (61.7)   |         |
| Lack of knowledge about landscape technologies| 48 (80.0)   | **      |
| High population pressure                     | 59 (98.3)   | **      |
| High poverty                                 | 59 (98.3)   | **      |
| Climate change                               | 5 (8.3)     | **      |

Values in parentheses are percentages of respondents; $\chi^2$, chi-square test; ** and *, significant at $P \leq 0.01$ and $P \leq 0.05$, respectively; ns, non-significant at $P > 0.05$

Source: Own Survey Data (2017).

This study revealed that the high demand for firewood and charcoal as a local energy sources for cooking is the direct deriving factor for local community to highly exploit large volumes of wood from the forested areas in Ghana. The common survival strategy for the poor people in the events of crop failure due to drought is to sell firewood and charcoal from the nearby forest. Consistent with the present result, several previous reports have reported that firewood and charcoal production are the main cause for the
widespread of forest degradation in Sub-Saharan Africa countries (e.g., UNEP 1992; Braimoh 2006; El-Juhany 2009; Daksa and Kotu 2015; Tesfahuneg 2019). Against to this finding, there are several researchers who strongly directly related forest degradation to institutional failures to implement policy on natural resources management, food security, and management and protection of forest (e.g., Pandit and Thapa 2003; Kuemmerle et al. 2007; Daksa and Kotu 2015).

Consistent with this finding on the expansion of arable land which was perceived by the majority of the respondents as a cause of forest degradation, previous reports have reported that clearing of woodlands and forests to expand farmland due to unsustainable arable farming practices is the proximate causes of forest degradation in North East Ghana (e.g., Aniah et al., 2013; Bukari et al., 2013; Hassan et al., 2016). Similarly, in line with the present finding, previous reports have shown that factors such as over-cultivation and inappropriate land management have resulted in significantly severe degradation in Ethiopia (Tesfahunegn 2019), Sudan (Abdi et al. 2013), and other Sub-Saharan Africa countries (Kimaru and Juma 2005; Aksakal et al. 2011; Kiage 2013).

In addition, the participants in the group discussion confirmed that expansion of arable land towards the forest land is the cause of deforestation as there is no suitable condition for the regeneration of deforested areas in the study villages. In this study, illegal logging was largely perceived in the Eastern Region than the Northern Region of Ghana which could be associated with the existing of better forest potential for logging in the Eastern Region. In accordance to this finding, Matloob et al. (2014) and Hassan et al. (2016) have reported that illegal logging and timber smuggling could be a key cause for forest deforestation in Kashmir area.

Other reports indicated that poor people are unable to access to other sources of energy such as electricity and so depend on firewood and charcoal in which this enforces many people to utilize the forest resources improperly and thereby degraded it (Binswanger 1980; Onuche 2010; Bessie et al. 2014; Hassan et al. 2016)). Reports from the Northern Ethiopia catchment by Tesfahunegn (2019) has also indicated that poverty is perceived by most farmers as the indirect cause of land degradation. All the participants participated in the group discussions in the study villages from the two regions have perceived that population pressure had a great impact on forest degradation as farmers livelihood is mainly depends on natural resources. In line with the present finding, FAO (2001); Hassan et al. (2016) and Solomon et al. (2018) have also reported that increasing population pressure is the main root cause for forest degradation.

Farmers perception on forest cover, ownership and related ecosystem services

Significantly higher proportions of the respondents (97.1%) in the Eastern Region of Ghana study village perceived that there is no forest near to their residence area or farmland in 2017. About 8.6, 54.3, 98.6 and 100% of the respondents perceived that there was a forest 5, 10, 20 and 40-years ago, respectively. Significantly higher proportions of the respondents (97.1%) perceived that large portion of the natural
forest has disappeared in many sites and 84.3% of the respondents indicated forest land has been decreased each year to a large extent. Under such conditions, forest ecosystem services such as timber, palm tree, forest animal meat, cultural and aesthetic, and erosion regulations, were drastically decreased. There are conditions totally stopped the delivery of such services (Table 4b).

In the Eastern Region, the majority of the respondents (70%) perceived that plantation trees decreased slightly in their village from time to time. However, significantly fewer number of the respondents (21.4%) perceived that plantation of forest land has been increased in the Eastern Region of Ghana. According to the majority of the respondents, there were natural plants (e.g., Mahogany (*Khaya ivorensis*) and animal species (e.g., Leopard (*Panthera pardus*) in the forest, but now disappeared. From such forest species a lot of benefits were being lost because of forest degradation (Table 4a). According to 94.3% of the respondents, forest is owned by individuals in the Eastern Region and so there is no government owned forest land in this region study village.

