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Research Application Summary

Dynamics of agricultural expansion into forest habitats in Ghana

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Abstract

Ghana's increase in farm productivity is at the detriment of the preservation of the forest. Should we preserve the forest or use it to farm. This study look at the profitability of an investor in keeping a forest or farming. The big question here is, is it economically feasible to manage forestland or use for farm production. Sample pollution for the study is 385. Primary data will be collected from the two zones in Ghana namely the high forest and the savannah zone. Three districts each in the zones would be selected based on their forest dominance. Two communities from each district would be randomly selected where 32 respondents each would be interviewed.

Keywords: Depletion, economically viable, farmland, farm productivity, forest, future

Resume

L'augmentation de la productivité agricole au Ghana se fait au détriment de la préservation de la forêt. Faut-il préserver la forêt ou l'utiliser à des fins agricoles ? Cette étude examine la rentabilité d'un investisseur dans la conservation d'une forêt ou dans l'agriculture. La grande question ici est de savoir s'il est économiquement faisable de gérer des terres forestières ou de les utiliser à des fins de production agricole. L'échantillonnage pour l'étude est de 385. Les données primaires seront collectées dans deux zones au Ghana, à savoir la forêt dense et la zone de savane. Trois districts de chaque zone seront sélectionnés en fonction de leur domination forestière. Deux communautés de chaque district seront sélectionnées de manière aléatoire, où 32 répondants chacune seront interviewés.

Mots-clés : Épuisement, rentable économiquement, terre agricole, productivité agricole, forêt, avenir

Introduction

Sartoretto *et al.* (2017) mentions that intensive commercial farming in developing countries is associated with about 40 percent of deforestation since vast portions of land is required. There is a typical resource economic management problem of overutilization of renewable resource (unmanaged forest) with conflict arising due to two main concerns: economic growth concern (destruction of unmanaged forest cover for farming in the present generation) and intergenerational concern (conservation of managed forest cover for future). Even though there are negative effects on use of the unmanaged forestland such as erosion and carbon sequestration, people continue to farm on unmanaged forestlands in other to achieve SDG 2 (Zero Hunger). It is needful to determine factors that influence use of the unmanaged forest for farming expansion.

Ghanaweb (2019) states that Government is allocating GHC400million to promote lending in the farming sector. This is to boost production of food in Ghana. Boosting production of food in Ghana would mean more use of unmanaged forestland for farming expansion. It is unclear the cost the future generation might pay because of turning unmanaged forestlands into farmlands. The programmes of Ghana such as planting for food and jobs has encouraged commercial farms to further use the unmanaged forest. Meanwhile unmanaged forestland can be managed to generate much timber which would be harvested in due time to generate much income for Ghanaians. There would be sustainability of the forest and the environment would be preserved.

Gakpo (2017) mentioned that Ghana would import timber as a result of excessive use of the unmanaged forest reserve. This implies that the future generation would have to pay more in other to get timber for use. The question is: should we manage forestland or use for farming?

It appears that people misuse unmanaged forest since they do not even know the value of managing forestland. They thus are not able to compare the benefit derived from the use of unmanaged forestland for farming and the economic value of the managed forest.

It is unclear the cost the future generation might pay as a result of turning unmanaged forestlands into farmlands. The big question here is, is it economically feasible to manage forestland or use for agricultural production.

Objectives

1. To access the factors that influence use of the unmanaged forest for farming expansion.
2. To determine the profitability of managed forest in Ghana.
3. To determine the profitability of using unmanaged forestland for farming.

