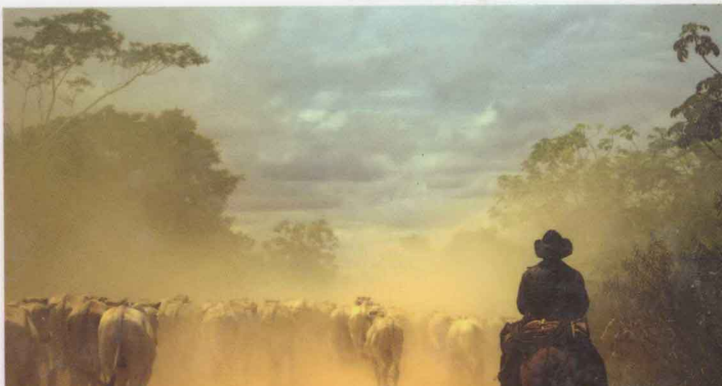
CROPS AND CARBON

Paying Farmers to Combat Climate Change


MIKE ROBBINS

Crops and Carbon

Paying Farmers to Combat Climate Change

Mike Robbins

earthscan
publishing for a sustainable future

London • New York

First published 2011
by Earthscan
2 Park Square, Milton Park, Abingdon, Oxon OX14 4RN

Simultaneously published in the USA and Canada
by Earthscan
711 Third Avenue, New York, NY 10017

Earthscan is an imprint of the Taylor & Francis Group, an informa business

British Library Cataloguing in Publication Data
A catalogue record for this book is available from the British Library

Library of Congress Cataloging in Publication Data
Robbins, Michael W.
Crops and carbon : paying farmers to combat climate change / Mike Robbins.
p. cm.
Includes bibliographical references and index.
1. Farmers—Economic conditions. 2. Agriculture—Economic aspects. 3. Sustainable development—Environmental aspects. 4. Agriculture—Environmental aspects. 5. Leadership. I. Title.
HC79.E5R597 2011
363.738'746—dc22

2011004456

ISBN: 978-1-84971-375-7 (hbk)

Typeset in Times New Roman
by JS Typesetting Ltd, Porthcawl, Mid Glamorgan

MIX
Paper from responsible sources
FSC www.fsc.org FSC® C004839

Printed and bound in Great Britain by the MPG Books Group

Crops and Carbon

By the same author

Even the Dead are Coming: A Memoir of Sudan

List of Abbrevations

AFOLU	Agriculture, Forestry and Land Use
AI	artificial insemination
AIJ	activities implemented jointly
BAU	business-as-usual
BBC	British Broadcasting Corporation
BNDES	Banco Nacional do Desenvolvimento
BNF	biological nitrogen fixation
BP	British Petroleum
C&C	contraction and convergence
CA	conservation agriculture
CARB	California Air Resources Board
CBD	Convention on Biodiversity
CCX	Chicago Climate Exchange
CDF	Clean Development Fund
CDM	Clean Development Mechanism
CEIVAP	Comitê para a Integracão da Bacia Hidrografíca do Rio Paraíba do Sul
CER	certified emissions reduction
CGIAR	Consultative Group on International Agricultural Research
COP	Conference of the Parties
CSE	Centre for Science and the Environment
CT	conservation tillage
CTIC	Conservation Tillage Information Center
EB	Executive Board
EMATER	Empresa de Assistência Técnica e Extensão Rural
EMBRAPA	Empresa Brasileira de Pesquisa Agropecuária
ER	emissions reduction
EU ETS	European Union Emissions Trading Scheme
EU	European Union

EUA	European Union Allowance
FACE	free-air CO_2 enrichment
FAO	Food and Agriculture Organization
FFW	food-for-work
FDI	foreign direct investment
FEBRAPDP	Federacão Brasileira de Plantio Direto na Palha
GCM	General Circulation Model
GDP	gross domestic product
GEF	Global Environment Facility
GHG	greenhouse gas
GNP	gross national product
GPG	global public good
GPS	geographic positioning system
IADB	Inter-American Development Bank
IBGE	Instituto Brasileiro de Geografia e Estatística
ICARDA	International Center for Agricultural Research in the Dry Areas
IFOAM	International Federation of Organic Agriculture Movements
IFPRI	International Food Policy Research Institute
IMA	Institute Mineiro de Agropecuária
INCRA	Instituto Nacional de Colonização e Reforma Agrária
INS	inelastic neutron scattering
IPCC	Intergovernmental Panel on Climate Change
JI	Joint Implementation
LAC	Latin America and Caribbean
LDC	least-developed countries
LIBS	laser-induced breakdown spectroscopy
LULUCF	land use, land-use change and forestry
MCA	multi-criteria analysis
MRT	mean residence time
MRV	measurable, reportable and verifiable
MST	Movimento dos Trabalhadores Rurais Sem Terra
NGO	non-governmental organization
NIRS	near infrared reflectance spectroscopy
NPP	net primary production
NT	no-till
ODA	official development assistance