**Table 4a.** Farmers’ perception on forest cover, species and ownership in Eastern Region, Ghana (n = 70).
| Was/ is there forest | Respondents | Remark |
|----------------------|-------------|--------|
|                      | Yes (%)     | No (%)  | \( \chi^2 \) |
| Just in 2017         | 2 (2.9)     | 68 (97.1) | **       |
|                      |             |         | Very small (patched) areas of forest cover |
| 5-years ago?         | 6 (8.6)     | 64 (91.4) | **       |
|                      |             |         | Poor forest cover |
| 10-years ago?        | 38 (54.3)   | 32 (45.7) | ns       |
|                      |             |         | Medium forest cover |
| 20-years ago?        | 69 (98.6)   | 1 (1.4)  | **       |
|                      |             |         | Good forest cover |
| 40-years ago?        | 70 (100)    | 0 (0.0)  | **       |
|                      |             |         | Large landscape covered by forest |

| Who owns forest | Respondents | \( \chi^2 \) | Remark |
|-----------------|-------------|--------------|--------|
|                 | Yes (%)     | No (%)       |        |
| Individuals     | 66 (94.3)   | 4 (5.7)      | **     |
| Community       | 4 (5.7)     | 66 (94.3)    | **     |
| Government      | 0 (0.0)     | 60 (0.0)     | **     |
|                 |             |             | Almost all farmers perceived individual owned forest in the village |
|                 |             |             | Few farmers perceived as community forest |
|                 |             |             | Farmers did not have information about this |

| Forest cover status | Respondents | \( \chi^2 \) | Example of species and services lost |
|---------------------|-------------|--------------|-------------------------------------|
|                     | Yes (%)     | No (%)       |                                     |
| Natural forest has been disappeared | 68 (97.1) | 2 (2.9) | ** Mahogany (*Khaya ivorensis*), odum (*Milicia excelsa*), Giraffe (*Giraffa camelopardalis*), Deer (*Odocoileus virginiana*), Leopard (*Panthera pardus*), Antelope (*Hippotragus equinus*), soil exposed to erosion, siltation of reservoirs, decreases production |
| Natural forest has been increased | 3 (4.3)     | 67 (95.7)  | ** Natural tree species available |
| Natural forest has been decreased | 59 (84.3) | 11 (15.7) | ** Timber, palm tree oil (*Elaeis Guineensis*), cocoa (*Theobroma cacao*), wild fruits, herbal plants, bush meat e.g., grass cutter (*Thryonomys swinderianus*) decreased and in some areas total lost |
| Plantation forest has | 15 (21.4) | 55 (78.6) | ** Example, neem (*Azadirachta indica*) tree |
Plantation forest has been decreased

|                | 49 (70.0) | 21 (30.0) | Indicator: critical shortage of timber and non timber forest products |

Values in parentheses are percentages of respondents; χ², chi-square test; ** and *, significant at P ≤ 0.01 and P ≤ 0.05, respectively; ns, non-significant at P > 0.05

Source: Own Survey Data (2017).

In the study village from the Northern Region of Ghana, the proportions of farmers (3.3%) who perceived the presence of forest just during the interview time (June 2017) were significantly lower than those who did not perceive it. The proportions of farmer respondents who perceived forest in their village 40, 20, 10 and 5-years ago were 100, 98.3, 51.7 and 6.7%, respectively. The majority (significantly higher) of the respondents (91.7%) were perceived that forest land in their village has been owned by the community. About 98.3% of the respondents from the study village in the Northern Region agreed that natural forest is almost disappeared. Similarly, 65% of the respondents showed that plantation forest has decreased from time to time due to mismanagement. Examples of forest and animal species disappeared and lost their ecosystem services were Shea (*Vitellaria paradoxa*) from trees and Bufallo (*Bubalus bubalis*) from wildlife (Table 4b).

**Table 4b.** Farmers’ perception on forest cover, species and ownership in Northern Region, Ghana (n = 60).
| Was/is there a forest in your area | Respondents | χ² test | Remark |
|-----------------------------------|-------------|----------|--------|
| **Just in 2017?**                 |             |          | **     |
| Yes (%)                           | 2 (3.3)     |          |        |
| No (%)                            | 58 (96.7)   |          |        |
|                                  | **         |          |        |
| **5-years ago?**                  |             |          | **     |
| Yes (%)                           | 4 (6.7)     |          |        |
| No (%)                            | 56 (93.3)   |          |        |
|                                  | **         |          |        |
| **10-years ago?**                 |             |          | ns     |
| Yes (%)                           | 31 (51.7)   |          |        |
| No (%)                            | 29 (48.3)   |          |        |
|                                  | ns         |          |        |
| **20-years ago?**                 |             |          | **     |
| Yes (%)                           | 59 (98.3)   |          |        |
| No (%)                            | 1 (1.7)     |          |        |
|                                  | **         |          |        |
| **40-years ago?**                 |             |          | **     |
| Yes (%)                           | 60 (100)    |          |        |
| No (%)                            | 0 (0.0)     |          |        |
|                                  | **         |          |        |

**Who owns forest**

| Respondents | χ² test | Remark |
|-------------|---------|--------|
| **Individuals** | | **     |
| Yes (%)     | 3 (5.0) |        |
| No (%)      | 57 (95.0)|        |
|             | **      |        |
| **Community** | | **     |
| Yes (%)     | 55 (91.7)|        |
| No (%)      | 5 (8.3)  |        |
|             | **      |        |
| **Government** | | **     |
| Yes (%)     | 2 (3.3)  |        |
| No (%)      | 58 (96.7)|        |
|             | **      |        |

