



ORGANIC AGRICULTURE AND POST-2015 DEVELOPMENT GOALS

BUILDING ON THE COMPARATIVE
ADVANTAGE OF POOR FARMERS

Edited by
Sununtar Setboonsarng
Anil Markandya



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Foreword

Agriculture remains an integral part of inclusive development as it is 2–4 times more effective in poverty reduction compared to other sectors given the same level of investment. The sector employs over 65% of the poorest population and contributes about a third of gross domestic product in developing countries. However, there is an increased concern that the conventional practice of agriculture is causing soil and water pollution, emitting a significant amount of greenhouse gas, reducing biodiversity, and bypassing poor farmers, particularly in rainfed areas. Moreover, the quality and safety of food produced under conventional agriculture are increasingly being questioned by consumers. Accordingly, a fundamental transformation toward alternative production systems that are more environment- and climate-friendly, inclusive, and producing safer food is urgently needed.

Among the alternative agriculture systems, organic agriculture has received much attention as the sector has been growing at double-digit rates, expanding from \$18 billion in 2000 to about \$64 billion in 2012. Organic agriculture is a production system that sustains the health of soils, ecological processes, biodiversity, and nutrient cycle to produce food without using agrochemicals. Organic agriculture is also climate-friendly as it minimizes fossil fuel-based chemical inputs, while sequestering carbon from the atmosphere into the soil. As organic agriculture builds on the comparative advantage of poor farmers practicing traditional agriculture in less contaminated marginal lands, linking these organic farmers to global value chains can potentially offer them the benefits of higher income and improved health, while involving them as part of the solution for climate change and enhancing their climate resilience and food security. In fact, organic agriculture has been popularly advocated as a development tool to help developing countries achieve the eight Millennium Development



Goals (MDGs) targeted for 2015. With the proposed continuance of the MDGs beyond 2015 in Sustainable Development Goals, organic agriculture is poised to continue its development role with respect to market-based sustainable solutions.

While there is a large body of anecdotal evidence on the positive impacts of organic agriculture, concrete evidence to support policy formulation remains limited. To contribute toward the use of empirical evidence in the design of public policy and development programs, the Asian Development Bank Institute (ADBI) in Tokyo commissioned a comprehensive empirical study to evaluate the impacts of organic agriculture in selected Asian countries. With primary survey data, the analysis was conducted using rigorous methodology (propensity score matching) to determine the overall impacts of organic agriculture in the context of the MDGs. With further support of the Asian Development Bank in Manila, this publication is a compilation of both published ADBI working papers and unpublished works based on the empirical study. The results of the study reveal direct positive outcomes on poverty reduction, as well as indirect ones on health, education, sanitation, gender, and environmental sustainability in the context of the MDGs. Using the case of organic agriculture to demonstrate the wide-ranging benefits of investment in agriculture, the hope is for this compilation to contribute toward unlocking the potential of agriculture in contributing to the achievement of Sustainable Development Goals.

James Nugent
Director General
Southeast Asia Department

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Abbreviations

ADB	Asian Development Bank
ADBI	Asian Development Bank Institute
AMS	Agricultural Marketing Section
ASEAN	Association of Southeast Asian Nations
ALRO	Agriculture Land Reform Office (Thailand)
BML	Bundesministerium für Ernährung, Landwirtschaft und Forsten (Federal Ministry for Food, Agriculture and Forestry [Germany])
CA	conventional agriculture
PRC	China, the People's Republic of
CIF	cost, insurance, and freight
CEDAC	Cambodian Center for Study and Development in Agriculture
CFC	chlorofluorocarbon
CFMG	Community Forest Management Group
CNY	Chinese yuan
CO ₂	carbon dioxide
DEFRA	Department for the Environment, Food and Rural Affairs
EC	European Commission
EEC	European Economic Community
EODP	Essential Oil Development Program
EU	European Union
ESCAP	Economic and Social Commission for Asia and the Pacific



FAO	Food and Agriculture Organization
FLO	Fairtrade Labelling Organizations
FiBL	Forschungsinstitut für biologischen Landbau (Research Institute for Organic Agriculture)
GAP	Good Agricultural Practice
CGE	computable general equilibrium
GDP	gross domestic product
GHG	greenhouse gas
GtC	gigaton of carbon
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit (German Institute for Technical Cooperation)
ha	hectare
HIPC	heavily indebted poor countries
IBS	IFOAM Basic Standards
IFAD	International Fund for Agricultural Development
IFOAM	International Federation of Organic Agriculture Movements
IFPRI	International Food Policy Research Institute
ILO	International Labour Organization
IPCC	International Panel for Climate Change
ISSC-MAP	International Standard for Sustainable Wild Collection of Medicinal and Aromatic Plants
ISP	Independent Science Panel
JAS	Japanese Agricultural Standard
LCA	life cycle assessment
LDC	least developed country
LGO	lemongrass oil
MDG	Millennium Development Goals
CH ₄	methane
MJ	mega joules
NGO	nongovernment organization
N ₂ O	nitrous oxide



NOP	National Organic Program (Bhutan)
NTFP	non-timber forest product
Nu	ngultrum
NWFP	non-wood forest product
OA	organic agriculture
ODA	official development assistance
OECD	Organisation for Economic Co-operation and Development
OOP	out-of-pocket (expense)
PSM	propensity score matching
REDP	Rural Enterprise Development Programme
SAM	social accounting matrix
SDGs	Sustainable Development Goals
SLRe	Sri Lankan rupee
SRI	System Of Rice Intensification
TOTA	Thai Organic Trade Association
UK	United Kingdom
UN	United Nations
UNDP	United Nations Development Program
UNCTAD	United Nations Conference on Trade and Development
US	United States
USDA	United States Department of Agriculture
USDA ERS	United States Department of Agriculture Economic Research Service
USEPA	United States Environmental Protection Agency
USNOP	National Organic Program (United States)
WHO	World Health Organization
WTO	World Trade Organization
WWF	World Wide Fund for Nature

Executive Summary

Introduction

Many people see organic agriculture as a luxury: something that environmentalists pursue for their own ends and that the rich support in the belief that they are both helping the environment and hopefully doing some good for their health. This book shows, however, that such a view is very far from the truth, certainly as far as developing countries are concerned. A careful review of the evidence from a number of Asian countries demonstrates that organic agriculture has contributed to several of the Millennium Development Goals (MDGs) and that it also serves the broader objective of managing the environment in a sustainable way. While it is still a very small fraction of total agriculture,¹ the scope for organic agriculture to contribute to the MDGs and to their successors after 2015 (the post-2015 Sustainable Development Goals [SDGs]) is really quite significant.

