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## ABSTRACT

Agricultural land use and the management of agricultural lands in Ghana as evidenced from farmer practices have been analysed using descriptive and regression analysis. The analysis shows that different land management practices affect crop yields differently in the different ecological zones. Also, the types of land management practices farmers use differ across the different ecological zones. The policy implication is that agricultural interventions should be developed on the basis of agro-ecological zones, and blanket crop improvement packages should be avoided. The recommended policy action is that food crop farmers should be helped to improve the management of their agricultural lands by ecological zones at two levels. First, the practices that are common and promote agricultural production in each zone should be targeted for improvement. Such a policy will re-orient farmers towards the adoption of more sustainable farm practices. Second, land management practices that are not currently being used by farmers in each zone but have potential to improve crop production should be identified and promoted in the respective agro-ecological zones. A pro-active policy of this kind will provide farmers better land use alternatives in each ecological zone.



Key Words: Land Management, Crop Yields, Ecological Zones, Productivity, Practices


## INTRODUCTION

Agricultural production growth rate in Sub-Saharan Africa has declined over the years since the 1970s. Food production declined steadily from an annual average of 2.6% in the 1960s to 1.6% in the 1970s, and then to 0.9% in the 1980s (World Bank, 1982). A combined effect of declining food production and increasing population resulted in the increase in the importation of food to West Africa at an annual rate of 9.7% during the period 1986 to 1992 (Olayemi, 1996). Real GDP growth rate for West Africa also declined from a moderate 5% in 1990 to a low 2.7% in 1999, while the debt service ratio for the sub-region averaged roughly 20% of exports during the 1990s (African Development Report, 2000). These declining trends have not changed much in the 2000s, in spite of both regional and country efforts to reverse the trend.

Okai (1997) asserts that destructive traditional land use and conservation practices have reduced soil fertility levels in the sub-region, which has reflected in declining crop yields. There are several factors responsible for land degradation, defined by Gretton and Salma (1997) as decline in the biological productivity or usefulness of land resources in the predominant intended use, which stem from human activity. These include cultivation of lands that were originally marginal (such as superficial soils and land with steep slopes), crop rotations that are too close, mining agriculture, and the absence of soil and water conservation practices (Gough and Yankson, 1997; Kufogbe, 1996). Melane, (2008) argues that some major problems of soil productivity in SSA include population growth, pressure on land, food production practices, land degradation and soil fertility decline, drought, land rights, technology, etc. There is therefore the need for holistic and integrated approaches for sustainable land management and soil productivity improvement.

In addition, the encroachment upon marginal lands as a result of increasing populations, and reduction in rainfall has been identified as a major cause for yield declines. Ampadu-Adjei, et al (1994) estimate that over 70% of the original 8.2 million hectares of closed forest in Ghana have been destroyed by unsuitable agricultural practices resulting from high demand for agricultural lands, fuel wood, logging and bush fires. A study by Gyasi (1998) also established that between 1970 and 1996, increases in the production of cassava and yams in Ghana were achieved by extensive (bringing more land into cultivation) rather than intensive cultivation.

Also, overgrazing of livestock, inappropriate land use practices due to absence of coherent and enforceable land use policies, breakdown of traditional enforcement mechanisms for conserving common property, as well as the use of inappropriate technologies by small scale farmers for cultivating land are all responsible for land degradation. Indeed, the rate of land degradation is on the increase, and poses a threat to food security in the sub region (Hudson, 1987; Dregne, 1990). Work done by Melane et al (ibid.) on sustainable management practices such as reduced tillage, stone bunds, and chemical fertilizers in Ethiopian highlands showed that there is indeed strong evidence that adoption of stone bunds, reduced tillage and chemical fertilizers have impact on agricultural productivity.

Due mainly to the rainfall pattern and environmental conditions, agricultural activities in Ghana tend to follow the ecological zones, namely: coastal savannah, forest, transition, Guinea savannah and Sudan savannah zones, implying different agricultural practices in the different zones. This pattern tends to associate certain crops with specific ecological zones, such as sorghum and millet in the northern savannah region, and maize and cassava in the forest and transition zones; even though arguably, most food crops are found across all ecological zones. The issues that arise then are: (a) what are the common agricultural practices associated with the different crops in the various ecological zones of Ghana? (b) what are the common land management practices in the different zones, and how do these affect crop yields? And (c) what are farmer preferences in terms of land management practices and why?

