WORLD BANK DISCUSSION PAPER NO. 364

Work in progress
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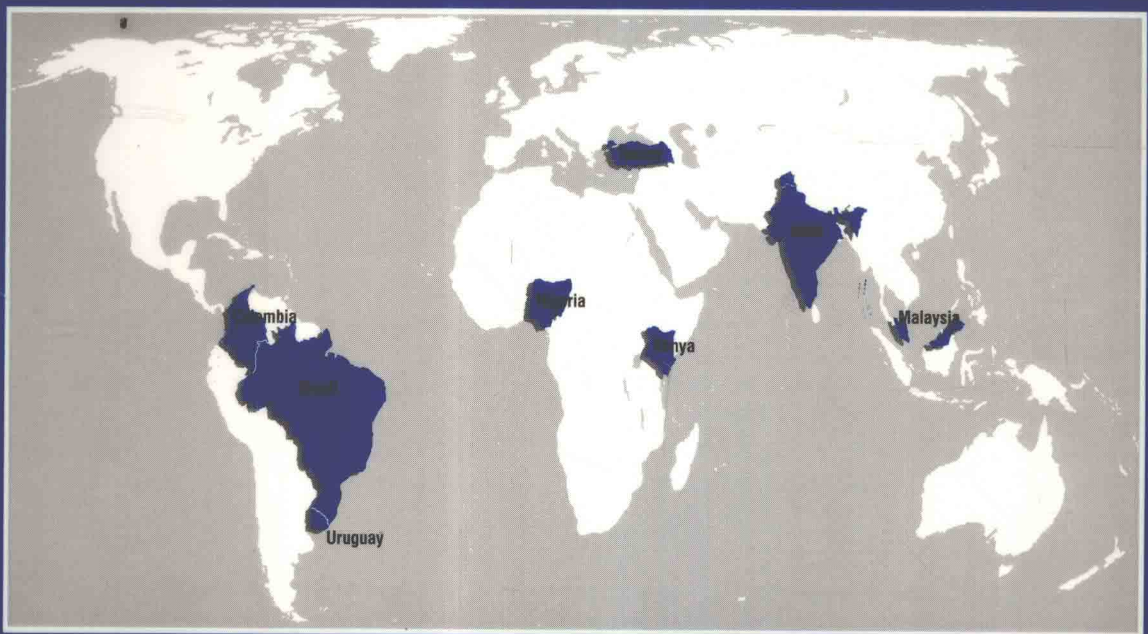
Intensified Systems of Farming in the Tropics and Subtropics



J. A. Nicholas Wallis

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The World Bank
Washington, D.C.

First printing June 1997

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Cover: World Bank map IBRD 28778, April 30, 1997.

ISSN: 0259-210X

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Library of Congress Cataloging-in-Publication Data

Wallis, J. A. N.
Intensified systems of farming in the tropics and subtrops /
J.A. Nicholas Wallis.
p. cm. — (World Bank discussion paper ; 364)
Includes bibliographical references (p.).
ISBN 0-8213-3944-3
1. Agricultural systems—Tropics. 2. Dry farming—Tropics.
3. Agricultural systems. 4. Dry farming. I. Title. II. Series:
World Bank discussion papers ; 364.
S481.W35 1997
630'.913—dc21 97-16487
CIP

FOREWORD

The human population will continue to grow for the next several decades, and most of this population growth will occur in the developing world. It is well established that the demand for food from the rural sector will increase, and world's poor, who are concentrated in rural areas, will seek to increase their production from ever more scarce land and water resources.

This paper has involved the collaboration of staff from several departments in the World Bank and many others throughout the world, and is part of a growing repertoire of cases where agricultural production systems are intensified without depleting the natural resource base. The cases contribute to our experience of policy environments, institutions, and practices which are integrated to meet the demand for food, to reduce poverty, and to utilize resources in an environmentally, socially, and financially sustainable way. They illustrate the importance of production systems which are capable of continually adaptating to changing social, economic, and environmental conditions. Additionally, each case demonstrates the importance of reliable infrastructure to the transition of farms from subsistence-level to more intensive systems of farming.

This paper contributes to increasing the awareness of the possibilities and opportunities for sustainably intensifying agricultural production systems.

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ABSTRACT

A review of eight intensified systems of land use on unirrigated farms in developing countries is used as a basis to propose three complementary sets of conditions necessary for farming systems to be sustainable in the long run. These three sets of conditions or "domains" are public sector policies and investments; private farmers, their families, and institutions; and scientific principles, natural resource endowments, and ecological systems.