The book makes an evidence-based case for organic agriculture in developing countries, particularly those in Southeast Asia. It starts by examining the data from organic agriculture farms, comparing them with those from nonorganic agriculture farms to see what can be said about the effects of organic agriculture on the livelihoods of comparable people and in terms of the MDGs (Chapters 1, 8, and 9).

The book then goes on to look at the economic dimension of promoting organic agriculture and actual experiences in implementing it. It explores the following questions: Are the benefits of such programs

¹ Organic agriculture is about 1% if one follows the strict definition based on certified organic production, but perhaps as much as 3% if one takes a broader definition of organic farming as any land managed under modern ecological conditions. See Chapter 6 for details.



justified in terms of their costs (Chapter 2)? Does certification help farmers in terms of increased incomes for their products (Chapter 3)? How well has certification worked to increase incomes and livelihoods in particular cases (Chapter 4)? Which benefits motivate farmers to adopt organic agriculture (Chapter 5)? (This is important as a guide to which policies to use to promote the practice.) Is organic agriculture the best way to improve rural livelihoods, or can we do better through other interventions, such as promoting biofuels (Chapter 6)? What are the macroeconomic impacts of promoting organic agriculture (Chapter 7)?

Following these chapters, the book looks at evidence on some of the big environmental questions related to sustainable agriculture. The first is its role in sequestering carbon, a major issue given the threats we face from climate change (Chapter 11). A second is enhancing biodiversity and preventing the loss of genetic material (Chapter 12).

Finally, the book considers some of the big issues in the debate surrounding agriculture which touch on organic agriculture in developing countries. One deals with the environmental costs of shipping agricultural products over large distances (food miles, Chapter 13). Another is whether organic agriculture does indeed lower yields and thereby reduce our capacity to feed the growing population of the planet (Chapter 14).

Organic Agriculture and the Millennium Development Goals

In Chapter 1, Sununtar Setboonsarng analyzes data from farms practicing organic agriculture and compares them to farms that are as similar in other respects as possible with the only difference being that the second group does not practice organic agriculture. The matching samples are taken from rural communities in Thailand (rice), the People's Republic of China (tea), Sri Lanka (tea), Cambodia (Nieng Mali rice), the Lao People's Democratic Republic (Japanese rice), and Bhutan (lemongrass). The samples are compared using the propensity score matching (PSM) method, which provides a statistically sophisticated approach to comparing the performance of organic and conventional farmers by accounting for their inherent differences. Samples are compared with respect to the eight MDGs: eliminating hunger (MDG 1), achieving universal education (MDG 2), promoting gender



equality (MDG3), improving child and maternal health and sanitation (MDGs 4, 5, and 6), promoting environmental sustainability (MDG 7), and promoting global partnership in development (MDG 8).

By comparing household expenditure and other indicators of well-being, the author finds that organic farmers earn higher net incomes than conventional farmers due to lower production costs and price premiums, making them less likely to face hunger. Organic farming households also spend more on their children's education. Some health indicators for organic farming households are superior to those of their nonorganic agriculture counterparts (especially with respect to out-of-pocket medical expenditure and access to improved water and sanitation). In terms of environmental sustainability, organic farms practice techniques that are more conducive to better soil and land management. The study quantifies effects on these MDGs and concludes that with public support for organic agriculture, especially in rainfed marginal areas, the potential for such farming to contribute to meeting the MDGs can be realized to a much greater extent.

Two other chapters also contribute to the MDG discussion. Chapter 8 by Sununtar Setboonsarng and Rouselle Lavado asks whether organic agriculture leads to better health outcomes for the farmers. It investigates data on health care among organic and conventional rice-farming households in north and northeast Thailand in 2006. The results show that the health expenditure of conventional farmers is 56% higher than that of organic farmers. The burden of health expenditures is also disproportionately borne by the poor with the two poorest quintiles spending approximately 3% of discretionary expenditure on health care, compared with only about 2% for the two richest quintiles. Catastrophic health expenditure is also significantly higher for conventional farmers than organic farmers. Among households with health expenditures exceeding 40% of discretionary expenditure, the percentage is 1.3% for conventional households compared to 0.25% for organic households. Although health outcomes are influenced by factors other than pesticide exposure, the results suggest that organic farmers should have better health outcomes. The results also show that organic farmers have more to spend on other household necessities rather than having to spend more discretionary income on health care, implying better welfare. This would suggest that organic agriculture as a development strategy might lead to improved health, one of the foundations to sustainable poverty reduction.



Chapter 9 by L.H.P. Gunaratne compares a group of conventional tea growers in Sri Lanka against another group that is participating in a program under which they are contracted to grow organic tea for a buyer. It was found that contract farming has brought a number of benefits to the rural community, such as reduction of production cost and risk, cuts in the expenditure on purchases of outside food, enlarged participation in training by women, reduction of child sick days, increased adoption of environment-friendly farming methods, and improvement of social capital. The analysis further found that although the yield and gross income of the organic cultivation is still lower than that of conventional tea cultivation, organic farmers have the potential to improve their farm income with experience over time while sustaining the environment.

The Economic Impacts of Organic Agriculture

As with most policy instruments, the question of how much it costs to implement the policy and who pays and who benefits is critical. A number of chapters in the book address these issues. A key policy question when looking at the contribution of organic agriculture to the MDGs is about the costs of promoting organic agriculture compared to other policies for achieving the MDGs. Chapter 2 by Anil Markandya and others looks at this. They find that the costs of adopting organic agriculture vary a lot. The results depend in part on how efficiently the programs run, with the most inexpensive programs being as much as 10 times cheaper than the most expensive programs. Nevertheless, organic agriculture can be cost-effective in reducing poverty and, even with the highest cost options, the amount involved per person taken out of poverty is much lower than that of development programs that achieve the same goals through investment in overall economic growth. This indicates that organic agriculture can play an important role in poverty reduction, especially so when the costs of adopting it can be kept low by drawing on lessons from the more effective programs such as those in northeast Thailand.

In Chapter 3, Sununtar Setboonsarng looks at the respective roles of organic certification and ethical trade certification. While the latter rewards farmers significantly in terms of premium prices and better market access, it does not deal with social aspects, such as targeting smallholders in marginal areas. In addition, the financial benefits of fair-trade certification are immediate while organic certification



requires a transition period. Thus, in achieving the MDGs, the two sets of measures are complementary and both have a role to play.

