

**MULTI-AGENT SIMULATION APPROACH ON THE IMPACT OF AGRICULTURAL  
LAND-USE CHANGE ADAPTATION STRATEGY (FARM CREDIT) ON FARM HOUSEHOLD  
LIVELIHOOD IN SEMI-ARID GHANA**

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**ABSTRACT**

This study applied multi agent simulation to investigate the impact of farm credit (an agricultural land-use change adaptation strategy) on farm household livelihood. General household and land use data were obtained from 186 sampled household. Two household types were identified; the first household type was better-off in terms of land area cultivated and income generated from rain-fed rice. On the other hand the second household type was better-off in terms of land area cultivated and income generated from maize. Determinant of crop choices of each household types were generated via logistic regression using household and plot characteristics as predictors. Crop choice model and agricultural yield dynamic model was programmed in Netlogo 5.0.5. Using a process based decision, household choice of maize adoption with respect to maize credit (maize credit scenario) was simulated, and its impact on farm household livelihood was compared with baseline scenario.

**1 INTRODUCTION**

Sahel and tropical West Africa are hotspot of climate change (Diffenbaugh and Giorgi, 2012). Adaptation is vital because, no matter how strong mitigation strategies are, some level of climate change will be experienced (IPCC, 2001). Agriculture is a key source of livelihood in the semi-arid region of Northern Ghana, and in this period of changing climate, changing agricultural land-use may be a possibility. Interestingly, changing agricultural practices have been identified amongst other climate variability and climate change adaptation measures in the study area. The concept of human decision making is crucial in land-use change. Also, heterogeneity can't be overlooked when addressing human decision making. This study implemented an Agent based/Multi-agent simulation model that can assess the impact of an agricultural land-use change adaptation strategy on farm household livelihood. This model (Vea-LUDAS model) explores the impact of maize credit on: (i) Agricultural land-use change; (ii) Farm household livelihood.

## 2 METHODS

The study was conducted in Veve catchment, in the upper east region of Ghana, and the framework of VN-LUDAS (Le, 2008), was applied. Land use data and general household characteristics were obtained from 186 surveyed households in the. These households were categorized using principal component and *K*-mean cluster analyses, and two household types were identified. They differ according to their human, natural and financial assets. The first household type (household-1) was described as traditional-rice farmers ( $n = 111$ ) while the second household type (household-2) was described as traditional-maize farmers ( $n = 75$ ). Household-1 was better-off than household-2 in terms of cultivated land area and income generated from rice. On the other hand, household-2 was better-off than household-1 in terms of area cultivated for maize, and income generated from maize. Determinants of crop choices of each household type were generated through logistic regression of crop choices using household characteristics (eg, age of head, household size, dependency ratio) and plots characteristics (eg, soil type, wetness index, elevation, upslope area, plot size proximity features). Two key sub-models namely, crop choice and agricultural yield dynamic sub-model was programmed in Netlogo 5.0.5 (Wilensky, 1999). Using a process based decision approach, the household choice of maize adoption with respect to maize credit scenario was simulated and assessed its impact on farm household livelihood by comparing with baseline scenario.

## 3 RESULTS AND CONCLUSION

From the simulation result, maize credit scenario influenced some farm household's decision to convert some other agricultural land-use into maize cropland (figure 1). The number of maize adopters increased from about 20% to about 50% (figure 2). Average annual aggregated household crop yield was 6.3% higher under maize credit scenario compared to baseline scenario (figure 3). Conclusively, this study shows that maize credit scenario is able to improve farm household livelihood. Other policies that will enhance crop production and household resilience to impact of climate change and variability should be made available to rural farmers in the semi arid northern Ghana.

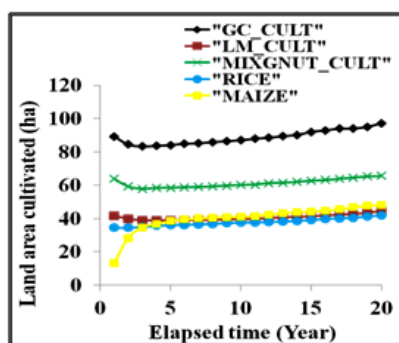


Figure 1

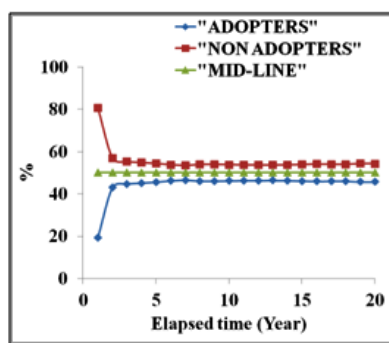


Figure 2

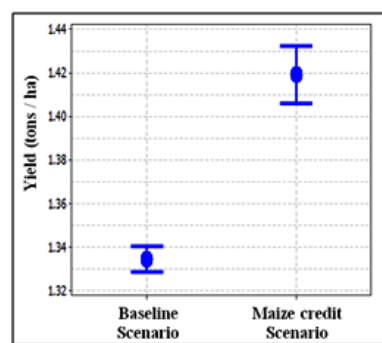


Figure 3

Figure 1: Agricultural land-use change under maize credit scenario (GC\_CULT = Guinea-corn, LM\_CULT = Late millet, MIXGNUT\_CULT = Mix cropping groundnut); Figure 2: Farm household adoption of maize under maize credit scenario; Figure 3: Average annual aggregated crop yield.

## REFERENCES

- Diffenbaugh, N. S. and Giorgi, F. 2012. Climate change hotspots in the CMIP5 global climate model ensemble. *Climatic change*, 114: (3-4) 813-822.
- IPCC 2001. Climate change 2001: Impacts, Adaptation and Vulnerability. Cambridge University Press.
- Le, Q. B., Park, S. J., Vlek, P. L. and Cremers, A. B. 2008. Land-Use Dynamic Simulator (LUDAS): A multi-agent system model for simulating spatio-temporal dynamics of coupled human-landscape system. I. Structure and theoretical specification. *Ecological Informatics*, 3 (2), 135-153.
- Wilensky, U. 1999. NetLogo. <http://ccl.northwestern.edu/netlogo/>.