OECD	Organisation for Economic Co-operation and Development
PES	payment for ecosystem (or environmental) services
ppm	parts per million
PRONAF	Programa Nacional de Fortalecimento da Agricultura Familiar
REDD	reduced emissions from deforestation and degradation
RGGI	Regional Greenhouse Gas Initiative
RUSLE	revised universal soil loss equation
SLM	sustainable land management
SOC	soil organic carbon
SOCRATES	Soil Organic Carbon Reserves and Transformations in Agro-Ecosystems
SOM	soil organic matter
SRES	Special Report on Emissions Scenarios
SWC	soil and water conservation
TAR	Third Assessment Report
T-CER	temporary certified emissions reduction
TDR	time domain reflectometry
TERI	Tata Energy Research Institute
UK ETS	United Kingdom Emissions Trading Scheme
UNCED	United Nations Conference on Environment and Development
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
USFS	United States Forest Service
VCS	Voluntary Carbon Standard
VER	verified emissions reduction
WMO	World Meteorological Organization
WRI	World Resources Institute
WUE	water-use efficiency
WWF	World Wide Fund for Nature
WOCAT	World Overview of Conservation Approaches and Technologies

Acknowledgements

Many people have assisted or influenced the production of this book, the more so because its origins go back many years. It would be impossible to thank them all properly. I must emphasize that they are not responsible for the book's content and would not necessarily endorse its conclusions.

First I must thank Tim Hardwick of Earthscan and Will Critchley of the Free University of Amsterdam, both of whom have backed the project wholeheartedly. They have also made important and helpful suggestions on the book's content. At the University of East Anglia, John McDonagh and Kate Brown were endlessly supportive during the years this book was taking shape. Other members of the faculty of the School of Development Studies at UEA have also provided inspiration and support; in particular, Piers Blaikie and Michael Stocking have shaped my thinking about rural development and farmers' use of technology. Their views are reflected in this book, but they are not responsible for anything I have misunderstood.

My work at UEA was supported by Britain's Economic and Social Research Council and by the Natural Environment Research Council. I am very grateful for their assistance.

Outside UEA, the roots of this book lie in a conversation about agriculture and climate change with John Ryan, soil scientist at ICARDA in Syria, in the 1990s. And its approach owes much to Michael Zoebisch, whose work and views on farmers and their environment have very strongly influenced mine. His encouragement when I started to think about these issues was invaluable. Many other staff at ICARDA also helped to form the way I think, as did those with whom I worked in the Ministry of Renewable Natural Resources in Bhutan. I also learned much from my colleagues at FAO in 2001 to 2002; in particular, I would like to thank Jose Benites and Theodor Friedrich for discussions on reduced tillage and its implications. I would also like to thank those who gave me time and advice on two trips to Washington, DC, in 2003 and 2005. On both trips, I had long and informative talks with Ian Noble and I am grateful for his time. Especially warm thanks are due to Scott Christensen and Andrea Pape-Christensen for their hospitality on both those trips.

Warm thanks must go to a number of people in Brazil, in particular Bob Boddey and Segundo Urquiaga; there is no question of my work there having been possible without them. Thanks too to Phil and Mercia Chalk for encouragement and hospitality. Eli de Jesus and Leila M. do Valle played a key part in the field survey; Eli also greatly enhanced my understanding of the issues faced by farmers in Minas Gerais. None of these people are in any way responsible for anything I have written, or may have misunderstood, about Brazil. I would also like to thank everyone, particularly the farmers, extension staff and other officials, who gave up their time to meet me and discuss their work. As this book goes to press, the State of Rio de Janeiro is coping with the aftermath of appalling floods that have taken hundreds of lives; I would like to offer my sympathies, and wish the state well for its future.

Last but not least, one's friends are the environment in which one's work is done. I cannot, I suppose, list them all; but Anna Allen, Patricia Almaguer-Kalixto, Emily Boyd, Dan Coppard, Marta Einarsdóttir, Ian Fuller, Lawrie Hallett, Joe Hill, Sylvie Koestlé, and Neil Monk, among many others, have been especially supportive at various times. And special thanks must go to Hazel Marsh in Norwich and Lisa Sutton in New York, for their warmth and humour and for keeping me sane as this project neared its end.

