

Nico Heerink • Herman van Keulen
Marijke Kuiper (Editors)

Economic Policy and Sustainable Land Use

Recent Advances in Quantitative Analysis
for Developing Countries

With 44 Figures and 41 Tables

Physica-Verlag
A Springer-Verlag Company

Table of Contents

Preface	V
----------------------	----------

1 Economic Policy Reforms and Sustainable Land Use in Developing Countries: Issues and Approaches

Nico Heerink, Arie Kuyvenhoven & Maarten S. van Wijk

Abstract.....	1
1.1 Introduction.....	1
1.2 Soil Degradation and Agricultural Production.....	2
1.3 Economic Policy Reforms and Soil Degradation.....	5
1.4 An Analytical Framework.....	8
1.5 Modelling Approaches.....	10
1.5.1 Bio-economic Models.....	11
1.5.2 Household and Village Models.....	12
1.5.3 Macro- and Regional Models.....	14
1.5.4 Potential Contributions.....	15
1.6 Purpose and Structure of the Book.....	16
1.7 References.....	17

2 Soil Degradation and Agricultural Production: Economic and Biophysical Approaches

Gideon Kruseman & Herman van Keulen

Abstract.....	21
2.1 Introduction.....	21
2.2 Soil Degradation: What Are We Talking About?.....	22
2.3 Economic Interpretation of the Production Function.....	25
2.4 Fundamental Issues Underlying the Debate.....	27
2.4.1 Efficiency.....	27
2.4.2 Cause and Effect.....	31
2.5 Biophysical Approaches to the Production Function.....	32

2.6	Generating Biophysical Inputs in Bio-Economic Modelling.....	36
2.6.1	A Technical Coefficient Generator (TCG).....	36
2.6.2	A Process Approach.....	38
2.6.3	A Tropical Soil Productivity Calculator (TSPC).....	39
2.6.4	Soil Depth Calculation and Changes in Yields.....	39
2.6.5	Multi-Period Modelling.....	40
2.7	The Interface Between Biophysical and Economic Models.....	41
2.8	References.....	42
3	Technical Options for Agricultural Development in the Ethiopian Highlands: A Model of Crop-Livestock Interactions	
	Ayele A. Abiye & Jens B. Aune	
	Abstract.....	49
3.1	Introduction.....	49
3.2	Choice of Agro-ecological Models.....	50
3.3	The Model.....	51
3.3.1	Collection of Household Data and Model Construction.....	51
3.3.2	The Soil-Crop Component.....	52
3.3.3	The Livestock Component.....	52
3.3.4	Socio-economic Data.....	53
3.4	Resource Efficiency of Different Crop-Livestock Systems in Ethiopia: Model Results.....	53
3.5	Development Paths for the Crop-Livestock System in Ethiopia.....	55
3.6	References.....	56
4	Land Degradation as a Transformation Process in an Intertemporal Welfare Optimisation Framework	
	Peter J. Albersen & Laixiang Sun	
	Abstract.....	59
4.1	Introduction.....	60
4.2	The Transformation Process.....	61
4.2.1	Overall Framework.....	61
4.2.2	Description of Land.....	63
4.2.3	Costs of Productivity-Increasing Transformation.....	65
4.3	The Degradation-Induced Transformation Process.....	68
4.4	Micro and Macro Level.....	70
4.5	References.....	71

5 Population Pressure and Land Degradation in the Ethiopian Highlands:

A Bio-Economic Model with Endogenous Soil Degradation

Bekele Shiferaw, Stein Holden & Jens Aune

Abstract.....	73
5.1 Introduction.....	74
5.2 The Conceptual Framework.....	75
5.3 The Biophysical and Economic System.....	77
5.4 The Bio-economic Model.....	80
5.5 Simulation Results.....	84
5.5.1 Impact of Population Pressure on Better-off Households.....	84
5.5.2 Impact of Population Pressure on Poor Households.....	87
5.6 Conclusions.....	89
5.7 References.....	90

6 Imperfect Food Markets and Household Adoption of Soil Conservation Practices in the Dominican Republic Highlands: Household Probit and Duration Models

Benedicte de la Briere

Abstract.....	93
6.1 Introduction.....	93
6.2 A Household Model of Adoption and Maintenance of Soil Conservation Techniques.....	95
6.2.1 Households Facing Food Market Imperfections.....	96
6.2.2 Households Facing Functioning Food Markets.....	98
6.3 Some Comparative Statics Results.....	99
6.4 Profitability over Time and Decision to Withdraw.....	101
6.5 Descriptive Statistics.....	102
6.6 Adoption Behaviour: Probit Analysis.....	105
6.7 Maintenance Behaviour: Duration Analysis.....	108
6.8 Conclusions.....	112
6.9 References.....	113

**Soil Conservation and Imperfect Labour Markets in El Salvador:
an Empirical Application of a Dynamic Control Model
of Farm Production**

Claudia B. Romano

Abstract.....	115
7.1 Introduction.....	116
7.2 Labour Allocation in a Model of Farm Production with Missing Agricultural Labour Markets.....	117
7.3 An Econometric Application of the Model.....	125
7.3.1 Data.....	125
7.3.2 Estimation Procedures.....	125
7.4 Results and Discussion.....	128
7.5 Conclusions.....	131
7.6 References.....	133