The eight farming systems represent a wide range of geographic and resource features and contrasting sociological conditions in Africa; south, east, and west Asia; and Latin America. They include the reduction of the proportion of fallow land in Turkey, dairy development in Uruguay, associated cropping on small farms in Colombia and Nigeria, the opening up of the *Cerrados* region of Brazil; and the development of minimum tillage and direct drilling practices on large-scale soybean farms, soybean growing by small-scale farmers on black cotton soils in central India; and two examples of perennial crop development on estates and smallholdings in Kenya (tea) and Malaysia (oil palm).

In all cases the role and policies of governments have been of crucial importance, particularly in the following respects:

- Creating transport infrastructure, such as railway and road systems;
- Facilitating and promoting active markets for farm products and, for some seasonal crops, establishing floor prices;
- Minimizing direct involvement in product marketing; and
- Maintaining realistic foreign exchange rates.

Farmers have responded rapidly to market opportunities when they have been confident that they can sell all their product surplus to family requirements. Price predictability appears to have been more important than the level of farm gate prices. Falling prices have generally induced intensification of production. Social customs affect considerably the sequence and degree of change in farming practices. Centrally organized group farming among small-scale oil palm growers in Malaysia has been successful, but in the other cases, the intensification of farming systems has been the result of many separate decisions by individual farmers. Major improvements in resource use have occurred, but in the cases of India, Nigeria, and Turkey, communal decisions and action on landscape planning will be necessary to sustain the changes already made.

All the cases show the importance of scientific research, but with the exception of tea in Kenya and oil palms in Malaysia, research efforts have been sporadic, seldom well-balanced, and usually not documented in the international scientific press. Plant breeding and selection has often been successful, but poorly supported by studies of soil and water management and hydrology. Soil studies have generally been weak regarding soil organic matter and biological activity in the rooting zone of crops and pasture plants. All the cases illustrate the importance of leguminous species in the farming system, but in general these species have not been adequately studied. Much research has been weak on socioeconomic variables, and consequently the results and possibilities for improved use of natural resources have been poorly understood by policymakers.

PREFACE

The purpose of this inquiry is to see whether intensified systems of rainfed farming have some characteristics or features in common that are not harmful to the environment. This is not a review of World Bank operations, although the Bank had promoted or encouraged policy changes that had enabled several of the systems to be intensified.

I spent ten to twenty days in each of eleven countries where I had been advised of the existence of one or more rainfed farming systems that:

- Had been notably intensified and widely adopted during the last ten to thirty years;
- Appeared not to threaten the local environment, although they did, of course modify the natural ecology;
- Were claimed to be generally viable financially and environmentally; however, it is not asserted that any system is sustainable unless it continues to evolve.

Further criteria for selection are summarized in the introductory chapter. In this first chapter I also outline my ideas, based on field observations, of necessary conditions for "sustainability." I extend the concept of sustainability to embrace three distinct domains: the natural sciences or "facts of life," the family's or firm's point of view and the public sector. There must be at least a moderate degree of consistency among these three domains for a system to have the possibility of being sustainable. One troubling consequence of this approach is that any apparently sustainable system may well become unsustainable if there is a change in one domain that is inconsistent with the developments in one or of both the other domains. Chapter 2 provides an overview of the findings from the eight cases and suggests lessons that may be broadly applicable.

Of the eight examples of intensified farming systems covered in this review, the one from Nigeria is only at an early stage of dissemination, but it is included as an interesting example of a promising set of adjustments to a traditional system of associated cropping on small-scale farms in the forest zone that has not yet been widely adopted. It illustrates some of the complexities involved in intensifying a traditional system of farming.

I was not persuaded that the changes in farming systems I was shown in Central Visayas, Philippines; the Loess Plateau, China; and the Eastern Lowlands, Bolivia, were sustainable as practiced at present. However, each of these cases is well worth revisiting as further changes are introduced and more convincing experience is evident.

A secondary, but also important, purpose of this paper is to draw attention to the great volume of information available in numerous papers, many of which have not been published in international professional journals, and consequently are not known outside the respective countries. Where these are cited in the bibliography, the issuing institution is included, and its mailing address is provided in the list of abbreviations.

Chapters 3 to 10 of this discussion paper provide an outline of each system, emphasizing the technical, institutional, and social variables. No evidence is offered on the financial or economic viability of each system, because the evidence of rapid adoption by farmers confirms that they have been financially attractive except in the Nigeria case (chapter 6). Indeed, it is interesting to observe that intensification has usually increased as world market prices have declined, presumably because farmers wish to maintain or improve the net farm family incomes and standard of living despite falling market prices. Each case warrants more detailed in-depth research, for which I hope the corresponding chapters will provide an overall orientation, and the bibliography a useful introduction to the relevant literature.