Introduction

It is reasonable to assume that the dry margins of semiarid lands contracted or expanded according to climatic variations. But to propose that civilization was chased from Babylon to London by a creeping drought is not reasonable. The evidence for climate as a destroyer of civilization is vague or nonexistent; the evidence of soil erosion is there for all to see.

(Carter and Dale, *Topsoil and Civilization*,1955)

The climate appears to be changing due to human activity. To stop or reverse this, there are now national and international systems of incentives for activities to mitigate emissions of greenhouse gases (GHGs). One such activity is sequestration of carbon dioxide – CO_2 – into sinks. The best-known carbon sinks are forests, but agricultural land is also a sink, and it is one that can be enhanced or degraded, depending on the way the land is farmed. Farmers in the developing world might benefit from this, either by receiving direct payments for the carbon removals, or through development funding leveraged by the environmental benefits. At least, that is the theory. The objective of this book is to examine the practical possibilities.

There is a clear theoretical rationale for considering agricultural sinks as a mitigation strategy. CO_2 emissions are fuelling climate change. Sinks are carbon pools, the contents of which are *not* adding to the atmospheric carbon pool because they are held elsewhere. The size and nature of sinks is highly variable; forests are the best-known but much carbon is also held in aquatic ecosystems, transported there by soil erosion, while the oceans absorb a considerable amount of carbon dioxide – and undersea formation of limestone is composed chiefly of carbon. Other carbon deposits include fossil fuels such as oil and coal, formed over millennia from plant material. The stability of these sinks clearly varies; fossil fuels are stable until disturbed by human agency, but forests are subject both to this and to natural fires.

The soil organic carbon pool is also subject to disturbance both by human activity and natural processes, and its size is significant. Estimates vary, but one suggested figure is 1550Pg[1] (Follett, 2001, pp78–89).This is roughly twice the atmospheric carbon pool, which is 770Pg (Lal, 2002, p353). Sombroek et al (1993, quoted in UNCCD, 2008, p3) suggest that the soil carbon sink in the top 1m of soil is 1.5 times the total for standing biomass. Soil carbon can be converted to CO_2 through land-use change, ploughing and erosive processes that are mainly connected to agriculture. Agriculture has therefore caused huge losses to the atmospheric pool ever since it began in settled form about 8000 years ago. How much, is arguable; Lal (2004a, p1623) reports that estimates vary from 44 to 537Pg, but that they typically range from 55 to 78Pg.

However, there is widespread acknowledgement that agriculture can, at least in theory, recover much of this. Lal and Bruce (1999, p178), who estimate the historic loss at 55Pg C, also believe that as much as 75 per cent might be recoverable through the sequestration of CO_2 into the soil – that is, its conversion into organic carbon, contained in plant material, through photosynthesis. FAO (2001a, p61) suggests 23–44Pg C in agricultural soils over the next 50 years; this implies that agriculture can be of comparable significance to forests, the global sequestration potential of which has been estimated at 60–87Pg C (ibid.). This sequestered carbon can to some extent be converted into soil organic matter (SOM) through (for example) the decomposition of root systems and the incorporation of crop residues. This in turn can have positive inputs to productivity, soil health and the sustainability of agriculture.

In 1998 nearly 100 North American scientists and agriculture-industry figures met at St Michaels, Maryland, to discuss the potential. In his summary of the workshop, Rosenberg reports it found that:

> *[R]eductions in atmospheric carbon content can be achieved by large-scale application of tried-and-true land management practices such as reduced tillage; increased use of rotational crops such as alfalfa, clover and soybeans; and by an efficient return of animal wastes to the soil. Forests and grasslands afford additional capacity for carbon sequestration when established on former croplands. Programs to further soil carbon sequestration will provide ancillary benefits including improvements in soil fertility, water holding capacity, and tilth, and reductions in wind and water erosion.* (Rosenberg et al, 1999, p1)

Although much of the potential lies in the developed world, increasing SOM could have particular significance in regions where, for economic reasons, farming must be pursued in fragile ecosystems; many of these are in poorer countries where low organic matter limits productivity and resistance to erosion. So sequestration of carbon in agriculture can both slow climate change, and benefit the rural poor. Meanwhile, the development of carbon-trading instruments means that the carbon may have cash value, and this might be used to fund initiatives to increase soil carbon. Despite this, agricultural sinks are currently excluded from the Clean Development Mechanism (CDM) of the Kyoto Protocol, and it is by no means assured that they will be eligible for any Kyoto Phase II, should such an agreement come into force after the current agreement expires in 2012.