**Forest cover**

| Respondents | χ² test | Example of species and services lost |
|-------------|---------|-------------------------------------|
| **Natural forest has been disappeared** | | **Shea (Vitellaria paradoxa), Dawadawa (Pakia biglobosa), Mahogany (Khaya ivorensis), odum (Milicia exels), Wawa (Triplochiton scleroxylon); Amla (Phyllanthus emblica), Bufallo (Bubalus bubalis), Giraffe (Giraffa camelopardalis), Deer (Odocoileus Virginiana), Leopard (Panthera pardus), Antelope (Hippotragus equinus)** |
| Yes (%)     | 59 (98.3)|        |
| No (%)      | 1 (1.7)  |        |
|             | **      |        |
| **Natural forest has been increased** | | **Natural tree species available** |
| Yes (%)     | 0 (0.0)  |        |
| No (%)      | 60 (100) |        |
|             | **      |        |
| **Natural forest has been decreased** | | **Timber, palm tree, cocoa, fruits, herbal plants, bush meat (e.g., grass cutter)** |
| Yes (%)     | 46 (76.4)|        |
| No (%)      | 14 (23.3)|        |
|             | *       |        |
| **Plantation forest has** | | **e.g., Neem (Azadirachta indica) tree** |
| Yes (%)     | 19 (31.7)|        |
| No (%)      | 41 (68.3)|        |
|             | *       |        |
In this study, two contrasted results related to the ownership of forest lands were found from the Eastern Region and Northern Region of Ghana. In the Eastern Region, significantly higher proportions of the farmers (94.3%) perceived that forest is owned by individuals whereas in the Northern Region the farmers (91.7%) perceived that forest land is owned by the community (community forest). The result from both regions is against the report by Opoku (2005) and Blay et al. (2009) which reported that all forest lands in Ghana should be held in trust by the government. The same report also stated that the Forest and Wildlife Policy of 1948 stipulated that the government manage forest resources independently, without the collaboration of forest fringe communities, but this did not yield many positive results on forest management and conservation. The 1994 Forest and Wildlife Policy encourages to increase public awareness so that to involve in the establishment, management and utilization of forest resources (Opoku 2005) though it has low achievements in benefit sharing and collaborative resource management effectively and efficiently. From such explanations and the present results, it is suggested for policy revision/ reform to be more participatory and also create awareness strategically on farmers and other local community with regard to the shared role of the government and the local community as an owner of a forest land (Agyeman 1993; Opoku 2005). At this time, it is highly demanded to share clear role and information of farmers with regard to the ownership of forest land and expected roles in Ghana.

In addition, consistent with the current results of farmers’ perception on forest status and ecosystem services which are being lost in the two study regions, several reports have reported that forest degradation badly affected habitat loss leading to wildlife species loss (Misana 1999; FAO 2001; Saeed 2002; Abbasi et al. 2011; Gabol et al. 2012; Hassan et al. 2016). Similarly, the results of this study is in conformity with the reports which revealed that forest degradation could be destroyed many plant species from their habitats (e.g., Saeed 2002; Abbasi et al. 2011; Gabol et al. 2012). According to Blay et al. (2009) and Meijaard et al. (2013), tree products such as gums, wild cocoa, flowers, fruits, seeds and species; whilst forest products for food include mushrooms, snails, bush meat, palm fruits, tortoise, snakes, food stuff-plantain, cocoyam in which local farmer reported that they used to obtain from the forest in the past, but not or rarely available in the current condition.

In both study regions, the majority of the farmers (70% in the Eastern and 65% in the Northern Region) perceived that plantation forest land has been decreased. This result is contrasted to the report from

| Plantation forest has been decreased | 39 (65.0) | 21 (35.0) | * | Shortage of timber and non timber forest products |

Values in parentheses are percentages of respondents; χ², chi-square test; ** and *, significant at P ≤ 0.01 and P ≤ 0.05, respectively; ns, non-significant at P > 0.05

Source: Own Survey Data (2017).
Food and Agriculture Organization of the United Nations, FAO (2015), Keenan et al. (2015) and Zewdu and Beyene (2018) who reported that planted forest area has been increased from year to year because of expansion of reforestation, afforestation and other forest rehabilitation and restoration strategies through community participation in Africa. The possible explanation for such variability could be associated with the view of farmers’ on the number of tree plantations which might not consider the poor survival rate and slow growing of trees.

**Farmers perception on indicators of forest degradation**

In both regions of Ghana, farmers’ perceptions on forest degradation indicators varied significantly among the respondents (Table 5). For example, the indicator “stream flow has been decreased or dried” was perceived by 84% of the respondents in the Eastern Region study village whereas this was perceived by 36.7% of the respondents in the Northern Region. Similarly, 74.3% of the respondents in the Eastern Region perceived the indicator of forest degradation which is “farm land has been fragmented and decreased in size and soil fertility” whereas this indicator was perceived by 90.0% of the respondents in the Northern Region study village. Generally, declined in crop yield, irregularity in rainfall, increased in temperature, increased in number of rills, few or disappeared trees, and few or disappeared wildlife were the most significantly noted forest degradation indicators in both regions. The respondents who identified ‘runoff/ flooding has been increased’ as an indicator of forest degradation showed non-significant difference among the respondents in the Eastern Region whereas significantly higher proportions of respondents perceived increase in runoff as an indicator of forest degradation in the Northern Region of Ghana (Table 5).

