



ADVANCES IN AGROFORESTRY



Valuing Agroforestry Systems

Methods and Applications

Edited by Janaki R.R. Alavalapati and D. Evan Mercer



Kluwer Academic Publishers

Advances in Agroforestry

Volume 2

Series Editor:

P.K.R. Nair

*School of Forest Resources and Conservation,
University of Florida, Gainesville, Florida, U.S.A.*

Aims and Scope

Agroforestry, the purposeful growing of trees and crops in interacting combinations, began to attain prominence in the late 1970s, when the international scientific community embraced its potentials in the tropics and recognized it as a practice in search of science. During the 1990s, the relevance of agroforestry for solving problems related to deterioration of family farms, increased soil erosion, surface and ground water pollution, and decreased biodiversity was recognized in the industrialized nations too. Thus, agroforestry is now receiving increasing attention as a sustainable land-management option the world over because of its ecological, economic, and social attributes. Consequently, the knowledge-base of agroforestry is being expanded at a rapid rate as illustrated by the increasing number and quality of scientific publications of various forms on different aspects of agroforestry.

Making full and efficient use of this upsurge in scientific agroforestry is both a challenge and an opportunity to the agroforestry scientific community. In order to help prepare themselves better for facing the challenge and seizing the opportunity, agroforestry scientists need access to synthesized information on multi-dimensional aspects of scientific agroforestry.

The aim of this new book-series, *Advances in Agroforestry*, is to offer state-of-the art synthesis of research results and evaluations relating to different aspects of agroforestry. Its scope is broad enough to encompass any and all aspects of agroforestry research and development. Contributions are welcome as well as solicited from competent authors on any aspect of agroforestry. Volumes in the series will consist of reference books, subject-specific monographs, peer-reviewed publications out of conferences, comprehensive evaluations of specific projects, and other book-length compilations of scientific and professional merit and relevance to the science and practice of agroforestry worldwide.

Valuing Agroforestry Systems

Methods and Applications

by

JANAKI R.R. ALAVALAPATI

*School of Forest Resources and Conservation,
University of Florida, Gainesville, Florida, U.S.A.*

and

D. EVAN MERCER

*U.S. Forest Service,
Southern Research Station,
Research Triangle Park, North Carolina, U.S.A.*



KLUWER ACADEMIC PUBLISHERS
DORDRECHT / BOSTON / LONDON

A C.I.P. Catalogue record for this book is available from the Library of Congress.

ISBN 1-4020-2412-6 (HB)
ISBN 1-4020-2413-4 (e-book)

Published by Kluwer Academic Publishers,
P.O. Box 17, 3300 AA Dordrecht, The Netherlands.

Sold and distributed in North, Central and South America
by Kluwer Academic Publishers,
101 Philip Drive, Norwell, MA 02061, U.S.A.

In all other countries, sold and distributed
by Kluwer Academic Publishers,
P.O. Box 322, 3300 AH Dordrecht, The Netherlands.

Cover photograph by D. Evan Mercer.

Printed on acid-free paper

All Rights Reserved
© 2004 Kluwer Academic Publishers
No part of this work may be reproduced, stored in a retrieval system, or transmitted
in any form or by any means, electronic, mechanical, photocopying, microfilming, recording
or otherwise, without written permission from the Publisher, with the exception
of any material supplied specifically for the purpose of being entered
and executed on a computer system, for exclusive use by the purchaser of the work.

Printed in the Netherlands.

JANAKI R. R. ALAVALAPATI, D. EVAN MERCER, AND
JENSEN R. MONTAMBAULT

AGROFORESTRY SYSTEMS AND VALUATION METHODOLOGIES

An Overview

1. INTRODUCTION

Agroforestry, the deliberate integration of trees with agricultural crops and/or livestock either simultaneously or sequentially on the same unit of land, has been an established practice for centuries. Throughout the tropics and, to some extent, temperate zones, farmers have a long tradition of retaining trees on their fields and pastures, as well as growing crops or raising domestic animals in tree stands or forests (Alavalapati & Nair, 2001; Gordon & Newman, 1997; Nair, 1989). In the late 1970s, agroforestry attracted the attention of the international scientific and development communities due to its potential for improving the environment and livelihood of rural tropical communities. The agroforestry prospective increased further during the 1990s as scientists and policy makers recognized the potential for applying agroforestry systems (AFS) to problems such as soil erosion, rising salinity, surface and ground water pollution, increasing greenhouse gases, and biodiversity losses in temperate zones and developed economies. Financial viability and attractiveness has also proven AFS an important land use alternative in various settings throughout the world (Garrett, 1997), generating increased interest in this sustainable land-use management practice with potential environmental and socioeconomic benefits.