I prepared this study during my eighteen-month period in the Senior Staff Resources Program attached to AGRDR. My operational expenses were financed jointly by AGR, ENV, EDI and some operations divisions where I was able to assist in a country operation during my field work for this study.

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ACKNOWLEDGMENTS

This review is based on interviews with many farmers, scientists, and senior managers of public and private institutions. Many of these people have written on subjects related to the intensification of farming and sustainable agriculture in their countries, and some of their important contributions listed in the bibliography at the end of this publication provided valuable material for this review.

I would particularly like to acknowledge the invaluable help provided by my main collaborators in the eight countries covered, as follows:

Turkey: Nedret Durutan (World Bank), Mufit Kalayci, Atakan Gunay, and Hasim Ogut

Uruguay: Olegario Menendez and Mark Fairless

Brazil: John Landers

Colombia: Luis Fernando Ceballos L. (FEDERACAFE)

Nigeria: Ray Unamma (World Bank) and Ndanusu Mijindadi (FACU)

India: M. Balasubramanian (World Bank) and P.S. Bhatnagar, Director, National Research Centre for Soybean

Kenya: Jacob Kampen (World Bank) and J. Ndegwa (World Bank), and Caleb O. Othieno, Director, Tea Research Foundation - Kenya

Malaysia: Keith Templeton (World Bank), Abdul Ghafar Wahap (FELDA), Ho Chai Yee (Sime Darby Ebor Research), and Chan Kook Weng (Gutherie Research Chemara)

In the production of this discussion paper I have been most ably assisted by Becky Price (figures), Jeffrey Lecksall (maps), and James Wilson (bibliography); and Alice Dowsett undertook the editing and provided valuable advice on formatting for the whole document.

I have received comments and advice from many people and institutions, including those mentioned above. I wish to thank all those who have assisted me in the past year and a half, however, as the author I accept full responsibility for any omissions or errors, and for the interpretation and opinions expressed throughout this publication.

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1
Introduction

This is a review of eight intensified farming systems most of which have proven effective in exploiting the natural resources upon which they are based, not degrading them, but sometimes restoring them. Each case brings out the interactions and complementarity among sound scientific and practical knowledge, market factors, social and political contexts, and public policies and investments. Seven of these systems are apparently viable under current circumstances, but are they "sustainable"?

Sustainability is a term that has come into widespread use, particularly during the past decade. Its use has been so extensive and it has been applied to so many distinct circumstances that it has come to be interpreted in many different ways (Dixon and Fallon, 1989; Munasinghe, 1993a; Pezzy 1989). Some people have applied it to an unchanging system of production or to a lifestyle that can be perpetuated indefinitely. Such a static interpretation is inappropriate for farming systems. For a system of natural resource management to be sustainable, it must be able to withstand sharp climatic fluctuations and evolve steadily in response to social changes and the costs and availability of inputs of land, labor, and knowledge. The names and addresses of organizations concerned with sustainable agriculture have been listed in Reijntjes, Haverkort, and Waters-Bayes (1992, pp 232-235). In a recent issue of Finance and Development, a useful review of the present state of thinking on sustainable development was provided by a sociologist (Cernea 1993), an ecologist (Rees 1993), and an economist (Munasinghe 1993b), while Steer and Lutz (1993) considered how sustainable development might be measured and Serageldin (1993) combined the specialists' views into a triangular model representing social, economic, and ecological objectives.

One of the first points to be considered is what is to be sustainable, and for whose benefit. As Norgaard (1988) pointed out, some people will emphasize the maintenance of ecological systems, while others will press for sustaining the level of consumption and for improving the level of employment. Governments cannot alleviate poverty except by seeing that the net added value created for each unit (for example, day of work) is increased substantially. In the primary and secondary sectors this generally requires using both renewable and nonrenewable resources. For services and academic output this is less obvious.

While populations continue to increase, as they are likely to do in the developing countries for many decades to come, the availability of nonrenewable resources per person will clearly decline. Another issue of increasing importance is the need to dispose of waste products safely and to prevent production and marketing processes from contaminating the environment. Sometimes this relationship has been condensed to a balance between "sources" of inputs and "sinks" for the disposal of unwanted outputs. Between these two extremes complex physical and biological processes are at work. This review uses the term farming system to encompass the whole cycle, from the sources of resources all the way through to the final consumer and sinks for wastes.