Specific case studies in the book provide some interesting findings. Chapter 4 by Karma Yangzom and others looks at the experience of Eastern Bhutan, where organic certification for lemongrass was introduced. Current practices for extraction of the product from forests are unsustainable and income from exploiting it is very low. Introducing certification has directly improved the income of those involved in the sector and improved the sustainable management of sources in the forests as well as the role of women. Yet, the program has not addressed all the related problems. Fuelwood consumption, for example, in processing lemongrass has remained high and little progress has been made on the efficiency of distillation.

Chapter 5 by Sununtar Setboonsarng and Acharya Bhim Nath looks at a case in Thailand in more detail. In particular, the authors ask what motivates farmers to adopt organic practices in north and northeast Thailand. A major factor is the cost of agrochemicals; many farmers simply cannot afford these and look to alternative methods that will produce acceptable results. Thus, financial considerations are paramount. At the same time, when asked about their reasons for adopting organic agriculture, health benefits, availability of labor, and soil fertility improvement emerge as important.

Chapter 6 by Anil Markandya and Sununtar Setboonsarng looks at organic agriculture in Cambodia and asks whether organic crops are a more effective way of improving rural livelihoods than the alternative of energy crops, which are also being promoted. The study finds that the poverty reduction impacts appear to be greater for organic agriculture than for biofuels, so organic agriculture should be given priority, if limited funds are available. Since the growing areas do not generally overlap, however, both types of crops could be promoted. The potential for organic agriculture in this country is considered especially high, given that the agricultural environment is generally clean with a low level of chemical inputs.

Chapter 7 by Somchai Jitsuchon and Nuntaporn Methakunavut looks at the impacts of organic agriculture through the economy-wide lens of a computable general equilibrium (CGE) model applied to the Thai economy. The results show that organic agriculture promotion yields



favorable macroeconomic consequences in general, although the impacts are very small relative to the size of the economy. Furthermore, these impacts are by no means exclusive to an increase in demand for organic agriculture. An equal increase in demand for nonorganic agriculture would yield similar macroeconomic results, except with fewer employment impacts. The rationale for promoting organic agriculture, therefore, is more at the microeconomic level and based on its noneconomic benefits. The authors also explore one of the most important benefits of organic agriculture: the health impacts. The literature on health benefits of organic agriculture is large and growing. At the individual level, organic farmers are more protected from the detrimental health effects of pesticides used heavily in conventional agriculture. At the community level, a cleaner farming environment prevents various kinds of community sicknesses. Implementing the kind of increases in organic agriculture that were simulated reduces the number of cases of pesticide poisoning and related effects at a significant scale.

Finally, Chapter 10 by L.H.P. Gunaratne looks at data from Sri Lanka, comparing the economic efficiency of contract-based organic growers versus conventional tea growers. The analysis reveals that organic tea growers use inputs more efficiently than their conventional counterparts. Moreover, the analysis also identified the factors that positively influence improved efficiency, which was mainly attributed to the institutional intervention of contract farming, as it uses fewer resources, thus cutting down their cost of cultivation and utilizing family and environmental resources efficiently. These are mainly driven by institutional support, which provides market access and premium prices, and reduces transaction cost.

Organic Agriculture and Agricultural Policy

The issues related to agricultural policy and organic agriculture are also examined in the book. The first is the use of food miles to reduce demand for products that have to be transported over long distances and to substitute them with locally grown products. Chapter 13 by Els Wynen and David Vanzetti examines this policy, which has some support in the developed countries of Europe and North America. Food miles have recently gained in popularity with the rise in the costs both of food and transport. Indeed, some organizations that set standards



for organic certification are considering incorporating, or have already incorporated, food miles into their standards, including a ban on air-freighted goods. Although not directly targeting organic production, the idea would have an impact on organic exports from developing countries to the developed markets. The authors point out quite clearly that the concept of food miles is flawed because it ignores the costs of production, the mode and scale of transport, and the importance of other inputs such as capital and labor. They show a number of cases in which products that have traveled long distances have a smaller environmental footprint than those locally grown (e.g., because the latter have required artificial energy). In short, adopting food miles may cause consumers and foreign producers to be worse off and may lead to increases in global energy use and emissions, contrary to the stated objectives.

The other policy debate relating to organic agriculture is that of declining yields: the view that moving to organic agriculture will cause a decline in yields over time. Chapter 14 by Sununtar Setboonsarng explores the evidence on this. It looks at case studies from Thailand and Sri Lanka to determine whether there is a declining trend in organic agriculture yields of rainfed ecosystems compared to conventional agriculture. The findings of this study provide evidence that in marginal, rainfed regions, yields under an organic system do not decline and in some cases are significantly higher than under a traditional production system. In all cases, the most important factors determining the level of organic yields appear to be the farmers' level of understanding and adherence to organic methods and the availability of organic inputs. Just as hybrid seeds, agrochemicals, and irrigation were necessary for the Green Revolution, organic fertilizer, organic pesticides, and high-quality seeds are necessary for successful adoption of organic agriculture. To obtain high yields under organic production, nongovernment organizations (NGOs) and firms that seek to promote organic agriculture among poor farmers in marginal areas should ensure that farmers have access to organic inputs and training.

Organic Agriculture and Sustainable Development

The final theme of the book is the relationship between organic agriculture and sustainable development more widely. Issues examined include carbon sequestration and biodiversity. Chapter 11 by Paul Reed Hepperly and Sununtar Setboonsarng looks at how organic agriculture



might affect the level of carbon sequestered in agriculture. This chapter shows the greenhouse gas storing capacity of soil and how farmers around the world can participate in mitigating and reversing climate change, improving water quality, and eventually enhancing long-term farm productivity. It aims to provide information on agriculture's role in climate change by attempting to discuss the role of organic farming in trapping of carbon dioxide. In doing so, the chapter discusses the trends of carbon levels in soil, the methods to reduce soil carbon losses and produce net gains, the comparison of agricultural approaches and methods of soil's greenhouse gas mitigation potential, the problems and issues of mitigation processes and practices, and the policy changes that are needed. Evidence based on farm trials shows that while conventional farming practices result in a decline in the carbon content of soil by about 4% over 25 years, organic crops and dairy products actually result in an increase in the carbon content of the soil by about 25% over the same period. A key role in land management is the use of tillage, which contributes significantly to carbon loss.