**Assessing the Effects of Policy Measures on Household Welfare
and Agro-Ecological Sustainability:
an Overview of Farm Household Modelling Approaches**

Gideon Kruseman

Abstract.....	135
8.1 Introduction.....	135
8.2 Theoretical Underpinnings of Farm Household Modelling.....	137
8.3 Empirical Estimation of Bio-economic Farm Household Models.....	140
8.4 Mathematical Programming Models: Advantages and Shortcomings...	141
8.5 Metamodelling.....	145
8.6 Discussion and Conclusions.....	147
8.7 References.....	148

**Agricultural Prices and Land Degradation in Koutiala, Mali:
a Regional Simulation Model Based on Farmers' Decision Rules**

TjarkStruifBontkes

Abstract.....	151
9.1 Introduction.....	151
9.2 Structure of the Model.....	153
9.3 Detailed Description of Model Components.....	155
9.3.1 Choice of Crops and Inputs Applied per Farm Type.....	155
9.3.2 Availability of N and P for Crop Uptake.....	157

9.3.3	Crop Production, Including Production of the Common Pastures.....	157
9.3.4	Animal Production Based on Available Quantity and Quality of Feed.....	158
9.3.5	Cereal Prices.....	158
9.3.6	Sale or Purchase of Cattle on the Basis of Farm Incomes.....	159
9.3.7	Changes in the State Variables.....	159
9.4	Some Illustrations of Simulation Results.....	161
9.4.1	Base Run.....	161
9.4.2	Policy Experiment.....	162
9.5	Discussion.....	164
9.6	References.....	166

10 Integrating Site-Specific Biophysical and Economic Models to Assess Trade-offs in Sustainable Land Use and Soil Quality

John M. Antle & Jetse Stoorvogel

	Abstract.....	169
10.1	Introduction.....	169
10.2	Defining and Measuring Soil Quality.....	171
10.3	An Economic Model of Site-Specific Land Use and Management.....	174
10.4	Site-Specific Management and Soil Quality.....	176
10.5	Aggregation and Policy Analysis.....	178
10.6	An Example: Mechanical Erosion.....	181
10.7	Conclusions.....	182
10.8	References.....	182

11 Effects of Land Degradation in a Diversified Economy with Local Staple and Labour Markets: A Village-Town CGE Analysis from Mexico

George Dyer, Antonio Yunez-Naude & J. Edward Taylor

	Abstract.....	185
11.1	Introduction.....	185
11.2	The Model and Data.....	186
11.2.1	The Village-Town Model.....	187
11.2.2	Data.....	189
11.3	Simulations.....	189

11.4 Results.....	194
11.4.1 Experiment 1: Decrease in Staple Productivity.....	194
11.4.2 Experiment 2: Decrease in Land Availability.....	194
11.4.3 Experiment 3: Increase in World Market Price for Staples.....	195
11.5. Conclusions.....	195
11.6 References.....	197

12 Agricultural Production and Erosion in a Small Watershed in Honduras: a Non-Linear Programming Approach

Bruno Barbier

Abstract.....	199
12.1 Introduction.....	199
12.2 Model Structure.....	200
12.2.1 Land Limitation.....	201
12.2.2 Water Limitation.....	201
12.2.3 Labour Limitation.....	202
12.2.4 Cash Limitation.....	202
12.2.5 Market Limitation.....	202
12.2.6 Crop Production Modelling.....	202
12.2.7 Erosion.....	203
12.3 Application to a Small Watershed in Honduras.....	205
12.4 Discussion and Conclusion.....	207
12.5 References.....	207

13 Alternative Approaches to the Economics of Soil Nutrient Depletion in Costa Rica: Exploratory, Predictive and Normative Bio-Economic Models

Hans G.P. Jansen, Robert A. Schipper, Peter Roebeling, Erwin H. Bulte, Huib Hengsdijk, Bas A.M. Bouman & Andre Nieuwenhuys

Abstract.....	211
13.1 Introduction.....	212
13.2 Methods.....	212
13.2.1 The SOLUS Methodology.....	212
13.2.2 The UNA-DLV Methodology.....	218
13.2.3 An Optimal Control Model.....	222
13.3 Study Area.....	225

13.4 Results.....	226
13.4.1 Explorative SOLUS Methodology.....	226
13.4.2 Predictive UNA-DLV Methodology.....	229
13.4.3 Normative Optimal Control Methodology.....	230
13.5 Conclusions.....	233
13.6 References.....	234

14 Effects of Economic Policies on Farmers, Consumers and Soil Degradation: a Recursively Dynamic Sector Model with an Application for Burkina Faso

Daniel Deybe

Abstract.....	239
14.1 Introduction.....	239
14.2 The Multilevel Analysis Tool for the Agricultural Sector.....	241
14.3 The Production Module.....	242
14.4 The Marketing/Consumption Module.....	247
14.5 The Macro-Economic Context.....	249
14.6 Results of Policy Simulations for Burkina Faso.....	249
14.7 Conclusions.....	252
14.8 References.....	252