Sustainability here refers in the first place to a farming system's physical, chemical, and biological elements and how these interact over space and time. The World Commission on Environment and Development (WCED 1987, p.8) considered that:

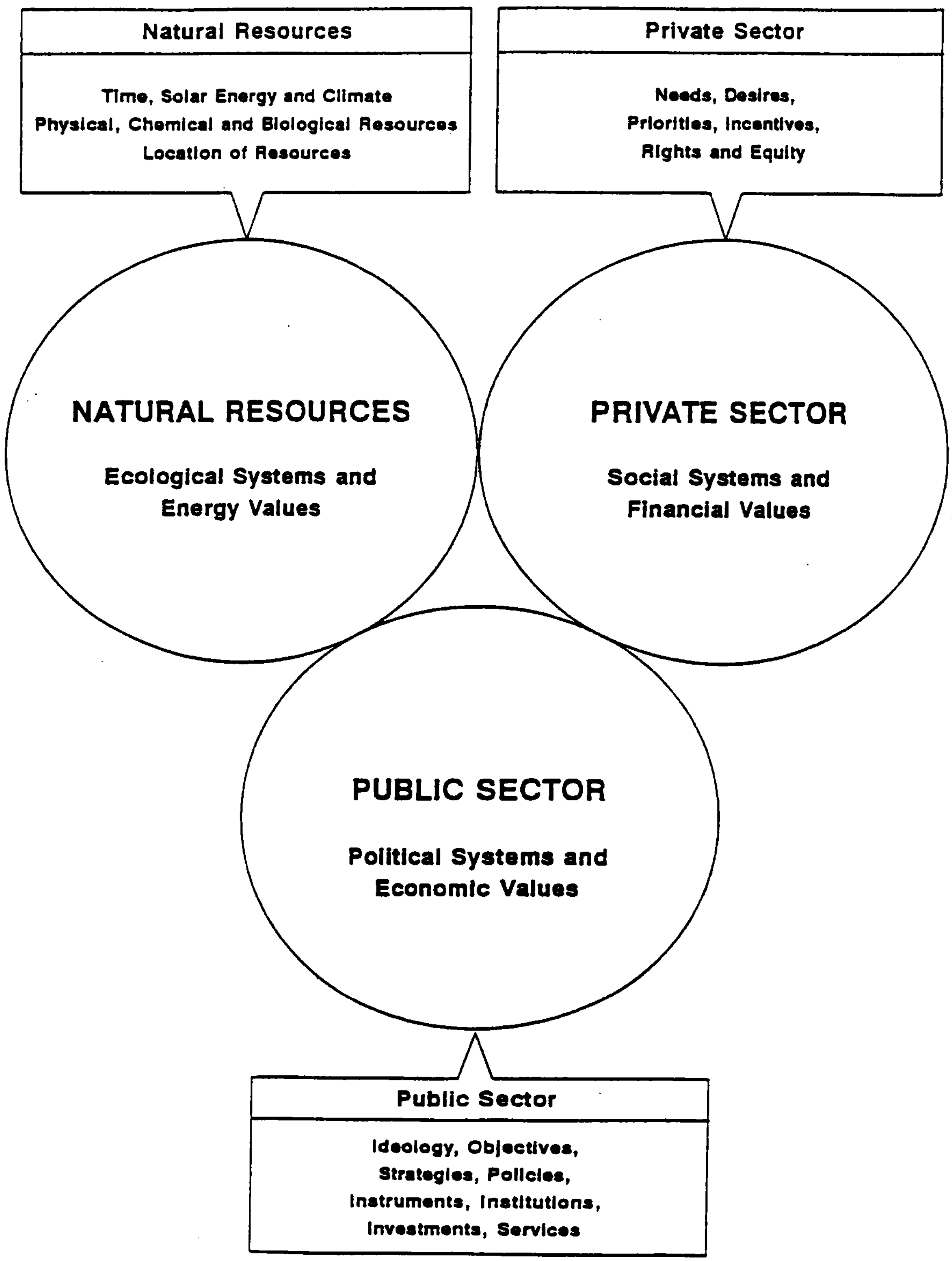
> Humanity has the ability to make development sustainable - to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs. The concept of sustainable development does imply limits - not absolute limits but limitations imposed by the present state of technology and social organization on environmental resources and by the ability of the biosphere to absorb the effects of human activities. But technology and social organization can be both managed and improved to make way for a new era of economic growth. The Commission believes that widespread poverty is no longer inevitable. Poverty is not only an evil in itself, but sustainable development requires meeting the basic needs of all and extending to all the opportunity to fulfill their aspirations for a better life. A world in which poverty is endemic will always be prone to ecological and other catastrophes.