Justification

Land use, for a long time, is seen as a field for geography instead of agribusiness. Agribusiness look at how to minimize cost and maximize shareholders income. Agribusiness then looks at the business side of farming which includes production, transportation, value addition, processing and the final delivery to the consumer. Forestland is a major input in farming production. Few studies in farming has looked at the profitability of use of forestlands. Economic feasibility of farming and forestland is more inclined to agribusiness than geography. This study is therefore important to determine the best choice to use forestlands. Scholars in agribusiness would also be encouraged to do more research in the forest industry in order to enhance the development of this industry.

von Amsberg (1998) stated that land is put to the use that maximizes the present value of profits to the decision maker. Many of the benefits derived from the unmanaged forest is not measured monetarily. Decision taken around the management of unmanaged forest may therefore be unsustainable and sub-optimal. This study aims to make these cost and benefits visible by estimating the value of managed forestlands in Ghana. The study would enlighten investors on the lucrativeness of operating managed forest.

Gakpo (2017) mentioned that Ghana would import timber as a result of excessive use of the unmanaged forest reserve. This implies that the future generation would have to pay more in other to get timber for use. Meanwhile the government is investing about 10% of the 2019 budget to

farming by embarking on planting for food and jobs and rearing for food and jobs. This programme has a long-term effect of depleting the forestlands. Jobs can be created from managing the forest. This study would support the government of Ghana in its efforts towards the sustainable land use and forest management so as to safeguard the ecosystem services supply to both local and downstream stakeholders.

Material and Methods

Theoretical framework

Von Thunen model. Von Amsberg (1998) stated that land is put to the use that maximizes the present value of profits to the decision maker. The partial equilibrium model of profit-maximizing land use is used to determine dynamic land use as a function of an exogenous path of log prices over time. The model analyzes the timing of land-use changes for each specific parcel of land. Initially, all land is covered with unmanaged forest so there is no profit to the owner. When the unmanaged forest is converted, the owner puts the land to its profit-maximizing use, either as managed forest or as farm land depending on the profit or loss at the time of conversion (value of logs-if sold- minus clearing or logging costs) and the profits from alternative land use after logging (farming or managed forest). In this model, the value of logs represents all managed forest products, including latex, fruits, nuts, and fuelwood. The model is equally applicable in cases where (a) the unmanaged forest is logged, the logs are sold, and the land is subsequently cultivated. (b) the unmanaged forest is logged but the land is left idle after logging, or (c) the removal of logs is not profitable, and the unmanaged forest is simply cleared for subsequent farming or managed forestry as shown in Figure 1. After the initial conversion of the unmanaged forest, the owner may switch between different alternative land uses. Of course, on some lands logging not occur in finite time. The following diagram shows the sequence of possible land use.

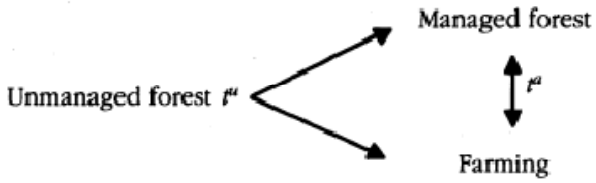

Figure 1. Theoritical Farmework
Adopted from Von Amsberg (1998)

where t^u is the time of converting unmanaged forest to managed forest or farming, and t^a is the time of switching from managed forest to farming or from farming to managed forest in Eq1.

$$\Pi^{ia}(t^{iu}, k) = \int_{t^{iu}}^{\infty} e^{-rs}\pi^{ia}(s, k)\mathrm{d}s \qquad \text{.....Eq1}$$

Equation 1 defines the present value of profit from profit-maximizing land use, Π^{id}, in land class i from the time of conversion of unmanaged forest to infinity. Superscript a refers to the profit-maximizing land use-either managed forest or farming-after logging the unmanaged forest. *k* is a parameter that represents the effect of exogenous policy changes on the log price,π is profit in each period, and *s* is the time passed after conversion of the unmanaged forest at t" Superscript *u* refers

to unmanaged forest, and r is the discount rate of the decision maker.