**Table 5.** Farmers’ perception of indicators of forest degradation in the Eastern and Northern Regions of Ghana.
| Indicators                                                                 | Eastern Ghana Respondents (n = 70) | χ² test | Northern Ghana Respondents (n = 60) | χ² test |
|---------------------------------------------------------------------------|-----------------------------------|---------|-------------------------------------|---------|
|                                                                           | Yes (%)                           | No (%)  | Yes (%)                             | No (%)  |
| Stream flow has been decreased or dried                                  | 59 (84.3)                         | 11 (15.7) | **                                 |         |
| Farm land has been fragmented and decrease in size and soil fertility    | 52 (74.3)                         | 18 (25.7) | *                                  |         |
| Runoff/ flooding has been increased                                      | 35 (50.0)                         | 35 (50.0) | ns                                  |         |
| Runoff/ flooding has been decreased                                      | 2 (2.9)                           | 68 (97.1) | **                                 |         |
| Crop yield has been declined                                             | 67 (95.7)                         | 3 (4.3)   | **                                 |         |
| Gullies have been increased                                              | 44 (62.9)                         | 26 (37.1) | *                                  |         |
| Rills have been increased                                                | 57 (81.4)                         | 13 (18.6) | **                                 |         |
| Temperature has been increased                                           | 64 (91.4)                         | 6 (8.6)   | **                                 |         |
| Irregularity of rainfall has been increased                              | 67 (95.4)                         | 3 (4.3)   | **                                 |         |
| Fewer trees and increased distance and time to collect fuel wood         | 70 (100)                          | 0 (0.0)   | **                                 |         |
| Wildlife number has been decreased and there are many totally disappeared | 70 (100)                          | 0 (0.0)   | **                                 |         |
| Local tree species have been decreased and totally disappeared           | 70 (100)                          | 0 (0.0)   | **                                 |         |

Values in parentheses are percentages of respondents; χ², chi-square test; ** and *, significant at P ≤ 0.01 and P ≤ 0.05, respectively; ns, non-significant at P > 0.05. Source: Own Survey Data (2017).

In agreement to the indicators of forest degradation perceived by farmers in both study regions in the present results, reduction in soil fertility, increased in erosion, presence of burnt areas in the forest, reduced water supply and quality, reduction on forest sourced food, honey, fruits, seeds and tubers, have reported in the existing literature (e.g., Hall and Swaine 1976; Hawthorne and Abu-Juam 1995; Blay et al. 2009; Meijaard et al. 2013; Zewdu and Beyene 2018). When the forest land being degraded protective functions of forest resources can reduce in which this aggravates soil erosion such as the presence of rills, gullies and ravines, and plant root exposure and water quality and quantity related problems (Blay et
al. 2009; Hosonuma et al. 2012). Other researchers have also reported that soil characteristics and plant communities as indicators forest degradation can be described using water associated problems such as flooding of streams, rivers, ponds, springs and wetlands (Fitch and Adams 1998; Gregory et al. 1991; Blay et al. 2008).

In addition, in support to the present finding, forest degradation could affect the livelihoods and environment of the rural poor people in different ways including shortages of firewood, shortages of timber and non-timber forest products, accelerated soil erosion and low agricultural productivity (Stoorvogel and Smaling 1990; Blay et al. 2009; Zewdu and Beyene 2018). Consequently, maintaining and sustaining the diversity of indigenous forest tree species in natural forests is a matter of increasing concern not only for the condition of Ghana, but also for the entire world as forest degradation directly influences global climate conditions such as carbon emission and sinks. Such effect shows the need to give due attention for forestland rehabilitation and management options, particularly the degraded areas by involving local community. However, farmers assessment of forest degradation is not from the view of its contribution to climate change, but it is in terms of soil fertility depletion and soil erosion as those indicators are highly correlated to crop yields (Pulido and Bocco 2003; Malley et al. 2006). Farmers also reported elsewhere that locally derived site-specific common indicators of forest degradation are reported as reduced in plant species and density, high weed abundance, and changes in soil texture to stoniness (Warren et al. 2003; Oberthur et al. 2004; Styger et al. 2007; Hosonuma et al. 2012).

**Farmers’ perception on strategies that reduce forest degradation**

Farmers’ perception on possible strategies that reduces forest degradation in both in the Eastern and Northern Regions of Ghana study villages is presented in Table 6. The most frequently noted strategy to reduce forest degradation by farmers’ was strengthening and enforcement of forest related rules, regulations and strategies as perceived by 92.9% in the Eastern Region and 98.3% of the respondents from the Northern Regions of Ghana. This was followed by the strategy to practice afforestation/reforestation programme extensively, as perceived by 91.4% and 95.0% of the respondents from the Eastern and Northern Regions of Ghana, respectively. Introduction of zero grazing was suggested as a strategy to reduce forest degradation by significantly lower number of respondents. However, the proportion of respondents who did not perceive zero grazing as a strategy were higher in the Eastern Region (84.3%) than in the Northern Region (63.3%). In both regions, farmers have also poor perception on the strategies such as introduction of alternative sources such as solar energy, adaptation of crop types/varieties that are suitable to perform on degraded soils, and implementation of soil and water conservation practices (Table 6). Hence, awareness creation forums should be arranged for farmers and extension workers about such strategies and their contribution to tackle for forest degradation and improve soil productivity.