Chapter 12 by Marie Mondeil and Sununtar Setboonsarng looks at the role of organic agriculture in enhancing biodiversity. It outlines how certified organic agriculture can be one of the most promising market-based development strategies for protecting the diversity of plant genetic resources (PGRs). The diversity of PGRs from which the world's food crops are derived is steadily declining, due in part to the reliance of modern agriculture on a limited number of improved varieties. This erosion of genetic variation can lead to increased vulnerability to plant pests and diseases, as well as to the potential loss of future varieties that will be required to meet the challenges brought about by climate change. Having recognized that the protection and sustainable management of PGRs is critical to ensuring food security and alleviating poverty, governments and the international community have used public funds to establish seed banks and protected areas in an effort to preserve the existing PGRs. However, given their small scope and susceptibility to genetic drift, the effectiveness of these public efforts may be limited. The vast majority of the remaining PGR diversity is in the hands of smallholder farmers, who cultivate a wide array of traditional varieties, in remote areas of developing countries. The authors argue that a comprehensive system of market-based incentives is necessary to ensure that smallholder farmers continue to conserve PGRs. By providing incentives in the form of premium prices as a payment for environmental services, farmers can be encouraged to adopt sustainable cultivation of



local varieties and thus maintain high levels of biodiversity, without a burden on public expenditures. It is more likely that farmers practicing organic agriculture will respond to such measures than those using conventional methods.

Conclusions and the Future

Organic agriculture in developing countries is fast growing but is still a small part of the agricultural scene. As this book argues, however, it has an important role to play in helping meet the MDGs (and the SDGs that will replace them after 2015). Organic agriculture has been adopted by farmers who are often poor and working on marginal land, frequently with no irrigation. Their current situation is poor and a conventional pathway to improve yields is costly and difficult. At the same time, adoption of organic agriculture, with support from the government or NGOs can make a big difference, so much so that organic farmers' poverty levels fall and their well-being in the widest sense (including income, health, and education) rises, even above those of conventional farmers. Moreover, this book shows that the costs of this pathway to development can be quite reasonable, although the cost range is high.

The economic impacts of organic agriculture are generally positive, but they depend on the institutional support available and what other instruments are in place. Organic agriculture needs strong support for organic certification, and where this can be complemented by fair-trade labeling the benefits are enhanced. Organic agriculture compares favorably with other possible rural development options such as energy crops. The macroeconomic effects of further expansion of organic agriculture, though positive, are, however, small and indistinguishable from those of an expansion in conventional agricultural productivity.

Finally, organic agriculture can much better contribute to the environmental goals of carbon sequestration and maintenance of biodiversity than conventional agriculture.

All in all, the book makes a strong case for promoting organic agriculture as a strategy for sustainable agricultural development.

PART I: Poverty Reduction and Organic Agriculture



Chapter 1 | Organic Agriculture, Poverty Reduction, Climate Change, and the Millennium Development Goals

Sununtar Setboonsarng

1.1 INTRODUCTION

Approximately 75% of the world's poorest—about 880 million men, women, and children—depend on agriculture and related activities for their livelihood (Faures and Santini 2008). Although changing, poverty for the most part is still a rural phenomenon with roughly 3.1 billion people (or 55%) of the global population live in rural areas and about 80% of rural households are engaged in agriculture. It appears, therefore, that one important path toward poverty reduction is through rural development by way of agriculture (IFAD 2011). However, agricultural development, which can greatly reduce poverty and improve global food security, still receives limited attention from most donors and governments.

As climate change intensifies and erratic weather patterns increase the risk of floods and drought, it is likely that the problem of rural poverty will become more severe in the years to come. By 2050, the global population is projected to grow to 9 billion—an additional 2 billion people will need to be fed with less water and less arable land under unstable climate conditions. Unfortunately, our current food production and consumption systems are depleting the productive land, water, and biological resources essential for long-term sustainable production. They are also contributing significantly to climate change. In addition, the safety and nutrition of food are growing concerns as malnutrition, obesity, and micronutrient deficiencies are increasingly experienced



both in poor and rich countries. These factors, particularly food safety and climate concerns, have led to growing interest in alternative agriculture systems; one of which is organic agriculture and which has received much attention in the development community.

Organic agriculture has been shown to offer sustainable income-earning opportunities for smallholder farmers in developing countries. International trade data on organic produce signal a promising future for farmers who can benefit from this rapidly growing market. Economic benefits are expected to be well on the rise in the future as the demand for organic produce in both developed and developing countries continue to grow. Moreover, organic agriculture builds on comparative advantages of the rural poor in remote areas that oftentimes are pristine and suitable for quality organic production. Organic agriculture of indigenous varieties is also harmonious with traditional farming practices so will not require public support for technical extension but only for market linkages.

Globally, the rising production cost of conventional farming has led farmers to reconsider low-cost alternatives. Conventional farming has principally benefited the better-off farmers in irrigated areas, who have access to fertilizers, pesticides, high-yielding varieties, and mechanization. Conventional farming has been less effective in marginalized and resource-poor areas where access to modern inputs and agriculture is lacking (IFAD 2005; Scialabba and Hattam 2002). The palpable detrimental effects of conventional agriculture to the farmers' health and to the environment, as well as the high input costs, have contributed to farmers turning toward organic agriculture. Nongovernment organizations (NGOs) that have witnessed the plight of smallholder farmers practicing conventional farming have been a strong force in advocating organic agriculture.

As more farmers adopt organic agriculture, anecdotal evidence of its positive and multipronged benefits in terms of poverty reduction abounds. Farmers across the globe have reported general improvements in income, food security, health, and the environment after adopting organic practices. However, empirical evidence is limited when it comes to impacts on poor organic farmers in developing countries; this lack of information has hindered an in-depth understanding and policy formulation crucial to promoting organic agriculture sector—a key to inclusive value chain development to uplift the lives of the poorest populations in Asia.



To address this gap, the Asian Development Bank Institute (ADBI) in Tokyo commissioned a series of surveys in 2005–2006, whose results are summarized in this chapter and discussed in detail in other parts of this volume. They provide an empirical evaluation based on rigorous methodologies such as propensity score matching of the impact of organic agricultural practices in poor rural areas in selected Asian countries. The aim is to help developing countries achieve their respective development goals through agricultural development and go beyond the Millennium Development Goals (MDGs) targeted for 2015, toward the Sustainable Development Goals (SDGs) agreed at the United Nations Conference on Sustainable Development (Rio+20 Summit) in June 2012 in Brazil.