Research over the past two decades has focused on exploring the biophysical and ecological aspects of agroforestry with a limited emphasis on social aspects of agroforestry, especially economics, policy analysis, and valuation of associated environmental services (Mercer & Miller, 1998). Concern over adoption rates has highlighted the importance of integrating socioeconomic elements into traditional biophysical agroforestry research (Nair, 1998; Rochelau, 1998). As a result, there is a growing interest and need for enhancing economic and policy research among

agroforestry professionals. Montambault and Alavalapati (2003) conducted an extensive review and analysis of socioeconomic research in agroforestry literature between 1992 and 2002. Results showed a clear increasing trend in publications with more complex analyses, such as econometrics and optimization. The development of more sophisticated economic models creates applications that give more realistic and useful results for agroforestry practitioners. Indeed, the first World Agroforestry Congress (June 2004, Orlando, Florida) identified economics and policy as one of the key areas for enhancing the impacts of agroforestry. As an emerging facet of an interdisciplinary science, no single reference book prior to this publication has provided adequate coverage of applied economic and policy analysis methodologies for agroforestry professionals. By addressing this need, the present text offers practical means for strengthening the economics and policy elements of the agroforestry discipline.

2. DIVERSE AGROFORESTRY SYSTEMS AND ECONOMIC METHODOLOGIES

Small-scale AFS range from slash-and-burn and taungya systems to traditional, yet complex, homegardens. More recent innovations include alley cropping and improved fallows and have been expanded to larger-scale production. As shown in Tables 1A and 1B, the nature, complexity, and objectives of AFS vary greatly between the tropics and the temperate zone.

Table 1A. Major agroforestry practices in tropical systems.

<i>Agroforestry practice</i>	<i>Brief description</i>
Taungya	Agricultural crops grown during the early stages of forest plantation establishment.
Homegardens	Intimate, multistory combinations of a variety of trees and crops in homestead gardens; livestock may or may not be present.
Improved fallow	Fast-growing, preferably leguminous woody species planted during the fallow phase of shifting cultivation; the woody species improve soil fertility and may yield economic products.
Multipurpose trees	Fruit and other trees randomly or systematically planted in cropland or pasture for the purpose of providing fruit, fuelwood, fodder, and timber, among other services, on farms and rangelands.
Plantation-crop combinations	Integrated multistory mixtures of tree crops (such as coconut, cacao, coffee, and rubber), shade trees, and/or herbaceous crops.
Silvopasture	Combining trees with forage and livestock production, such as grazing in existing forests; using trees to create live fences around pasture; or to provide shade and erosion control.

forecasting, policy analysis, and decision-making (Buongiorno & Gilles, 2003). These methodologies are diverse in terms of their focus, scale (temporal and spatial), and scope (Table 2). Some economic methodologies are designed to assess simple cost and benefits of outputs and inputs for which markets are fairly established while others may be limited only by scientists' capabilities and imagination. Methodologies are also available for assessing a variety of environmental advantages and challenges (e.g., carbon sequestration, biodiversity, and soil erosion) for which there are no established markets. While some methodologies are appropriate for assessing AFS at the individual farm or household level, others are applicable at regional and national scales. Partial equilibrium models are used to assess impacts on particular economic sectors by assuming that changes in AFS only affect certain sectors of the economy. Broader impacts can be analyzed with general equilibrium models that include intersectoral linkages capturing the multiplier and/or trade impacts of changes in AFS on other sectors of the economy. Although these models and methods have been extensively applied in agricultural and forest economics literature, AFS applications are relatively rare.

Table 2. Economic methodologies common in agricultural and/or forest economics literature.

<i>Economic methodology</i>	<i>Brief description</i>
Enterprise/farm budget models	Estimate the profitability of a farm or enterprise by deriving indicators such as net present values (NPV), benefit-cost ratio (BCR), and internal rate of return (IRR).
Policy analysis matrix models (PAM)	Similar to farm budget models, but also include market failures, assessing their impact on profitability at a farm or regional level from both the individual and society perspectives.
Risk assessment models	Incorporate probabilities of events occurring and estimate the expected profitability of AFS enterprises.
Dynamic optimization models	Estimate optimum values (e.g., timber rotation age and tree cover) under limited, terminating time periods or perpetual scenarios.
Liner and non-linear programming models	Estimate optimum resources use/allocation subject to various constraints faced by the decision maker.
Econometric models	Estimate the relationships among variables under investigation for forecasting, policy analysis, and decision-making.
Non-market valuation models	Hedonic and contingent valuation models, for example, estimate values for environmental goods and services such as reducing soil erosion, improving water quality, and carbon sequestration.
Regional economic models	Generally used to estimate changes in income, employment, and price levels at regional or national scales, in response to a policy or programmatic change by incorporating intersectoral linkages.

in press). The exclusion or inclusion of non-market goods and services, often referred to as externalities, largely differentiates private and social profitability. The third section of this book (Chapters 7-10) offers several environmental economic methodologies to value both market and non-market benefits of AFS. Chapter 7 examines the cost of carbon mitigation by means of agroforestry systems using a case study of farmers' participating in the Scolel Té project, Chiapas, Mexico. The methodology includes fixed and variable costs of implementing new AFS and the opportunity cost to farmers of diverting land from current land use, in addition to the cost of monitoring and internal verification of project performance. Chapter 8 deals with the estimation of external costs of dryland salinity emergence and the environmental and monetary benefits of tree planting in Australia. Using a dynamic programming model, the optimal area for forest on agricultural land is determined by explicitly considering the interactions between trees and crops. Chapter 9 assesses key environmental services such as conservation of on-farm soils and reduction of pressure on public forests through the adoption of AFS. Household production theory is used to conceptualize environmental services and policy levers and to frame testable hypotheses. Drawing from household survey data on agroforestry-based soil and forest conservation in the Manggarai region in Indonesia, the authors use an econometric model to test the hypotheses concerning soil erosion and AFS. Chapter 10 models an important externality problem, Florida ranchers' willingness to accept (WTA) for adopting silvopasture and generating environmental services, using a dichotomous choice, contingent valuation approach. In this chapter, a price premium is used as a payment vehicle to reflect the environmental services generated through silvopasture.