**Table 6.** Farmers’ perception on strategies that reduce forest degradation in the Eastern and Northern Regions of Ghana.
| Strategies                                                                 | Eastern Region: respondents (n = 70) | Northern Region: respondents (n = 60) | $\chi^2$ test |
|---------------------------------------------------------------------------|--------------------------------------|---------------------------------------|---------------|
| Introduce alternative livelihood sources such as solar energy             | Yes (31.4) 48 (68.6)                | Yes (48.3) 31 (51.7)                 | * ns          |
| Institutionize community awareness forums                                | 60 (85.4) 10 (14.6)                 | 53 (88.3) 7 (11.7)                   | **            |
| Strengthening and enforcement of forest related rules, regulations and strategies | 65 (92.9) 5 (7.1)                   | 59 (98.3) 1 (1.7)                    | **            |
| Adapt crop types suitable to degraded soil                                | 15 (21.4) 55 (78.6)                 | 14 (23.3) 46 (76.7)                  | **            |
| Intensification of soil and water management/conservation practices       | 28 (40.0) 42 (60.0)                 | 20 (33.3) 40 (66.7)                  | * ns          |
| Practice afforestation/reforestation programme                            | 64 (91.4) 6 (8.6)                   | 57 (95.0) 3 (5.0)                    | **            |
| Massively introduce agroforestry practices                                | 53 (75.7) 17 (24.3)                 | 35 (58.3) 25 (41.7)                  | ns            |
| Introduce zero grazing                                                    | 11 (15.7) 59 (84.3)                 | 22 (36.7) 38 (63.3)                  | * ns          |

Values in parentheses are percentages of respondents; $\chi^2$, chi-square test; ** and *, significant at $P \leq 0.01$ and $P \leq 0.05$, respectively; ns, non-significant at $P > 0.05$

Source: Own Survey Data (2017).

The participants in the interview and group discussions argued that forest degradation can be reduced through the introduction of forest and proper land management enforcement rules and regulations, price subsidizing for alternative sources of energy (solar), and institutionalize educational programs that enhance awareness levels of local people to manage and conserve forestland sustainably. Consistent with the present results on forest strategies perceived by the farmers in the two study regions, several previous reports have confirmed the need for natural regeneration and enrichment planting and soil and water conservation structures and their integration (Aerts et al. 2009; Hosonuma et al. 2012; Al-Subaiee 2016), strengthen forest governance and law enforcement, promote sustainable firewood collection (e.g. through awareness-raising, local regulations and law enforcement), and firewood efficiency (e.g., use of efficient stoves and heaters) (Hosonuma et al. 2012; Al-Subaiee 2016).

For actions against forest degradation to be successful the involvement of local communities is foreseeable as one of the most essential principles at local level development endeavours (Blay et al. 2008; Meijaard et al. 2013; Tesfahunegn 2019). Despite of such fact, local people are still in many cases not actively or genuinely involved in development projects in the sense that project initiators remained the
main decision makers and literally give advice to farmers on what to do in the two study regions conditions (Borrini-Feyerabend 1996; Fisher 1995). Farmers’ involvement is crucial because when real decision-making roles are devolved to local people they have the feeling of shared responsibility and they are likely to foster sound forest management (Appiah 2001; Zooneveld 2001; Blay et al. 2008). The direct involvement of local farmers on the exchanging of ideas and knowledge and practices can enhance their awareness, perception and commitment towards taking actions against forest degradation (Appiah 2001; Blay et al. 2008; Meijaard et al. 2013).

**Determinants of farmers’ perception on forest degradation**

The binary logistic analysis result indicated that age, education, farming experience, total farm size, farmland slope and income were the six variables that influenced significantly farmers’ perception on forest degradation in the study village from the Eastern Region of Ghana. The remaining variables did not influence significantly farmers’ perception on forest degradation (Table 7a). The logistic regression model correct prediction using the six determinant explanatory variables was explained by the model correct prediction value of 85% and model chi-square of 86 at $P = 0.001$ in the Eastern Region of Ghana.

The contribution of all the other variables remained constant; the odds ratios of the six determinant variables did show significant relationships with the likelihood of farmers being perceived on forest degradation. Such relations are explained using the odds ratios of the independent variables of age, farming experience, education, farmland slope, income, and farmland size as 3.725, 3.564, 3.416, 2.835, 2.712, and 2.658, respectively. The interpretation of the odds ratio of 3.725 for age as an explanatory variable indicates that all the other variables kept constant for every one-unit increase in this independent variable, the likely of a farmer being perceived on forest degradation increased by 3.725 folds. The same interpretation can be used for the odds ratios of the other determinant variables in Table 7a.

