



**Dynamic costs of soil degradation and determinants of adoption of soil
conservation technologies by smallholder farmers in Malawi.**

by

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Dedication

To my dear wife Candida and son Joshua-Thanthwe.



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I have benefited a lot from the wonderful atmosphere in the Department of Agricultural Economics, Extension and Rural Development. Special thanks are due to Professor Johan Kirsten, Head of Department, for his untiring support and profound love. I have also enjoyed the friendship of Ferdinand Meyer and Marnus Gouser, which I acknowledge with gratitude. My thanks and deep appreciation should also go to Mrs Zuna Botha for her untiring efforts in making the department a wonderful place. I am deeply indebted to Dr Simphiwe Ngqanqweni, a true friend who has always been there for me.

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Finally, the love and great strength of my “dear wife and best friend” Candida and son Joshua-Thanthwe, really inspired me throughout the period. I really thank you guys for your untiring patience and understanding, but most of all, enduring love.

Many others have contributed in various ways to the completion of this thesis, and although not mentioned by name, you are really appreciated.

Any errors in thinking or omissions are solely my responsibility.

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Degree: PhD
Department: Agricultural Economics, Extension and Rural Development
Promoter: Professor Rashid Mekki Hassan

Abstract

This thesis aimed at measuring the economic costs of soil degradation and to determine factors that influence the incidence and extent of adoption of soil conservation technologies by smallholder farmers in Malawi. A dynamic optimisation model was used to derive and analyse the optimal conditions for soil resource extraction and use in Malawi, while a selective tobit model was used to simulate the two-step decision-making process of farmers with respect to adoption of soil conservation technologies.

Soil degradation has long-term consequences and static models, which form the bulk of studies that have so far been carried out in Africa on this topic, do not account for the inter-temporal dimension of optimal resource management. To deal with this shortcoming, this thesis used an inter-temporal optimisation framework, which considers soil in a time-dependent resource extraction perspective. This thesis has demonstrated that soil degradation is causing an enormous reduction in the productive value of smallholder land in Malawi. Current user cost of soil quality based on current practices of



estimated to be US\$21 per hectare. Based on this value and land area under smallholder agriculture in Malawi, economic costs of soil degradation among smallholder farmers were estimated to amount to 14 per cent of the agricultural GDP. If left unabated, soil degradation threatens not only the future of smallholder agriculture but also, economic growth prospects of the nation.

Although not operating on the SS optimal path in terms of soil resource management, current practices show that smallholder farmers in Malawi still consider, to certain degree, the dynamic costs in soil resource use. Hence, there is no strong evidence to suggest that current trends in land degradation are due to an institution failure (i.e., smallholder farmers have private incentives to conserve their soil resource). A result that suggests presence of other factors, most likely market distortions, behind existing deviations of farmers' practices from dynamic optimum. Government's serious support of the input and output market reforms is important not only to make the markets work but also, to make smallholder agriculture a profitable enterprise. It is only when smallholder agriculture becomes profitable that farmers can seriously invest in the soil resource. Agricultural support programs such as "food for work" if extended to include soil conservation, could lead to substantial curtailment of soil erosion since farmers can invest their labour in their own gardens during the critical times of land preparation.

The sensitivity analysis indicated that increasing the discount rate to 5%, SS solutions were close to current practice solutions. This suggests that one reason smallholder farmers are exploiting the soil resource is because they have a higher time preference. The high levels of poverty, especially among the smallholder subsistence farmers in Malawi, entail that farming households are more concerned with their survival now than their future well being.

The study estimated an optimal output of 1.5ton/ha and nitrogen fertiliser rate of 49 kg/ha at SS. The fertiliser estimates are based on smallholder farming system that incorporates soil conservation. In one of the most detailed studies on nitrogen use efficiency in

Malawi, Itimu (1997) indicated that with the incorporation of manure, nitrogen fertiliser use dropped from 60 to 30 kg/ha to produce about 2.5 tons of maize. Malawi uses area specific recommendations for fertiliser application. However, using “best bet” technologies, at least 35kgN/ha is recommended for smallholder farmers on average. The SS optimum fertiliser estimated in the current study was somehow higher due to the fact that an inter-temporal framework, which considered the dynamic costs of soil nutrient extraction, was used. Results from fertiliser recommendation trials may be reinforced if researchers consider the inter-temporal nature and dynamic costs associated with the use of soil.

The selective tobit model results indicate that factors that influence smallholder farmers’ decisions to adopt soil conservation technologies may not necessarily be the same factors that influence subsequent decision on levels of adoption. The implication of this finding is that different policy prescriptions on soil conservation should strictly be guided by the goals the government wants to achieve. With fertiliser prices being out of the reach of most smallholder farmers in Malawi, soil conservation is one of the reliable options available to reduce soil degradation. However, any policy aimed at improving adoption of soil conservation technologies among smallholder farmers would succeed only if the various needs of smallholder farmers at the two decision stages are properly identified and addressed.

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ACRONYMS AND ABBREVIATIONS

ADD	Agricultural Development Division
ADMARC	Agricultural Development and Marketing Corporation
ALDSAP	Agriculture and Livestock Development Strategy & Action Plan
CD	Cobb Douglas
CEC	Cation Exchange Capacity
DFID	Department for International Development (Previously ODA)
EPA	Extension Planning Area
EPIC	Erosion Productivity Impact Calculator
FAO	Food and Agriculture Organisation
FEWS	Farming Early Warning System
GDP	Gross Domestic Product
GIS	Geographical Information System
GoM	Government of Malawi
IFDC	International Fertiliser Development Centre
IITA	International Institute for Tropical Agriculture
LUPMAP	Land Use Policy & Management Action Plan
MoAI	Ministry of Agriculture and Irrigation
MK	Malawian Kwacha
MLE	Maximum Likelihood Estimation
MPTF	Maize Productivity Task Force
NEAP	National Environmental Action Plan
NEC	National Economic Council
NGO	Non Governmental Organisation
NRI	Natural Resources Institute
NTRM	Nitrogen Tillage Residue Management
OLS	Ordinary Least Squares
PI	Productivity Index
PLCE	Presidential Land Commission of Enquiry
RDP	Rural Development Project

RUSLE	Revised Universal Soil Loss Equation
SLEMSA	Soil Loss Estimation Model for Southern Africa
SNA	System of National Accounts
SOC	Soil Organic Carbon
SOM	Soil Organic Matter
SSA	Sub-Saharan Africa
TIP	Targeted Input Program
UNDP	United Nations Development Programme
UNEP	United Nations Environmental Programme
UNO	United Nations Organisation
USAID	United States Agency for International Development
US\$	United States Dollar
USLE	Universal Soil Loss Equation