1.1.1 Organic Agriculture

Organic agriculture is defined as “a production system that sustains the health of soils, ecosystems and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects. Organic Agriculture combines tradition, innovation, and science to benefit the shared environment and promote fair relationships and a good quality of life for all involved” (IFOAM 2005). Simply put, organic agriculture is a farming system that excludes the use of synthetic chemicals, such as fertilizers, pesticides, herbicides, or antibiotics, in both crop and livestock farming. Unlike conventional agriculture which relies heavily on external inputs, organic agriculture relies on ecosystem management to enhance its productive and functional capacities.

Organic agriculture can be certified or noncertified. Certified organic agriculture typically refers to third-party certification, in which an unbiased third-party certifier reviews the production process to ensure that national and international organic standards are followed. Certification of organic agriculture is most important in international trade, as a standardized system is necessary to make the process of providing information across borders more cost-efficient. The information attached to the produce generates value, reflected as a price premium for the certified products. Noncertified organic agriculture, on the other hand, is not subject to third-party review or certification under national or international standards. It is typically practiced by small traditional farmers who follow agroecological principles. Production is mainly for subsistence or for local markets with no or limited price premium. NGOs or traders who maintain close contacts with farmers



can act as trading agents for noncertified organic products and ensure product quality to consumers.

1.1.2 Green Revolution

As a response to a looming Asian famine in the 1960s, innovations to increase food production led to a phenomenal growth in agricultural yields. This came to be known as the Green Revolution, which mainly consisted of three components: high-yield seed varieties; irrigation; and agrochemicals, including both pesticides and chemical fertilizers, which are mostly fossil fuel-based (IFPRI 2002).

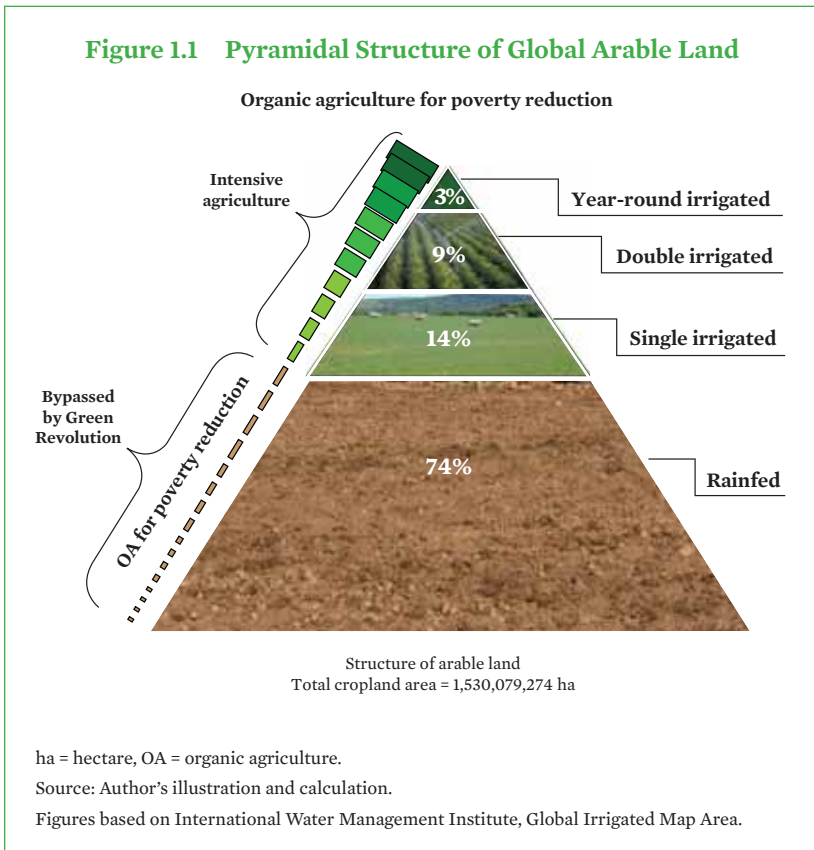
While yields increased substantially under the Green Revolution, gains did not always translate to substantial reductions in rural poverty. Throughout the 1980s and 1990s, the declining and fluctuating commodity prices, the increasing price of inputs, and vulnerability of high-yielding seeds to pests and disease drove many farmers into a spiral of debt and deeper poverty. Moreover, the increased productivity came at the expense of the environment and health of both producers and consumers. For instance, roughly 25 million agricultural workers in developing regions in Asia suffer an episode of poisoning each year (Jeyaratnam 1990), a particularly bleak situation for poor and illiterate farmers who have limited knowledge about the proper use and handling of chemicals. In Viet Nam, the actual level of poisoning among farmers along the Mekong Delta is worse than the self-reported symptoms in the official data (Dasgupta et al. 2005).

The reach of the Green Revolution has also been limited. It failed to benefit roughly three-quarters of the rainfed arable land in the world. Of the remaining quarter, a mere 3% enjoys a reliable year-round supply of water (Figure 1.1). This has huge implications for rural poverty as only the better-off farmers were able to capitalize on the technologies of the Green Revolution. Rainfed areas, which cover 80% of the world's agricultural area and produce over 60% of staple food, were largely left out by the Green Revolution. The importance of rainfed agriculture in feeding the world population, now and in the future, is increasingly recognized. Alternative strategies to promote ecological intensification of agriculture systems, including organic agriculture, hold promise for poverty reduction in rainfed areas.

When Green Revolution technologies are applied on fertile land under irrigation, yields initially increase rapidly. However, to maintain such



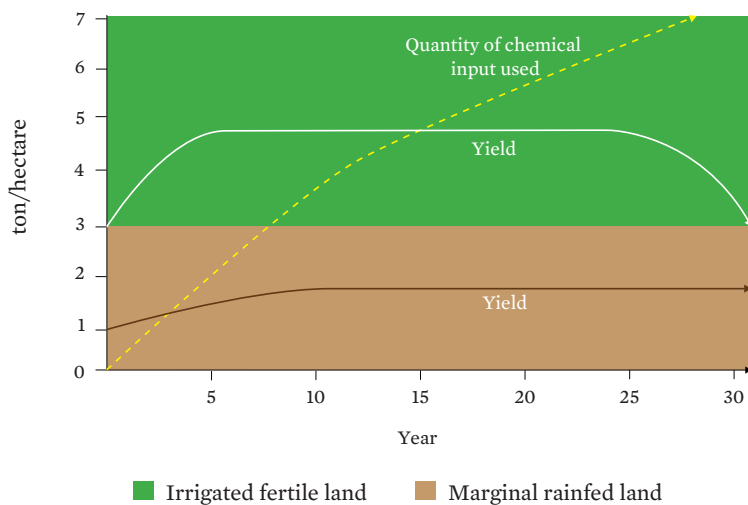
Figure 1.1 Pyramidal Structure of Global Arable Land