**Table 7a.** Logistic analysis of determinant variables of farmers’ perception on forest degradation in Eastern Region, Ghana.
| Variables                      | B    | S.E.  | Wald<sup>a</sup> | Exp(β)<sup>b</sup> | Sig.  |
|-------------------------------|------|-------|------------------|-------------------|-------|
| Gender                        | 0.67 | 0.38  | 1.763            | 0.190             | 0.295 |
| Age                           | 4.41 | 3.30  | 1.785            | 3.725             | 0.001**|
| Marital status                | 0.93 | 0.91  | 0.036            | 0.176             | 0.237 |
| Education                     | 3.51 | 3.66  | 0.910            | 3.416             | 0.002**|
| Total family size             | 1.20 | 1.36  | 0.882            | 1.008             | 0.210 |
| Farming experience            | 3.90 | 4.04  | 0.965            | 3.564             | 0.002**|
| Total livestock               | 0.26 | 1.71  | 0.023            | 0.774             | 0.462 |
| Total farmland size           | 2.43 | 2.28  | 1.136            | 2.658             | 0.032*|
| Farmland slope                | 2.69 | 2.82  | 0.910            | 2.835             | 0.030*|
| Farmland owned                | 1.33 | 2.50  | 0.283            | 0.013             | 0.450 |
| Farmland inherited            | 1.09 | 2.04  | 0.285            | 0.123             | 0.220 |
| Farmland rented in            | -1.05| 1.05  | 1.110            | 0.150             | 0.170 |
| Land security/tenured         | 1.15 | 2.08  | 0.306            | 1.005             | 0.215 |
| Farmland rented-out           | 1.06 | 1.31  | 2.239            | 0.1634            | 0.170 |
| Off-farm activity             | -1.30| 1.03  | 2.72             | 1.185             | 0.200 |
| Income from agriculture       | 2.59 | 3.26  | 0.631            | 2.712             | 0.031*|
| Forest distance from home/ main road | -1.20| 1.51  | 0.632            | 1.110             | 0.190 |
| Access to extension           | 1.12 | 2.80  | 0.129            | 1.108             | 0.570 |
| Access to credit              | 0.86 | 1.12  | 0.590            | 0.590             | 0.620 |
| Access to radio               | 0.73 | 1.94  | 0.143            | 0.480             | 0.631 |
| Access to association membership | 1.04| 1.62  | 0.412            | 0.561             | 0.350 |
| Constant                      | 4.232| 1.007 | 17.672           | 69.00             | 0.000 |
| Model chi-square (χ<sup>2</sup>) | 86   |       |                   |                   | 0.001 |
| Model Nagelkerke R<sup>2</sup> | 0.88 |       |                   |                   | 0.001 |
| Model correct prediction      | 85%  |       |                   |                   | 0.002 |

β, Estimated coefficient; SE, Standard error; R<sup>2</sup>, Coefficient of determination.
** Significant at probability level, \( p \leq 0.01 \). * Significant at \( p \leq 0.05 \); Values without asterisks are non-significant at \( p > 0.05 \).

The Wald statistic is the square of the ratio of the estimated coefficient to its standard error, which closely approximates a chi-square distribution (Cary and Wilkinson, 1997).

\[ \text{Exp(\( \beta \)) is the ratio of change in the odds of the event of interest to a one-unit change in the predictor.} \]

Source: Own Survey Data (2017).

In the study village from the Northern Region of Ghana, the determinant variables that influenced significantly (\( P < 0.05 \)) farmers’ perception on forest degradation were: age, education, total family size, farming experience, income from agriculture, farm distance from main road/home, and access to information (radio). The remaining explanatory variables were non-significantly influenced for the relationships between the dependent and independent variables (Table 7b). For example, farmers who involved the majority of their time on off-farm activities showed significantly lower perception on forest degradation. The binary logistic model correct prediction was explained by 84% and model chi-square value by 83 at 99% confidence level, indicating that the remaining small variability is due to the influence of other variables.

All the other variables remaining constant, the odds ratios of the seven determinant variables showed significant relationships with the likelihood of farmers’ perception on forest degradation in descending order as: age (3.25), farming experience (3.20), education (2.85), access to radio (2.49), family size (3.35), income from agriculture (2.26) and forest distance from the main road/home (2.17). The odds ratios of the determinant explanatory variable is interpreted as all the other variables kept constant for every one-unit increase in the independent variable (e.g., age), the likely of a farmer being perceived on forest degradation increased by 3.25 folds. Similar interpretation approach can be done on the odd ratios of the other independent variables that influenced significantly on the dependent variable.