Daly (1987) considers that present generations can only provide future generations with a "resource dowry," and how future generations use it to produce happiness or misery is their own affair. This legacy must surely also include all the information and knowledge earlier generations have accumulated, as well as the physical resources.

The accumulated knowledge resource will no doubt lead to changes in technology and the development of substitutes in response to the new needs of future generations. This has been termed the "possibilistic" or "technological optimistic" view, which assures us that market-induced responses will arise that will solve problems that are as yet unknown. This view overlooks the undoubted problems of imperfect access to knowledge, rent-seeking behavior, and greed of individuals. A positive advantage of this view, however, is that it reminds us that the combination of resources that will be essential to future generations will almost certainly be different from what we now consider to be essential.

Another common subject of debate is how far into the future we should worry about. For an individual the distance of the time horizon depends upon that person's wealth and security. We will all die one day, but the poor will almost surely die younger. The time horizon of governments and elected representatives of the people should be much longer than the individual's, although in practice this is often not the case. Norgaard and Dixon (1986) present an argument for combining economic and "co-evolutionary" methodologies when designing development projects. Their approach draws attention to concurrent changes in physical and social systems. This view is also helpful in accommodating the imponderables and uncertainties we face today when deciding which farming systems are likely to be sustainable and which are not. The authors emphasize the continuing changes that should and can be made as new knowledge and experience is acquired. This evolutionary development will be most effective if the initial technical and social systems are both broadly based and diverse, as this provides many opportunities to learn from experience.

Figure 1-1. Factors in a Sustainable Farming System



Source: *J.A. Nicholas Wallis.*

Building upon Norgaard and Dixon's approach, Figure 1-1 illustrates that in addition to the physical and social systems or "domains," there is a third public sector domain made up of political systems and economic, rather than financial, valuations. It is how these three broad domains interact that determines whether or not a system has the possibility of being truly sustainable. All the cases discussed in the later chapters illustrate that sudden changes in farm productivity may occur when the three domains come into reasonable compatibility, including the subjects listed in the boxes in Figure 1.1. It is, of course, equally true that an apparently sound and sustainable system may not continue to be sustainable if a major change occurs in any of the three domains, for instance, if public policy leads to a seriously misaligned exchange rate.

In their review of economics, the environment, and sustainable development, Pearce and Warford (1993) outline a general theory of poverty and the environment within which they advocate two broad strategies for the sound development of the agricultural sector, namely:

- Raise agricultural productivity in the most resilient and potentially productive areas, thereby improving the well-being of 250 million of the most impoverished poor, and reducing the pressure exerted on marginal lands by populations who would otherwise be displaced from resilient areas.
- Decrease the fragility of marginal areas through policy responses to introduce schemes of water conservation, agricultural extension, afforestation, and agroforestry. As with resilient areas, the policy mix must consist of investment, incentives schemes, infrastructure, credit, extension, and institution building, in many cases including the establishment or reinforcement of resource rights through land and resource tenure.

This review of intensified farming systems shows that some conditions have to be met for any system of farming to be sustainable. These are summarized in Figure 1-2. It is essential that the public sector ensures a reasonable degree of peace and stability to provide a general feeling of **security** in rural areas. The public sector also has a special responsibility to promote education and research, disseminate **information,** and provide means of **communication**. Services are often most effectively carried out by private sector entities, but as all these cases illustrate, the public sector usually has to take the important first steps.

The main driving force for agricultural intensification is a **demand** for farm products. Before farmers will actually intensify their operations, they need to have reliable commercial **information** and ready **access** to markets for their products, and also for any essential farm inputs. Within the ecological system, an essential feature of a satisfactory intensified farming system is that marketable output is increased per unit of input. The most appropriate measure of **productivity** is not always yield per unit of area or animal, but may be per unit of labor, energy, or water input, depending upon which is the most limiting factor. **Stability** and reliability of output from season to season is an important condition, and the concept of sustainability as applied to farming systems also needs to encompass the capacity to withstand and recover from major shocks, which may be from natural events such as droughts or floods, or from sharp fluctuations in commodity prices. **Resilience** is, therefore, an important characteristic in reducing a farming system's vulnerability. The final highly desirable, although possibly not essential, characteristic of a sustainable farming system is that it is **flexible** and readily adapted to produce new outputs in response to unforeseen market demands.