an increased yield, agrochemical inputs have to be raised further (Figure 1.2). Despite the increasing inputs, yields can eventually decline due to land degradation. Documented cases in some Asian countries illustrated the bleak future of conventional agriculture, particularly in rice production. As early as the 1980s, fertilizer use had to increase by a factor of 4 and pesticides by a factor of 9 in the northern Philippines to achieve a 6.5% improvement in yield. In West Java, a 23% yield increase meant tripling the amount of fertilizer and pesticides used. Since 2000, yields have further declined to such an extent that grain production has actually fallen (Ho et al. 2008). Furthermore, the Green Revolution does not lead to increased yields on marginal lands where there is no irrigation and access to external inputs (lowest line of Figure 1.2). In these areas, however, modern organic agricultural practices could significantly improve soil fertility and enhance productivity.



Figure 1.2 Yields and Chemical Input Use in Green Revolution



Source: Author's illustration.

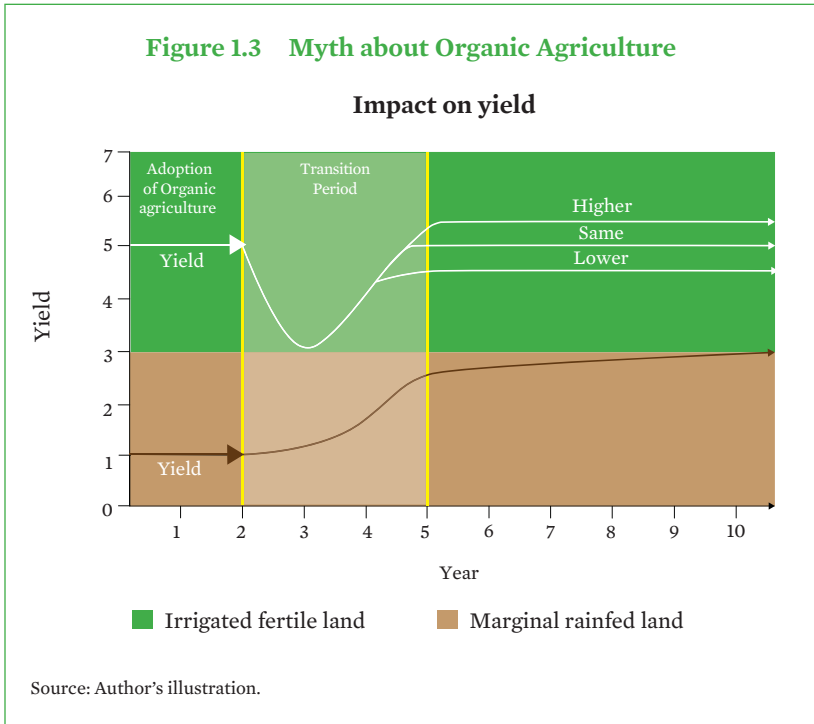
Figure 1.3 shows the misconceptions on low yield of organic agriculture. When converting from conventional to organic agriculture, as illustrated, the decline in yield is generally transitory, usually lasts 2–3 years following the conversion, after which yields eventually go up. In fertile areas, based on crop types, farm microenvironment, and farming practice, the yield can be restored to slightly below, same, or even higher than conventional practices. In marginal areas, however, the increase in yield after adoption of organic practices can generally be assured. The increased levels depend on a combination of factors, from the natural growth environment to farm management. As small farmers often have uncontaminated lands with minimal exposure to agrochemicals, organic agriculture turns their comparative disadvantage to their benefit as they use traditional low-input agriculture.

1.1.3 New Market Opportunity for the Poor through Organic Agriculture

Figure 1.4 shows that the global market for organic products has been one of the most rapidly growing markets. According to figures from Organic



Figure 1.3 Myth about Organic Agriculture

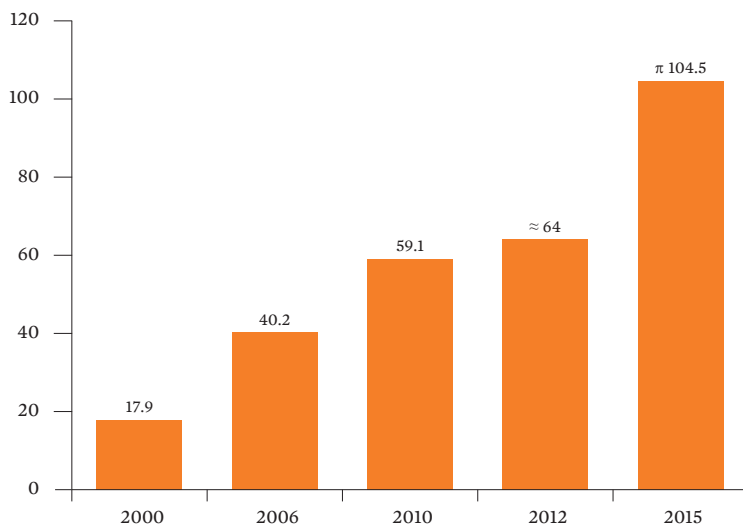


Monitor, international sales of organic food and drinks approached \$64 billion in 2012 from \$59.1 billion in 2010. Growth in the Asian region is expected to be dramatic in the coming years as indicated by the rapid increase in land being certified as organic, which has grown by about 1,000% from 300,000 hectares in 2001 to 3.2 million hectares in 2012 (Willer and Lernoud 2014). The Soil Association (2012) predicted that organic sales in Asia as a whole are expected to grow by 20% in the next 5 years.

In the United States (US) alone, organic products are available in nearly 20,000 natural food stores and nearly 3 of 4 conventional grocery stores (USDA ERS 2012). Even Wal-Mart, a giant retailer in the US, has long joined the organic bandwagon (Gogoi 2006). Despite the financial crisis in 2008, the growth of the organic market continues in Europe as well. Organic growth is also strong in emerging economies. The People's Republic of China (PRC) has seen its organic market quadruple in the last 5 years, while that of Brazil poses an annual growth rate of roughly 40%. There is good reason to believe that this trend of growing demand will continue as consumers become increasingly health- and environment-conscious.



Figure 1.4 Global Organic Food Market Value (\$ billion)



Note: ≈ denotes approaching value in 2012, π denotes projected value in 2015.