In order to understand the food production patterns in the various ecological zones and their implications for food security, and also appreciate farmer resource use in agriculture in these zones, there is the need to investigate the foregoing issues. This paper attempts to do same. In particular, the ecological zones in Ghana have been regrouped into three broad areas – forest zone, transition zone, and savannah zone, and the unique characteristics of each zone and how they impact farming activities analysed.

The focus of the study is therefore to assess farmer strategies in land management practices that directly affect food production in Ghana. The specific objectives are to:

- Determine the land management practices associated with various crops in the different ecological zones of Ghana.
- Determine the effect of different land management practices on the yield of various crops in Ghana.
- Determine weather land management practices in food production differed across ecological zones; and

## METHODOLOGY

The analysis was done at three levels using descriptive statistics and regression analysis. Descriptive analysis was used to show the distribution of farmers and their production across the ecological zones. Multiple regression analysis was applied to determine the effect of land management practices on the yields of various crops in the different ecological zones.

The first level of analysis, which used descriptive statistics, identified the different land management practices commonly used by farmers across the different ecological zones. Frequency tables were constructed to show the proportion of farmers that used different land management practices. Chi-square analysis was then applied to determine whether these practices were significantly different across ecological zones. The second level of analysis used Spearman's Correlation to determine the degree of association of crop yields with different land management practices. A multiple regression was then applied to determine the effect of these practices on crop yields by ecological zone.

### Theoretical Framework

A derivative of production function analysis was adopted to estimate the effects of land management practices on food crop yields. A basic practical assumption in the context of food production systems in Ghana is that farmers have a range of land management practices available to them, both within and across ecological zones. One way to measure the effects of such land management options is to include these management practices in the production function as variables, separate from physical inputs (Ali, 1996).

A general form production function (in matrix form) can be specified as:

$$Q = f(X, Z)\, e^{u} \qquad (1)$$

where Q is the output of the particular food crop, X is a vector of variable inputs, Z is a vector of land management practices, u is the error term, and e is the exponential term. The first derivative of equation (1) with respect to the various land management practices provides coefficients of the different land management practices that measure their accumulated carry-over effects on crop yields. In this analysis, a multiple regression model that related different crop yields to the land management practices was estimated to provide quantitative measures of the effects of these practices on crop yields.

The equation used for the estimation is given (in natural logarithm except the dummies) as:

$$Y_i = \beta_0 + \beta_L L_i + \beta_K K_i + \beta_S S_i + \beta_B B_i + \beta_P P_i + \beta_F F_i + \alpha_R R_i + \beta_A A_i + \beta_M M_i + U_T \qquad (2)$$

where $Y_i$ is yield of crop (kg/ha), $L_i$ is labour (man-days), $K_i$ is plot size (ha), $S_i$ is slash and burn (practice = 1, and 0 otherwise), B is bush fallow (i.e. if the farmer practices bush fallow; practice = 1, and 0 otherwise), P is the length of the bush fallow period (in years), F is fertilizer use (kg/ha), R is row planting technology (practice = 1, and 0 otherwise), A is practice of agro-forestry (practice = 1, and 0 otherwise), and M is practice of mixed-cropping (practice = 1, and 0 otherwise).

## Data Sources

The analysis was based on primary data collected through field surveys in nine districts in Ghana. Three districts were selected from each of the ecological zones, namely: Forest zone, Transition Zone, and Savannah zone. Three hundred and twenty (320) households were then randomly selected from a number of enumeration areas (based on MoFA demarcations) in each district for a total of nine hundred and sixty (960) households per zone. The total number of respondents interviewed for the study was two thousand eight hundred and eighty (2,880) households. Table 1 presents the districts and farming activities selected by zone. Note that fish and livestock were not covered in this analysis.