'15 Soil Degradation in Macro CGE Models

Solveig Glomsrad

Abstract.....	255
15.1 Introduction.....	255
15.2 Environment and Productivity.....	256
15.3 A CGE Model with Soil Nutrient Mining.....	258
15.3.1 Economic Core Model.....	258
15.3.2 The Agro-Ecological Model.....	259
15.3.3 Links Between the Two Modules.....	261
15.3.4 Policy Simulations.....	262
15.4 A CGE Model with Deforestation, Soil Degradation and Migration... ..	263
15.4.1 Model Specification.....	263
15.4.2 Policy Simulations.....	266
15.5 Some Final Comments.....	266
15.6 References.....	267

16 The Effect of Soil Degradation on Agricultural Productivity in Ethiopia: A Non-Parametric Regression Analysis

Michiel A. Keyzer & Ben G.J.S. Sonneveld

Abstract.....	269
16.1 Introduction.....	270
16.1.1 Constraints on Incorporating Soil Degradation into Economic Models.....	272
16.1.2 A Non-Parametric Approach.....	273
16.2 Data.....	274
16.2.1 Sources.....	274
16.2.2 Selection of Variables.....	276
16.3 The Mollifier Program: 3D-Visualisation of Kernel Density Regressions.....	277
16.3.1 Mollifier Mapping.....	277
16.3.2 Mollifier Program.....	277
16.4 Results of the Non-Parametric Analysis.....	278
16.4.1 The Qualitative Assessment of Soil Degradation and its Relation to Crop Yield.....	278
16.4.2 Reliability of Relationships Between Yield Ratio and Common Explanatory Variables.....	280
16.4.3 Spatial Correlation.....	283
16.4.4 The Relation with Population Levels and Fertiliser Use.....	284
16.4.5 BacktoGIS.....	286
16.5 Summary and Conclusions.....	286
16.6 References.....	287
Annex Chapter 16.....	290

17 Between Free Riders and Free Raiders: Property Rights and Soil Degradation in Context

Franz von Benda-Beckmann

Abstract.....	293
17.1 Introduction.....	293
17.2 Points of Departure and Assumptions.....	297
17.2.1 Empirical Generalisations.....	297
17.2.2 Categorical and Concretised Property Rights.....	298
17.2.3 The Conventional Four Property Categories.....	300
17.2.4 Legal-Institutional Pluralism.....	301

17.2.5 Towards a Post-Institutionalist Perspective.....	302
17.3 The Tragedy of Individual Rights under Different Property Rights Bundles.....	303
17.3.1 Revisiting Hardin and Open Access.....	303
17.3.2 The Tragedy and Other Property Rights.....	305
17.4 Features of Property Rights Constellations and Care for Resource Quality.....	305
17.4.1 The Temporal Dimension of Property Rights and the Time Horizon of Property Holders.....	306
17.4.2 The Functions of Property and Outside Opportunities.....	307
17.5 Conclusions.....	310
17.6 References.....	311

18 Land Rights, Farmers' Investment, and Sustainable Land Use: Modelling Approaches and Empirical Evidence

Ruerd Ruben, Marrit van den Berg & Tan Shuhao

Abstract.....	317
18.1 Introduction.....	317
18.2 Land Rights and Resource Management.....	318
18.3 Land Rights and Investment Decisions.....	320
18.4 Modelling Framework.....	323
18.4.1 Basic Model with Credit Constraints.....	323
18.4.2 Migration.....	325
18.4.3 Uncertainty of Land Ownership.....	326
18.5 Empirical Evidence.....	326
18.5.1 Effects.....	327
18.5.2 Implications.....	329
18.6 Discussion.....	331
18.7 References.....	332

19 Assessing Social Factors in Sustainable Land-Use Management: Social Capital and Common Land Development in Rajasthan, India

Anirudh Krishna & Norman Uphoff

Abstract.....	335
19.1 Social Factors in Soil Conservation.....	335
19.2 Setting the Stage: Location and Context.....	336
19.3 Evaluating Program Performance.....	339

19.4 Scaling Social Capital.....341
 19.5 Examining the Impact of Social Capital on Program Performance. 343
 19.6 What Do These Results Mean?..... 346
 19.7 References.....348

20 Modelling Economic Policy Reforms and Sustainable Land Use in Developing Countries: Key Issues

Marijke Kuiper, Nico Heerink & Herman van Keulen

Abstract..... 351
 20.1 Introduction..... 351
 20.2 Key Issues in Modelling Bio-Economic Interactions.....352
 20.2.1 Conceptualisation..... 352
 20.2.2 Interactions..... 356
 20.2.3 Aggregation..... 358
 20.2.4 Time Dimension..... 359
 20.3 Addressing The Key Issues: Comparing Approaches.....361
 20.3.1 Conceptualisation..... 362
 20.3.2 Interactions..... 366
 20.3.3 Aggregation..... 367
 20.3.4 Time Dimension..... 370
 20.4 Concluding Remarks..... 370
 20.4.1 Complementary Advantages of Different Approaches..... 372
 20.4.2 Directions for Future Research..... 372
 20.5 References..... 374