Sources: 2000–2012 Organic-world.net (FiBL and IFOAM survey data). 2015 Global Organic Foods & Beverages Market Analysis by Products, Geography, Regulations, Pricing Trends, & Forecasts (2010–2015).

1.1.4 Organic Agriculture and Climate Change

The Consultative Group on International Agricultural Research (CGIAR), a partnership of 15 major research centers around the world, reports that reducing agriculture’s carbon footprint is central to limiting climate change. Experts have recognized the potential of agriculture to mitigate our warming planet. However, only in recent decades have governments offered support to the organic movement in Asia, which was largely private sector–led. Traditionally, the public sector generally associated organic agriculture with backwardness and low yields, though this has changed with governments seeking adaptation practices and climate change strategies for the poor. As evidenced by numerous studies on organic agriculture (Pimentel et al. 2005; Chavas, Posner, and Hedtcke 2009; Mahoney et al. 2004), in contrast to conventional agriculture which involves greenhouse gas (GHG) emissions and heavy dependency on fossil fuels, organic agriculture mitigates GHG emissions, sequesters carbon from the atmosphere and stores it into



the soil, improves soil fertility, and provides environmental and health benefits (detailed discussion available under MDG 7).

1.1.5 The Empirical Study

For a quantitative evaluation of the pathways and magnitude of impacts of organic agriculture on the MDGs, this study uses 11 datasets from smallholder organic farmers in marginal areas in six countries: Thailand (rice), the PRC (tea), Sri Lanka (tea), Cambodia (Nieng Mali rice), the Lao People's Democratic Republic (Lao PDR) (Japanese rice), and Bhutan (lemongrass). In all but one case, household surveys were conducted on organic and conventional farmers of the same socioeconomic group and agroecosystem. The most extensive data were obtained from Thailand where ADBI had a formal collaboration with the government's Office of Agriculture Economics, Ministry of Agriculture.

Data from rice farmers in Thailand were obtained from surveys of 445 farms in 2003, 243 farms in 2005, and 626 farms in 2006. They are referred as Rice 2003, Rice 2005, and Rice 2006, respectively. Apart from rice, 2,747 farms using low external inputs in integrated agriculture/aquaculture were also studied.¹ It is worth noting that although the surveys were conducted in poor areas, economic development generally and also organic agricultural development in Thailand were clearly more advanced than in other countries.

Data from the PRC came from two counties in Jiangxing Province. At the time of the survey in 2006, in mountainous Wuyuan County, organic tea was produced in the uplands, while other crops such as rice, rape, and soybeans were produced under conventional farming. In Wanzai County, government support for organic exports made one whole village in the western part adopt organic agriculture. Other areas had mixed farming systems producing rice, ginger, sweet potatoes, and bamboo, among others. These are largely processed (i.e., frozen for export). A total of 240 farmers in Wuyuan and 220 in Wanzai were surveyed.²

In the Sri Lankan case, a survey of 200 farmers was carried out in 2006 in the Kandy area, an administrative district in the central highlands where organic tea is grown, a practice organized by a private firm.

¹ The survey of integrated farms did not cover production costs, only general socioeconomic impacts, including migration.

² More details on the case studies in the PRC are in Chapter 2 of this volume.



The cases of Cambodia and the Lao PDR are unique in that they represent farming systems in transition from subsistence to commercial agriculture. In these cases, the surveyed “organic” rice farmers practice noncertified organic agriculture under contract farming arrangements, while the “conventional” rice farmers have little experience with commercial agriculture and typically grow traditional varieties for home consumption. A total of 615 farmers in Cambodia and 368 in the Lao PDR were surveyed in 2006.

In Bhutan, participants in the 2006 survey on lemongrass oil included owners of distillation units, employed operators of distillation units, and grass and firewood collectors from organic and conventional management groups in the district of Drametse in Eastern Bhutan.

1.1.6 Propensity Score Matching Method

In an impact assessment study, one of the most difficult issues is the possibility of selection bias. This problem occurs because, in ascertaining the effect of the variable of interest on a participant’s outcome, it is impossible to simultaneously observe the outcome with and without treatment on the same individual. Simply comparing mean outcomes may not reveal the actual treatment effect, as participants and nonparticipants typically differ even in the absence of treatment (Caliendo and Kopeinig 2005). For example, organic farmers may differ systematically from conventional farmers and simple mean comparisons may reflect differences in their characteristics rather than the impacts of organic agriculture. In other words, failure to account for treatment selection biases may lead to biased estimation of the true treatment effect.

The propensity score matching (PSM) method (Becker and Ichino 2002) provides a more refined method of comparing the performance of organic and conventional farmers by accounting for their inherent differences. The basic concept is to compare organic farmers with conventional farmers who are similar to organic farmers in all relevant characteristics except their practice of organic agriculture. The differences in the outcomes of organic farmers and the selected conventional farmers can then be attributed to organic agriculture. In the next section, we show the comparison between organic and conventional farmers using the PSM method to compare like with like.



1.2 SURVEY RESULTS OF EVIDENCE OF ORGANIC AGRICULTURE'S CONTRIBUTION TO THE MILLENNIUM DEVELOPMENT GOALS

The MDGs refer to the eight international development goals adopted by member states of the United Nations (UN) and international development organizations in 2000. As the 2015 deadline approaches to achieve these goals, the UN has been accelerating its efforts in rallying support. As supported in the case studies, organic agriculture offers a cost-effective strategy to reduce rural poverty and help developing countries achieve the MDGs.

MDG 1: Eradicate Extreme Poverty and Hunger

Target 1A: Reduce by half the proportion of people living on less than \$1 a day

Target 1B: Reduce by half the proportion of people who suffer from hunger



Income generation can contribute most directly to poverty reduction. With regard to Target 1A, the survey results show that organic agriculture has a strong and direct contribution to improving household incomes.

Table 1.1 indicates that the practice of organic agriculture is more profitable than conventional agriculture in all 10 case studies investigated. Out of the nine cases where significance levels could be calculated, profitability is significantly higher at 1% in three cases (Thai Rice 2003, tea in the PRC, and horticulture in the PRC) and at 5% in two rice farming cases (the Lao PDR and Rice 2006 sample from Thailand). Among the cases where higher profit levels due to organic agriculture were not statistically significant, further investigation revealed that they were due to certain subsidies given to conventional farmers. For example, in the case of tea growing in Sri Lanka, the provisions for chemical fertilizers and pesticides received high levels of government financial support.