**Table 1. Farming activities in selected districts in the different ecological zones of Ghana**

| Ecological Zone | Selected Districts | Major Farming Activities |
|---|---|---|
| Forest | Atwima, Assin, and Akwapim South | Maize, Cassava, Livestock, Fish, and Conservation practices |
| Transition | Nkwanta, Kintampo, and Ejura/Sekyedumase | Maize, Cowpea, Yam, Livestock, and Conservation practices |
| Savannah | Lawra, West Mamprusi, and Builsa | Rice, Sorghum, Livestock, and Conservation practices |

## MAIN FINDINGS OF THE STUDY

The responses of farmers to questions on land management practices revealed that except for a few farming activities, generally farmer practices significantly differ across ecological zones. In terms of land clearing, slash and burn, for example, is the most common practice in the forest (92%) and transition (79%) zones, while tractor ploughing is the most important in the savannah zone (36%). And while 37% of farmers have adopted agro-forestry technology in the Savannah zone, none of the farmer respondents in the forest zone uses agro-forestry technology.

### Land Management Practices and Food Crop Yields

***Chi-square and Correlation Analysis***

The Chi-square analysis confirms that significant differences exist in land management practices across the three ecological zones. For example, except for soil conservation technology, which is rarely practiced in the forest zone, all other land management practices between the forest and transition zones significantly differ from each other (Table 2).

Correlation analysis showed positive association between some land management practices by farmers and crop yields across all zones, implying that such practices significantly affect crop yields. For example, length of fallow period and cropping system practiced significantly affect cassava yields in the forest zone, while length of fallow period and method of land clearing affect maize yields in the transition zone. On the other hand, the use of soil conservation technology is what most significantly affects rice yields in the savannah zone.

**Table 2. Comparing land management practices in the three ecological zones of Ghana**

| Ecological Zones | Management Practices | N | Chi-Square value | Significant Level |
|---|---|---|---|---|
| Transition vrs Forest zone | Length of fallow period | 201 | 70.427 | 0.019 |
| | Cropping system | 550 | 234.502 | 0.000 |
| | Crop rotation | 456 | 19.618 | 0.012 |
| | Adoption soil fertility improvement technology | 101 | 25.760 | 0.000 |
| | Soil conservation tech. | 86 | | No association |
| Transition vrs Savannah zone | Length of fallow period | 211 | 65.440 | 0.182 |
| | Cropping system | 577 | 338.368 | 0.000 |
| | Crop rotation | 426 | 43.529 | 0.000 |
| | Adoption soil fertility improvement technology | 132 | 14.443 | 0.000 |
| | Soil conservation tech. | 94 | 3.628 | 0.057 |
| | Agroforestry | 76 | 5.952 | 0.015 |
| Forest vrs Savannah zone | Length of fallow period | 253 | 51.437 | 0.648 |
| | Cropping system | 574 | 231.397 | 0.038 |
| | Crop rotation | 454 | 17.228 | 0.028 |
| | Adoption soil fertility improvement technology | 426 | 2.682 | 0.102 |
| | Soil conservation tech. | 406 | 0.112 | 0.738 |
| | Agroforestry | 340 | 0.576 | 0.448 |

Source: Computed from Survey data.

***Regression Analysis***

The magnitudes of the effects of the various land management practices on the yields of maize, cassava, yam, rice, cowpea and sorghum in the forest, transition and savannah zones were estimated using regression analysis. In each case, the ordinary least squares (OLS) method was used to estimate the respective multiple regression (see equation 2). The results are presented in Tables 3 to 5.

In the forest zone row planting and the number of family labour employed significantly influenced maize yield (Table 3). Row planting affects maize yield negatively which is in contrast to expectation. This is perhaps due to widespread practice of mixed cropping in the zone, and therefore inappropriate specification of the rows by the farmers. Also, row planting is usually more effective with other technologies such as the use of fertilizers and improved varieties, the use of which are not widespread among farmers in the forest zone. Extension services must therefore be extended to farmers to educate them on correct crop spacing (particularly when mixed-cropping is practiced), and the need to apply complete technological packages on their farms. Other farming practices adopted by farmers have no significant effect on maize yield in the forest zone.