Since the mid-1990s, agroforestry adoption research has increased, largely motivated by perceived discrepancy between advances in agroforestry science and low adoption rates. The fourth section (Chapters 11-13) is devoted to the issue of AFS adoption and the myriad of factors influencing the adoption decision. Using a five-year linear programming (LP) model, Chapter 11 conducts an economic assessment of household constraints to the adoption of improved fallows in Mangwende Communal Area, northeastern Zimbabwe. Chapter 12 extends the previous model by conducting a meta-analysis of factors determining agroforestry adoption and farmers' decision-making in Malawi. In this chapter, information produced from LP models is used as the basis for conducting meta-regression analyses. Chapter 13 provides another perspective by describing an alternative econometric-based method for *ex-ante* analysis of AFS adoption potential. In particular, an attribute-based choice experiment (ACE), a subset of conjoint analysis, is applied to develop information for improving the adoption potential of agroforestry projects in southeast Mexico.

Although information generated through microeconomic analyses, profitability analysis and environmental economic analysis is essential for making agroforestry adoption decisions, information about the effect of AFS on regional income and employment plays a critical role in policy making. The fifth section (Chapters 14-15) focuses on the role of AFS in rural development and institutional arrangements

- Garrett, H. E. G. (1997). *Agroforestry: An integrated land-use management system for production and farmland conservation*. [United States Department of Agriculture Soil Conservation Service [USDA-SCS] Report 68-3A7S-3-134]. Fort Collins, CO: USDA-SCS.
- Gordon, A. M., & Newman, S. M. (Eds.) (1997). *Temperate Agroforestry Systems*. New York: CAB International.
- Mercer, D. E. & Hyde, W. F. (1991). The economics of agroforestry. In W. R. Burch, Jr. & J. K. Parker (Eds.), *Social Science Applications in Asian Agroforestry* (pp. 111-143). New Delhi, India: Oxford & IBH Publishing.
- Mercer, D. E., & Miller, R. P. (1998). Socioeconomic research in agroforestry: progress, prospects, priorities. *Agroforestry Systems*, 38, 177-193.
- Montambault, J. R., & Alavalapati, J. R. R. (2003). Socioeconomic research in agroforestry: A decade in review. Manuscript submitted for publication.
- Nair, P. K. R. (Ed.). (1989). *Agroforestry systems in the tropics*. Dordrecht, The Netherlands: Kluwer Academic Publishers.
- Nair, P. K. R. (1994). *Agroforestry. Encyclopedia of agricultural sciences* (Vol. 1, pp. 13-25). New York: Academic Press.
- Nair, P. K. R. (1998). Directions in tropical agroforestry research: past, present, and future. *Agroforestry Systems* 38, 223-245.
- Rochelau, D. (1998). Confronting complexity, dealing with differences: Social context, content, and practice in agroforestry. In L. E. Buck, J. P. Lassoie, E. C. M. Fernandes (Eds.), *Agroforestry in Sustainable Agricultural Systems* (pp. 191-235). Boca Raton, Florida: CRC Press.
- Shrestha, R.K. & Alavalapati, J. R. R. (in press). Valuing environmental benefits of silvopasture practices: A case study of the Lake Okeechobee watershed in Florida. *Ecological Economics*.



ADVANCES IN AGROFORESTRY



Valuing Agroforestry Systems Methods and Applications

Janaki R.R. Alavalapati and D. Evan Mercer (Eds.)

There is a growing interest and need for enhancing economic and policy research in agroforestry. So far, no single reference book provides adequate coverage of applied economic and policy analysis methodologies for agroforestry professionals. This book, written by the leading experts in economics and agroforestry, addresses this need with 14 case studies (covering all the continents of the world) that describe and demonstrate the application of a wide range of cutting edge economic analysis techniques to agroforestry systems, policies and projects. The applied economic methodologies include enterprise/farm budget models, Faustmann models, Policy Analysis Matrix, production function approach, risk assessment models, dynamic programming, linear programming, meta-modeling, contingent valuation, attribute-based choice experiments, econometric modeling, and institutional economic analysis. This book provides a unique and valuable resource for assisting upper division undergraduate and graduate students and rural development professionals to conduct rigorous assessment of economic and policy aspects of agroforestry systems and to produce less biased and more credible information.

KLUWER ACADEMIC PUBLISHERS

ADAG 2

ISBN 1-4020-2412-6



9 781402 024122