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SUSTAINABLE AGRICULTURAL INTENSIFICATION IN SOUTHERN TANZANIA – A BIO-ECONOMIC MODEL APPROACH

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Abstract:

This study employs mathematical programming to examine the trade-off between improving biophysical attributes and preserving ecosystem services, using Southern Tanzania as a case study. This study used data primarily collected via household surveys. This study tries to provide insights into "best practices" of farming and how to minimize the environmental cost of intensification.

➢Introduction

➢ Sustainable agricultural intensification has been defined as: producing more output on the same area of land while reducing the negative environmental impacts but also increasing the delivery of ecosystems services (Royal Society 2009; Godfrey et al. 2010).

➢ One of the major issues in agricultural intensification is the interaction between the biophysical attributes that are essential for increased yields and the ecosystems services that unpin crop production.

➢ Improvement of biophysical attributes (soil quality and land vegetation cover) while minimizing the negative environmental factors (water quality deterioration, nutrient imbalance, soil erosion, increased greenhouse gas emissions and deforestation) is critical for sustainability.

➢ In 2010, the Southern Agricultural Growth Corridor of Tanzania (SAGCOT) was initiated to improve agricultural productivity and food security, alleviate poverty, and ensure environmental sustainability for farmers (SAGCOT 2012). This area is home to 11 million people mainly small holder farmed most of whom live on less that a $1 a day with less than 2 hectares of land.

➢The goal of the government is to initiate policies of sustainable agricultural growth and lift more than 2 million people out of poverty.

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Source: SAGCOT Partnership Generation Programme presentation, 2012

Figure1. SAGCOT Boundaries and Development Clusters

Objective:

➢We pursue a bio-economic household model to examine the impacts of agricultural intensification on economic and ecological indicators in the SAGCOT region.

Data used:

We use household data on agricultural management practices, socio-economic characteristics, and biophysical data :

- ➢ Crop yield and price data
- ➢ Livestock and crop consumption
- ➢Nutrient Balances
- ➢Inorganic fertilizer use
- ➢Length of growing season and planting time
- ➢Farm and off-farm labor
- ➢Farm investment – irrigation and farm implements
- ➢*Data was obtained from NBS and Ag. Center*

Methodology

➢ The model portrays representative households that first satisfy their consumption/food security needs then maximize profits/income of household subject to technological and sustainability constraints and prevailing market conditions.

➢Scenarios are examined with various changes in technology, farm management practices, and price changes to examine the tradeoffs between increase in household income and sustainability/ecological indicators.

Model Structure

The optimization formulation is as follows:

$$\max PY - CX$$

subject to

$$Y + Y_{fs} - A_y X \leq 0 \qquad (1)$$

$$AX \leq b \qquad (2)$$

$$Y_{fs} \geq T_{fs} \qquad (3)$$

$$A_{env} X \leq T_{env} \qquad (4)$$

where

- Y refers to crop output and X represents inputs;
- P and C are the prevailing market prices for outputs and inputs;
- T indicates the food security and environmental requirements.

The objective function is to maximize the profit of agricultural production.

The first constraint illustrates the input-output relationships between Y and X, where *fs* represents food security (minimum consumption for farming households) and A_y is the coefficient of output for inputs X.

The second constraint depicts the resources constraints, where A represents the technical coefficients describing resource usage and b refers to resources endowments.

The third constraint specifies that the food security requirements T_{fs} be met.

The fourth constraint indicates that the negative environmental impacts be lower than certain levels T_{env}. A_{env} stands for the environmental impacts coefficients associated with utilizing inputs X.

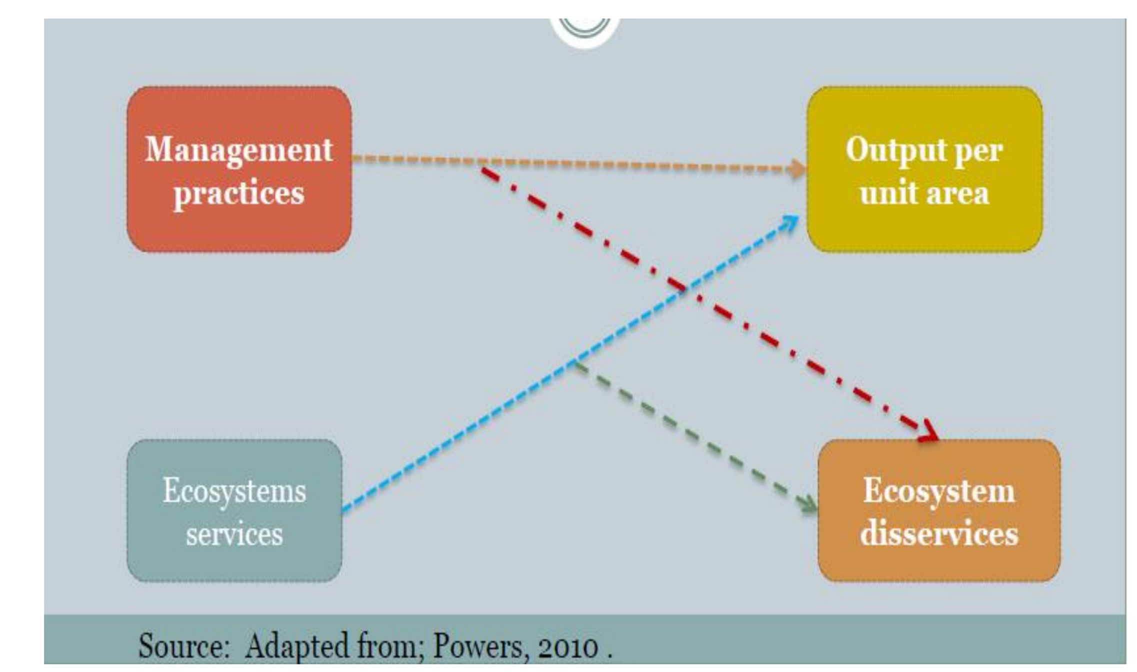

Figure 2. Interaction Between Agricultural Intensification and ecosystems service

Expected Results

We are in the process of finalizing the model and data input so preliminary results are not presented to avoid discrepancies. If you have any questions, please contact the authors

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