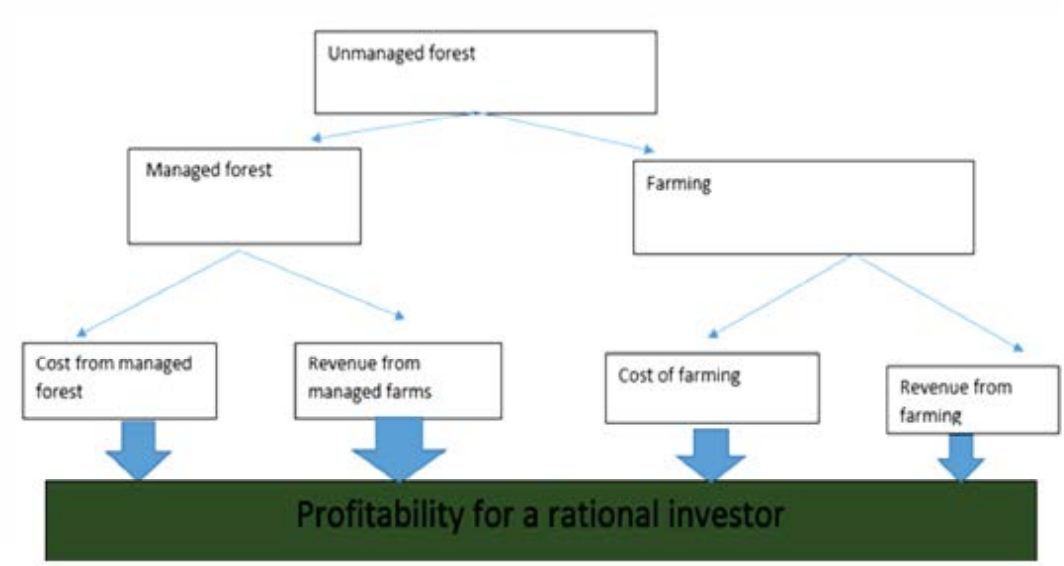

Figure 2. Conceptual Framework

From Figure 2, it is assumed that unmanaged forest give no money as a rational investor would choose between a managed forest and agriculture production

Method of data collection

Sample size. The sample size would be calculated using Scott (2012) formula for unknown population. A total of 385 respondents would be selected from the communities sampled.

Sample size = (Z-score)2 * StdDev*(1-StdDev) / (margin of error)2, where Z= confidence level and StdDev= Standard deviation (Scott, 2012).
The researcher would choose a 95% confidence level (1.96), a 0.5 standard deviation, and a margin of error (confidence interval) of +/- 5%.
(1.96)2 * 0.5*(1-0.5) / (0.05)2= 385

Selection of research site and sampling procedure. Primary data will be collected from the two zones in Ghana namely the high forest and the savannah zone (Boakye, 2010). The multistage sampling technique will be used to select respondents. Ghana is roughly divided into the High zone in the south and the Savannah Zone in the north (Boakye, 2010). The study would be done in all these two zone to give a representation of the country. Three districts (at most one district in a region) in each of the zones would be purposively selected based on the presence of the forest reserve (Kuma, 2011). The presence of forest reserve implies that the district is forest dominated (Schep *et al.,* 2016).
Three districts each in the zones would be selected based on their forest dominance. Two communities from each district would be selected where 32 respondents each will be interviewed.

Interview procedure. Data would be obtained through primary source. The primary data would be collected through interviews using a pre-tested structured questionnaire (Mack *et al.,* 2005). This study would employ quantitative research approach. The researcher would collect data from households.

Method of Data analysis

Identifying factors that influence use of the unmanaged forest. Linear regression would be used to estimate unknown parameters. Based on the theoretical discussion on the economic feasibility of replacing unmanaged forestlands with food farming and managed forestlands, the logit or probit model as specified in equation 2 would used. The probit or logit model would be used to show the factors that influence use of the unmanaged forest (See Table 1)

Use of unmanaged forest land = F(Hos,Sal,Age,Vir,Edu,Dis,Fob,Min,Opt,Agr)

$U = \beta 0 + \beta 1X1 + \beta 2X2 + \beta 3X3 + \beta 4X4 + \beta 5X5 + \beta 6X6 + \beta 7X7 + \beta 8X8 + \beta 9X9 + \beta 10X10 + E$…….Eq 2