**Table 7b.** Logistic analysis of determinant variables of farmers’ perception on forest degradation in Northern Region, Ghana.
| Variables                        | B   | S.E. | Walda | Exp(β)b | Sig.  |
|---------------------------------|-----|------|-------|----------|-------|
| Gender                          | -0.49| 0.52 | 0.871 | 0.580    | 0.472 |
| Marital Status                  | 0.73 | 0.49 | 2.227 | 0.689    | 0.365 |
| Age                             | 2.84 | 1.53 | 3.45  | 3.254    | 0.001**|
| Education                       | 2.54 | 1.46 | 3.053 | 2.850    | 0.004**|
| Total family size               | 2.17 | 1.59 | 1.863 | 2.349    | 0.021* |
| Farming experience              | 2.75 | 1.73 | 2.527 | 3.195    | 0.001**|
| Total livestock                 | 0.58 | 0.22 | 6.950 | 1.786    | 0.384 |
| Total farm size                 | 1.40 | 1.67 | 0.703 | 1.180    | 0.110 |
| Slope of farmland               | 1.49 | 0.84 | 3.160 | 1.200    | 0.096 |
| Own farmland                    | 0.34 | 0.69 | 0.252 | 0.600    | 0.512 |
| Inherited farmland              | 1.27 | 1.04 | 1.468 | 0.678    | 0.098 |
| Rented in farmland              | -0.41| 0.68 | 0.358 | 0.590    | 0.483 |
| Land security/tenure            | 1.03 | 1.14 | 0.816 | 0.752    | 0.194 |
| Rented out farmland             | -0.92| 0.73 | 1.599 | 0.120    | 0.174 |
| Off-farm activity               | -1.02| 1.28 | 0.635 | 0.853    | 0.203 |
| Income from agriculture         | 1.81 | 0.73 | 6.091 | 2.257    | 0.025* |
| Forest distance from main road/ home | -1.73 | 0.97 | 3.221 | 2.171    | 0.030* |
| Access to extension             | 0.93 | 0.75 | 1.55  | 0.891    | 0.284 |
| Access to credit                | 1.07 | 0.81 | 1.742 | 0.764    | 0.183 |
| Access to radio                 | 2.33 | 1.37 | 2.895 | 2.487    | 0.020* |
| Membership of association       | 0.63 | 1.92 | 0.107 | 0.533    | 0.354 |
| Constant                        | 3.367| 0.719| 21.921| 29.0     | 0.000 |
| Model chi-square (χ²)           | 83   |      |       |          | 0.001 |
| Model Nagelkerke R²             | 0.86 |      |       |          | 0.001 |
| Model correct prediction        | 84%  |      |       |          | 0.002 |

β, Estimated coefficient; SE, Standard error; R², Coefficient of determination.
**Significant at probability level, \( p \leq 0.01 \). *Significant at \( p \leq 0.05 \); Values without asterisks are non-significant at \( p \geq 0.05 \).

\(^a\)The Wald statistic is the square of the ratio of the estimated coefficient to its standard error, which closely approximates a chi-square distribution (Cary and Wilkinson, 1997).

\(^b\)Exp(\( \beta \)) is the ratio of change in the odds of the event of interest to a one-unit change in the predictor.

Source: Own Survey Data (2017).

In both study regions, gender did not influence significantly farmers’ perception on forest degradation (Table 7a and b). In contrast to the present finding, previous reports have indicated that farmers’ decision to clear vegetation for agriculture land is significantly influenced by gender because men are the head of household most of the time with the responsibility to meet family’s needs. This indicates that men involved highly in converting vegetation land into agricultural land more often than women (Chambers 1986; Vu et al. 2014; Meiyappan et al. 2016). In the present result, education status influenced significantly farmers’ perception on forest degradation in both regions because unwise decision to clear forest increases when a household head is illiterate. The illiterate farmers concern is to get income from selling of woods and charcoal and such farmers may not worry about the short-term and long-term consequences of cutting trees on soil productivity, and ecologically from local, national and global context (Mas et al. 2004; Vu et al. 2014; Dimobe et al. 2015). Besides to this, educated farmers can have better economic status and option to choose the best sustainable soil management practices as compared to illiterate farmers (Tesfahunegn et al. 2016; Tesfahunegn 2019). However, there are contrasting explanation to the present result on education by different researchers (e.g., Bekalo and Bangay 2002; Nigussie et al. 2017), who reported that educated farmers have not yet developed their capacity to take necessary measures against land degradation considering the different factors in the conditions of developing countries.

The family size of a household also influenced significantly the decision to clear vegetation and the perception on forest degradation in the conditions of the two regions. The bigger the family size usually connects with poverty (low income) in developing countries and is a key factor that leads to overexploitation of forest biodiversity resources and habitat degradation in forest areas in which this result conforms with the report by Chambers (1986); Hosonuma et al. (2012) and Meiyappan et al. (2016). A higher agricultural productivity from an arable land coupled with other landscape technologies can reduce the pressure on the adjoining forests (Vu et al. 2014; Meiyappan et al. 2016).

In addition, forest distance from the main road and/or home influenced significantly farmers’ perception on forest degradation in the study village from the Northern Region of Ghana (Table 7a). However, this variable was not significantly influenced farmers perception on forest degradation in the study village in the Eastern Region of Ghana (Table 7b). The mean distance of farmland, home and main road from the forest areas (mainly secondary forest) was reported as 1.6 km by many farmers in the study village from the Eastern Region in which this implies that there is similarity in the majority of the farmers’ perception on forest degradation due to this variable. In line with this result, it has reported that building of roads
increased the rate of forest degradation and deforestation and the nearest the road to the forest area affects positively farmers perception on degradation and vice versa (Mertens and Lambin 2000; Mas et al. 2004; Doygun and Alphan 2006; Keleş et al. 2008; Vu et al. 2014; Dimobe et al. 2015).