This is despite agricultural sinks appearing to be a true 'win-win' strategy with positive implications not only for climate-change mitigation and poverty alleviation, but also adaptation to climate change. Soils with more organic matter will better resist the erosive processes that might be increased in years to come – for example, greater temporal concentration of rainfall. Such soils will also have better water-infiltration capacity, which will be important for the same reason.

However, there are pitfalls. Some are fundamental. Is carbon really a commodity that can be priced, bought and sold in any meaningful sense? Our understanding of value in a market society would suggest not. If this is the case, then the 'carbon market' is a bureaucratic fiction that farmers would do well to avoid. And even if one accepts that carbon does have value, how does one price it?

There are also many questions specific to agriculture. Some of the agronomic practices required to sequester carbon are those already advocated for soil conservation; attempts to support this have had a difficult history in agricultural development. Linking these practices to carbon funding, as well as soil conservation, would not automatically eliminate these difficulties. Even if it did, there would still be major methodological constraints to linking agricultural carbon to the market. Not least would be additionality – that is, would the carbon have been sequestered anyway without the project? Proving that it would not is especially hard when the measures taken have other benefits.

Monitoring and verification of agricultural sinks is also challenging. To begin with, to prove that a carbon sink has been enhanced, it is necessary to know not just how large it was before the project, but how much carbon might have been sequestered or lost without intervention. This is called the baseline, and it is fundamental to any project, in any sector, that seeks to monetize emissions reductions or GHG removals.

Assuming that a baseline has been set, the amount of carbon being sequestered, or not emitted, from the farm must be monitored. Above-ground carbon – trees and other vegetation – can be quantified, although there are challenges. The soil carbon sink is more difficult. Tools to measure soil carbon have been around for a long time, but they measure a sample taken from a given point, and the amount may vary widely even within a single field.

A major methodological challenge is permanence. This applies to all land-use projects; how can one say a forest will never be cut down? The same applies to agricultural land; a farmer may agree to apply minimum tillage in order to increase the carbon in the soil, but can plough again very easily if there is some incentive to do so. Sinks have fared badly in negotiations partly for this reason.

Who is going to invest in carbon credits from agriculture? It will not be the cheapest way to generate them. And will there be a market? The Kyoto Protocol expires in 2012; it might not be replaced, and has provided few funding mechanisms for agriculture anyway. What are the alternatives?

This book examines these questions. It starts by explaining climate change and what it will do, especially to agriculture. Next it explains what agriculture can do to mitigate this process, and how. Other chapters review the carbon market and agriculture's place in it, and examine the methodological constraints mentioned above. Finally, the book examines the potential for agricultural sequestration in one biome – the Atlantic Forest region of Brazil. This includes how the above- and below-ground carbon stocks in the region become depleted, and what the farmers think the constraints might be to introducing carbon-friendly farming practices. This was done with a farmer survey. The responses, and the views expressed by the farmers, have helped to illuminate what some of the deeper, less visible constraints to 'carbon farming' might be.

Several themes emerge from this book. They include the need to fit carbon mitigation into both global and local contexts; it cannot be thought of in isolation. They also include the need to confront complexity; there is nothing simple about emissions mitigation, especially in agriculture. Not least of the complexities is the relationship between mitigation of

CO_2 emissions, and the other greenhouse gases closely associated with agriculture, nitrous oxide (N_2O) and methane (CH_4).

But one of the most important themes is scientific uncertainty. The unknowns around climate change itself are common knowledge. The Intergovernmental Panel on Climate Change (IPCC) has always clearly acknowledged them in its successive assessment reports. Climate science operates at the frontiers of knowledge and is essentially inductive; it must try to construct the future from the facts it has so far.

What is perhaps less well understood, is that there are sometimes specialized gaps in the knowledge regarding climate change that are also important, and *could* be filled. Data concerning (for example) the relationship between carbon emissions and soil erosion, or the agronomic properties of biochar, is not available because until recently nobody knew that they would be needed. It seems unlikely that this phenomenon is unique to agriculture.

The author hopes that this book will demonstrate the potential and, despite the challenges, feasibility of agricultural sinks in the developing world. But another message, almost as pressing, may be the importance of the biophysical sciences at every level in the drive to mitigate climate change.

Finally, a word of warning: climate science, and climate negotiations, are constantly moving on. The author has tried to ensure that the contents of this book are up to date at the time of going to press (February 2011); inevitably, however, there will be relevant events, and new papers published, by the time it appears.

Note

1 1Pg (petagram) C is equivalent to 10^{15}g – that is, 1000 million metric tonnes; this can also be expressed as gigatonnes (Gt). Also used is a Tg, or teragram, of C (10^{12}g), 1,000,000 tonnes. To reduce confusion, these measurements will generally be quoted in the same way as they are at source.

Contents