**Table 3. Regression of land management practices on yields of maize and cassava**

| | Maize in Forest Zone | | | Maize in Transition Zone | | | Cassava in Forest Zone | | |
|---|---|---|---|---|---|---|---|---|---|
| Variables | Coeff | Std. Error | t-Value | Coeff | Std. Error | t-Value | Coeff | Std. Error | t-Value |
| Constant | 1.42* | 0.77 | 1.86 | 2.59*** | 0.19 | 14.03 | 0.62 | 0.86 | 0.72 |
| Slash and burn | -0.22 | 0.20 | -1.06 | -0.17** | 0.08 | -2.20 | 0.45 | 0.37 | 1.23 |
| Bush fallow | 0.13 | 0.14 | 0.91 | -0.55*** | 0.16 | -3.38 | -0.49** | 0.18 | -2.67 |
| Length of fallow period | 0.02 | 0.04 | 0.59 | -0.05** | 0.02 | -2.40 | -0.07 | 0.04 | -1.64 |
| Fertility technology. | 0.12 | 0.12 | 1.02 | -0.03 | 0.10 | -0.28 | 0.41*** | 0.13 | 3.23 |
| Row planting technology. | -0.57*** | 0.08 | -7.12 | 0.26*** | 0.06 | 4.54 | -0.31*** | 0.09 | -3.40 |
| Agro-forestry technology. | 0.23 | 0.33 | 0.69 | - | - | - | 0.97*** | 0.34 | 2.85 |
| Mixed cropping | -0.28 | 0.41 | -0.68 | - | - | - | -0.18* | 0.10 | -1.79 |
| Crop Rotation | - | - | - | -0.05 | 0.13 | -0.37 | - | - | - |
| Plot size | -0.06 | 0.05 | -1.18 | -0.02*** | 0.00 | -6.64 | -0.16** | 0.05 | -3.03 |
| Family Labour | 0.37*** | 0.13 | 2.84 | -0.05 | 0.13 | -0.37 | 0.62*** | 0.13 | 4.63 |

Source: Authors' Computation
Significance level: *** = 1%, ** = 5%, * = 10%.

Maize farmers who practice slash and burn, bush fallow, and have relatively large farm sizes in the transition zone (Table 3) are more likely to have significant decline in maize yields compared to their counterparts who do otherwise and have relatively small farm sizes. Row planting significantly contributes positively to maize yield in the transition zone, implying that farmers who have adopted row planting are likely to obtain higher yields than those who have not.

Cassava yield is significantly affected by the number of family labour used, the use of fertilizer, agro-forestry practice, row planting, and bush fallow in the forest zone (Table 3). Row planting and bush fallow however affect cassava yield negatively contrary to expectation. This is more likely the result of mixed cropping which is the more common practice by farmers on lands they perceive to be fertile in the forest zone. Farmers who employ relatively large numbers of family labour and those who have adopted agro-forestry technology and use fertilizer are likely to obtain higher cassava yields.

None of the variables considered significantly influence yam yields at the 5% level of significant (Table 4). Slash and burn, mounding, and row planting, however, are significant at the 10% level. Cowpea yield in the transition zone is significantly affected by farm size (Table 4). Relatively higher yield is likely to be obtained on relatively large cowpea farms. This is perhaps due to the ability of large-scale cowpea farmers to afford inputs, especially chemicals, for pest control at the correct periods.

**Table 4. Regression of land management practices on yield of yam and cowpea in the transition zone**

| | Yam in Transition Zone | | | Cowpea in Transition Zone | | |
|---|---|---|---|---|---|---|
| Varibles | Coeff | Std. Error | t-Value | Coeff | Std. Error | t-Value |
| Constant | 7.00*** | 0.48 | 14.74 | 3.01 | 9.46 | 0.32 |
| Slash and burn | 0.67* | 0.34 | 1.96 | - | - | - |
| Mounding | -0.90* | 0.46 | -1.94 | - | - | - |
| Tractor Plough | - | - | - | 2.05 | 2.59 | 0.79 |
| Fertility technology. | 0.28 | 0.47 | 0.60 | 1.01 | 4.05 | 0.25 |
| Row planting technology. | 0.60* | 0.35 | 1.72 | 0.17 | 9.35 | 0.02 |
| Agro-forestry technology. | 0.59 | 0.61 | 0.96 | - | - | - |
| Plot size | -0.05 | 0.15 | 0.34 | 0.95 | 0.03*** | 38.46 |
| Labour | -0.19 | 0.23 | -0.83 | -1.91 | 3.95 | -0.48 |