**Conclusions**

This study result shows that the socioeconomic attributes (e.g., income, education, age), farm attributes (e.g., farming experience, farmland size) and institutional attributes (e.g., access to extension) varied significantly among the farmers and so influenced significantly farmers perception on forest degradation in both study regions. Significantly higher proportions of the farmers from both study villages were perceived on the severe problem of forest degradation.

In the study village from the Eastern Region, the major direct causes of forest degradation perceived by most of the farmers were identified as high firewood and charcoal demand, wildfire/ bush fire and expansion of arable land. In the Northern Region, all farmer respondents perceived that high firewood and charcoal demand and wildfire/ bush fire were identified as the major direct causes of forest degradation. These were followed by expansion of arable land and free grazing. However, free grazing as a direct cause of forest degradation was perceived by significantly fewer farmers (8.6%) in the Eastern Region and this demand less attention while developing management strategy.

In the study villages in the Eastern and Northern Regions of Ghana, poverty followed by population pressures were perceived as the major indirect causes of forest degradation by most of the farmers. In both study regions, significantly higher proportion of the respondents perceived that there is no forest near to their residence or farmland in 2017. The distance to forest area from the farmers’ home to the forest land is too far in the northern Region than in the Eastern Region of Ghana. Significantly higher proportions of the framers perceived that the ecosystem services from forest land are almost disappeared at the current condition as it remains with secondary semi-deciduous pocket forest sites in the study villages. Relatively, forest degradation in the Northern Region is more severe than in the Eastern Region in which this indicates the need for being prioritized while introducing suitable interventions based on the available resources. The scope of farmers’ perception towards the expansion of a new forest plantation in both regions is also too limited. In both study regions of Ghana, farmer perceived that there are different forest degradation indicators which varied significantly among the respondents’ perception and past experiences.

The common indicator of forest degradation used by most farmers in both the study villages are decreased in tree and wildlife species or even totally disappeared, increased distance for firewood collection, followed by declining of agricultural yield and increased in irregularity of rainfall and temperature. Such results indicate that site-specific indicators should be used for supporting decision-making process against forest degradation. The most suitable strategy to reduce forest degradation as perceived by significantly higher proportions of the respondents from both regions included as
strengthening and enforcement of forest related rules, regulations and strategy, and awareness creation about the demand of afforestation/ reforestation programme extensively.

This study suggested for successful strategy development and implementation, understanding the most important variables that influence farmers’ perception on forest degradation is crucial. Age, education, farming experience and income from agriculture are the determinant variables for farmers being perceived forest degradation in both the study regions. In order to maintain the existing conditions and restore degraded forest areas farmers perceived on management strategies such as environmental regulations and rules, strengthening the linkage between farmers and extension systems, energy options to replace gradually firewood and charcoal demand, community awareness on natural resources conservation and management, and introduction of massive reforestation and afforestation programme by involving all stakeholders. Such recommended interventions should be designed to improve the community livelihood and avoid pressure on forest land and support to sustain the forest and its ecosystem services for the local community.

Declarations

Ethical approval was obtained to conduct this study from the Research Director Research Ethics Review Committee of United Nations University Institute for Natural Resources in Africa (UNU-INRA), University of Ghana, Campus Legon, Accra, Ghana. Before executed the interview, brief introduction was given about the purpose of the study for the District Office of Agriculture staffs. The same briefing was given for the farmers in the presence of the extension staffs. The farmers were also requested orally for their consent to involve in the study. Full right was given to the study participants to refuse and withdraw their participation at any time. Confidentiality of respondents was preserved by the researcher and enumerators during the questionnaire interview. It was also noted that this research has no any other activity that directly influences on human being life as data were collected using an interview approach. It is a normal process to contact respondents for such data collection after introducing about the objective of the study and showing the approved proposal for the District Office of Agriculture extension staff. The extension staff is a focal person in the Office of Agriculture who facilitated directly our communication with the farmers (respondents) in the study villages related to this research. The author declares that there is no conflict of interest. Data is available from the corresponding author upon reasonable request.

Ethical approval and Consent to Participate

Not Applicable

Consent for Publication

Not Applicable

Availability of Data and Material

The dataset analyzed during this study is available from the corresponding author on reasonable request.
Competing interest

The authors declare that they have no competing interests.

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Authors’ contributions

The first author conducted the field data collection and analysis. The remaining authors involved from the proposal development, field organization and revised the draft of the manuscript.

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**Figures**
Figure 1
Map of Ghana with its regions and forest reserve sites (Source: Ghana Ministry of Lands and Natural Resources 2012).
Figure 2

Firewood, charcoal and bush burning observed in the Eastern Region of Ghana study village (Source: Gebreyesus Brhane Tesfahunegn, Feb 2017)

Figure 3

Firewood (A); and (B) bush burning observed in the Northern Region of Ghana (Source: Gebreyesus Brhane Tesfahunegn, June 2017)