Table 1. Measurement of Variables

Variable	Variable description	Measurement	Expected sign
Dependent variable D	Use of unmanaged forest land in the last one year	Farm=1 Managed forest=0	
Independent variables Socio-economic characteristics			
X_1 = Household size	The number of people in the household	Number of people	+
X_2= Salary	The amount of money received by the household at the end of the month	Amount in Ghana cedis	+/-
X_3= Age	Age in years	Number	-
Institutional policy			
X_4= Visitation by representatives from Forestry Commission	The number of visit from representative from Forestry Commission	Number of visitation	-
X_5= Education on importance of forest	The frequency at which he hears information on the importance of forest	Very frequent=1 Frequent=2 Neutral=3 Not frequent=4 Never=5	-
Technical factors X_6= Distance	Distance to the food market	Kilometers	-
X_7= Forest benefits	Whether he has been involved in logging and fetching products from the unmanaged forest for the past 6 months	Yes=1 No=0	-
X_8=Timber log prices	Perception on percentage change in timber log for the next 80 years	% decrease in price=1 No % change in price=2 0-49 % increase in price=3 50-100 % increase in price=4	+/-

		price=4 More than 100 % increase in price=5	
X_9= Option value on the unmanaged forest	Amount he is willing to pay every year for the preservation of the unmanaged forest	Amount in Ghana cedis	-
X_{10}= Farming	Whether he has been involved in farming for the past 6 months	Yes=1 No=0	+
Rise in price of farm goods	Perception on percentage change in farm goods for the next 80 years	% decrease if price=1 No % change in price=2 0-49 % increase in price=3 50-100 % increase in price=4 More than 100 % increase in price=5	+

Variable Description and Measurement in Table 1

Socio-economic characteristics. Household size is the number of people in the household. Household size of a respondent would be measured as a continuous variable. It is expected that increase in household size would have a positive effect on the use of unmanaged forestland for farming.

Salary is the amount of money paid to the household at the end of the month. Salary is the income of a respondent measured in Ghana cedis. The expectation of effect of salary on the use of unmanaged forestland for farming is mixed.

Age is the number of years of the person. Age is measured as a continuous variable. It is expected that increase in age of a respondent would have a negative effect on the use of unmanaged forestland for farming.

Government policy. Visitation by representatives from Forest Commission is the number of visit from representative from the Forestry Division. This is measured as a continuous variable. It is expected that increased number of visits by forest representatives would have a negative effect on the use of unmanaged forestland for farming.

Education on forest is the frequency at which a respondent is exposed to education on the importance of the forest. This is measured as Very frequent=1, Frequent=2, Neutral=3, Not frequent=4 and Never=5. It is expected that increased frequency of education on forest would have a negative effect on the use of unmanaged forestland for farming.

Technical factors. Distance is distance from respondent's house to the food market. It is measure in kilometers. It is expected that distance would have a negative effect on the use of unmanaged forestland for farming.

Forest benefit is the involvement of respondent in logging and fetching products from the

unmanaged forest for the past 6 months. It is measured as a dummy variable where Yes=1 and No=0. It is expected that involvement of respondent in logging and fetching products from the unmanaged forest for the past 6 months would have a negative effect on the use of unmanaged forestland for farming.

Timber log prices is the perception on percentage change in timber log for the next 80 years. It is measured as % decrease in price=1, No % change in price=2, 0-49 % increase in price=3, 50-100% increase in price=4, More than 100 % increase in price=5. The expectation of effect of perception on timber log prices on the use of unmanaged forestland for farming is mixed.

Option value on the unmanaged forest is the amount a respondent is willing to pay every year for the preservation of the unmanaged forest. It is measured in Ghana cedis. It is expected that an increased amount would have a negative effect on the use of unmanaged forestland for farming. Farming is whether a respondent has been farming for the past 6 months or not. It is measure as a dummy variable where Yes=1 and No=0. It is expected that involvement in farming for the past 6 months would have a positive effect on the use of unmanaged forestland for farming.