Source: Authors' Computation
Significance level: *** = 1%, ** = 5%, * = 10%.

The variables that significantly affect rice yield are bush fallowing and farm size (Table 5). Farmers with relatively small farm sizes are likely to obtained higher rice yields, probably because they are better able to provide good husbandry practices as well as scare away birds better due to the small sizes of their plots. Also farmers who practice bush fallow are likely to have relatively higher rice yields compared to their counterparts who do otherwise. On the other hand, fertilizer usage and row planting significantly influence sorghum yield (Table 5). Usage of fertilizer increases sorghum yield, while row planting applied alone decreases sorghum yield.

**Table 5. Regression of land management practices on yield of rice and sorghum in the Savannah zone**

| | Rice in Savannah Zone | | | Sorghum in Savannah Zone | | |
|---|---|---|---|---|---|---|
| Variables | Coeff | Std. Error | t-Value | Coeff | Std. Error | t-Value |
| Constant | 4.50*** | 0.98 | 4.61 | 0.46 | 0.35 | 1.32 |
| Slash and burn | -0.82* | 0.46 | -1.80 | -0.12 | 0.21 | -0.18 |
| Bush fallow | 1.44** | 0.55 | 2.28 | - | - | - |
| Animal traction | 0.01 | 0.01 | 1.24 | - | - | - |
| Tractor Plough | | | | 0.12 | 0.19 | 0.61 |
| Length of fallow | -0.10 | 0.17 | 0.60 | 0.07 | 0.06 | 1.02 |
| Fertility technology. | -0.86 | 0.52 | -1.65 | 0.38** | 0.15 | 2.59 |
| Row-planting technology. | 0.86 | 0.56 | 1.55 | -0.53*** | 0.17 | -3.17 |
| Plot size | -0.233 | 0.070 | -3.31 | -0.04 | 0.02 | -0.20 |
| Labour | -0.15 | 0.52 | -0.29 | 0.02 | 0.05 | 0.42 |

Source: Authors' Computation
Significance level: *** = 1%, ** = 5%, * = 10%.

## CONCLUSION AND RECOMMENDATIONS

Agricultural land use and the management of agricultural lands as evidenced from farmer practices have significant effect on the yield of food crops across all the ecological zones of Ghana. In the forest zone row planting and the number of family labour employed significantly influence maize yields. However, maize farmers in the transition zone who practice slash and burn, bush fallow, and have relatively large farm sizes are more likely to have significant decline in maize yields compared to their counterparts who do otherwise and have relatively small farm sizes. On the other hand, whereas row planting has a negative effect on maize yields in the forest zone, it significantly contributes positively to maize yields in the transition zone; and farmers who have adopted row planting in the transition zone are more likely to obtain higher yields than those who have not.

Similarly, cassava yield in the forest zone is significantly affected positively by the number of family labour used, the use of fertilizer (fertility improvement), and agro-forestry practice; but negatively affected by row planting and bush fallowing. In effect, the analysis shows that different land management practices affect crop yields differently in the different ecological zones of Ghana. The analysis shows that the types of land management practices farmers use differ across the different ecological zones of Ghana. These practices also affect food crop yields differently. The implication is that agricultural interventions should be developed on the basis of ecological zones, and blanket crop improvement packages should be avoided.

It is recommended that food crop farmers should be helped to improve the management of their agricultural lands by ecological zones at two levels. First, the practices that are common in each zone should be targeted for improvement. Second, land management practices that are not currently being used by farmers in each zone but have potential to improve crop production should be identified and promoted in the respective agro-ecological zones.

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