Rise in price of farm goods is the perception on percentage change in farm goods for the next 30 years. It is measured as % decrease in price=1, No % change in price=2, 0-49 % increase in price=3, 50-100% increase in price=4, More than 100 % increase in price=5. It is expected that increased perception of % change in price of farm goods would have a positive effect on the use of unmanaged forestland for farming.

Profitability analysis. The study would employ both discounting and non-discounting methods to analyse profitability of using unmanaged forest land for managed forest or farming. The discounting methods to be used include the net present value (NPV), the internal rate of return (IRR) and the benefit-cost ratio (BCR). The non-discounting method to be used is the payback period. Sensitivity analysis would also be used. Mathematical expression for these methods are shown in Equation 3 to 6:

$$NPV = \sum_{t=0}^{n} \frac{(c_t - b_t)}{(1+k)^t} \quad \text{.....Eq 3}$$

Where
c_t = cash inflows in each project year
b_t= cash outflows in each project year
n= number of years
k = interest (discount) rate

The selection criterion is to accept all independent projects with NPV of zero or greater, at a specified discount rate. A negative NPV implies that at the assumed opportunity cost of capital, the present worth of the benefit stream is less than the present worth of the cost stream, rendering the enterprise unable to recover its investments.

$$IRR = \sum_{t=0}^{n} \frac{(c_t - b_t)}{(1+k)^t} = 0 \quad \text{.....Eq 4}$$

c_t = cash inflows in each project year
b_t= cash outflows in each project year
n= number of years
k = interest (discount) rate

The general rule when estimating the IRR by trial and error is that; if at a given discount rate the net present value is positive, the discount factor is increased, and if at a given discount rate the net present value is negative, the discount factor is reduced The true discount factor, however, will usually lie between these two discount factors. The decision rule is to select the project that gives a higher IRR

$$BCR = \frac{\sum PV \text{ Cash inflows}}{\sum PVCash \text{ outflows}} \quad \text{..... Eq 5}$$

The decision rule is to accept the project that gives a higher BCR

$$\text{Payback period} = \frac{Cost \text{ of project or cashflows}}{Annual \ cashflows} \quad \text{.....Eq 6}$$

The decision rule is to accept the project that gives a lower payback period.

Sensitivity Analysis . Sensitivity analysis is the study of how uncertainty in the output of a model (numerical or otherwise) can be apportioned to different sources of uncertainty in the model input. It could be the most useful and widely used technique open to agricultural economists (Pannell, 1997). Sensitivity analysis can be used for the following purposes; to establish how robust the optimal solution is in the face of different parameter values, to determine under what circumstances the optimal solution would change, to know how the optimal solution changes in different circumstances and to find out how much worse off the decision makers would be if they ignored the changed circumstances and stayed with the original optimal strategy or some other strategy (Pannell, 1997). It shows generally the effect on what is being analysed if there is a deviation from expectation of variables.

Determining the profitability of managed forest. The study considers five mostly cultivated commercial timber cultivars namely Rose wood (Dalbergia nigra), Wawa (Triplochiton scleroxylon), Odum (Milicia excels), Sapele (Entandrophragma cylindricum) and Mahogany (Khaya ivorensis). The profitability analyses as specified would be used. A discount factor of 10% with a projected period of 80 years would be used. This is because a new generation would spring up by 80 years (Schep et al., 2016).

Determining the profitability of farming. Cocoa, cassava and maize would be the selected crops for farming. The profitability analyses as specified would be used to determine the profitability of farming. A discount factor of 10% with a projected period of 80 years would be used. This is because a new generation would spring up by 80 years (Schep et al., 2016).

Conclusions

Expected outputs

1. Factors that influence use of the unmanaged forest for farming expansion accessed.

2. Profitability of managed forest in Ghana determined.
3. Profitability of using unmanaged forestland for farming determined.

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