The less than significant higher profit level of organic rice in Thailand in the 2005 sample is also partly explained by the “rice pawning program” offering higher-than-market prices to conventional farmers. Under normal circumstances—i.e., without subsidies for conventional agriculture—the difference in profit would have been more significant. Although the level of significance of profitability varies depending on

**Table 1.1 Profit Comparison between Organic and Conventional Agriculture**

Case Studies		N	Profit per Area in Local Unit	<i>p</i> -value [^]
Rice 2003	Thailand	443	8,887 (baht/rai)	0.00**
Rice 2005	Thailand	243	90 (baht/rai)	0.72
Rice 2006	Thailand	626	1,127 (baht/rai)	0.04
Banana	Thailand	110	5,387 (baht/rai)	0.12
Asparagus	Thailand	148	9,720 (baht/rai)	0.12
Tea	PRC	240	837 (yuan/ha)	0.00
Tea	Sri Lanka	200	6,129 (rupee/ha)	0.25
Horticulture	PRC	220	1,101 (yuan/ha)	0.00**
Rice	Cambodia	615	179 (1,000 riel/ha)	0.14
Rice	Lao PDR	368	1,296 (1,000 kip/ha)	0.03*

PRC = People's Republic of China, ha = hectare, Lao PDR = Lao People's Democratic Republic, N = number of farmers.

Notes:

[^] The *p*-value of a random sample is the probability that its value will differ from the sample mean. Values range from 0 to 1. The smaller the *p*-value, the more significant is the result. A *p*-value of 0.001 means that there is only 1 chance in 1,000 that the observation is a coincidence. The symbol ** indicates significant difference at the 1% and * at a 5% level.

1. Cambodia and the Lao PDR are noncertified organic.
2. Cambodia figures are for cash profit only.
3. Bhutan figures are simple average; no use of propensity score matching.
4. Horticulture in data on the PRC 2006 included 12 major crops.
5. 1 hectare = 6.25 rai

Source: ADBI survey results.

the crop, institutional arrangements, and the wider policy environment, it could be concluded that the claim of organic agriculture's contribution to improved income is substantial.

Given the same farm size, organic farmers enjoy higher incomes in the case of Thailand as shown in Table 1.2. The difference is especially large for the smallest landholders. This result echoes the study conducted by the International Fund for Agricultural Development (IFAD) in Latin America and the Caribbean in 2003 supporting our assertion that organic agriculture is pro-small farmers. This is largely explained by the premium price commanded by organic products giving organic farmers higher levels of profitability.

Our surveys show, therefore, that organic crops can command a statistically significant price premium—between 10% (Thai rice in 2006)

**Table 1.2 Profitability by Farm Size in Thailand (baht/rai)**

Land Category	All Farms	Conventional Farmers	Organic Farmers	p-value [^]
0–5 rai	1,719	1,374	2,432	0.0000**
6–10 rai	1,744	1,413	2,076	0.0000**
11–20 rai	1,723	1,337	2,021	0.0000**
> 20 rai	1,646	1,276	1,866	0.0057*
Total	1,721	1,369	2,072	0.0000**

Notes:

[^] The p-value of a random sample is the probability that its value will differ from the sample mean. Values range from 0 to 1. The smaller the p-value, the more significant is the result. A p-value of 0.001 means that there is only 1 chance in 1,000 that the observation is a coincidence. The symbol ** indicates significant difference at the 1% and * at a 5% level.

Source: ADBI survey results.

Table 1.3 Price Premium Associated with Organic Products

Crop		Organic Agriculture	Conventional Agriculture	Premium (%)	Sig.
Rice 2006	Thailand (baht/kg)	10.26	9.35	9.7	**
Rice	PRC (yuan/kg)	1.58	1.41	12.4	***
Tea	Sri Lanka (rupee/kg)	40.00	22.82	75.3	***
Pepper	Sri Lanka (rupee/kg)	177.85	145	22.7	***
Ginger	PRC (yuan/kg)	1.9	1.88	4.8	

PRC = People's Republic of China, kg = kilogram, sig = significance.

Note:

** and *** indicate significance levels of 5% and 1%, respectively.

Source: ADBI survey results.

and 75% (organic tea in Sri Lanka) over their nonorganic counterparts—in all cases but one. The price premium may, however, erode over time as more organic farmers enter the market (Table 1.3). Yet, organic farmers are often motivated to continue with organic agriculture owing to its nonincome benefits, especially on health.



1.2.1 Production Costs

Another factor explaining the high level of profitability of organic agriculture is the lower cash cost in production. Table 1.4 shows that the cash cost of material inputs for organic agriculture is lower than for conventional agriculture across different crops and over time in Thailand, although in no cases are the differences significant.

Variable costs in conventional agriculture are significantly greater than those in organic agriculture as organic farmers enjoy lower production costs by utilizing compost made from locally available materials in lieu of chemical fertilizers. Farmers also replace chemical pesticides with either biological or herbal pesticides. In many instances, they stop using pesticides altogether. This makes organic agriculture appropriate for poorer farmers who generally do not have access to cash or credit for inputs.

As shown in Table 1.5, lower variable costs of organic tea farming in Sri Lanka add to incomes as farmers spend less on inputs, such as labor wages, seeds, fertilizer, pesticides, machinery and equipment, energy, irrigation, and other expandable items such as buckets.

In terms of cash cost for labor, the pattern differs with the type of crop as shown in Table 1.6. In rice production, which is less labor-intensive than horticultural crops, expenditures for hired labor in organic agriculture are slightly higher, though not significant. In banana and asparagus production, however, the use of hired labor is significantly higher in conventional agriculture. Conventional farmers often hire landless laborers to perform health-hazardous tasks, such as pesticide spraying, accounting for the higher cash expenditure in conventional agriculture.

Table 1.4 Material Cash Cost (baht/rai)

Crop		Difference (OA–CA)	Sig.
Rice 2005	Thailand	-21	No
Rice 2006	Thailand	-14	No
Banana	Thailand	-679	No
Asparagus	Thailand	-2,189	No

CA = conventional agriculture, OA = organic agriculture, sig = significance.

Source: ADBI survey results.

**Table 1.5 Production Cost of Sri Lankan Tea (SLRe)**

	Organic Agriculture	Conventional Agriculture	Sig.
Household income	144,074	141,089	No
Total variable costs	6,982	33,183	*
Net profit	24,451	23,774	No

sig = significance, SLRe = Sri Lankan rupee

* significance level of 10%.

Source: ADBI survey results.

Table 1.6 Labor Cash Cost (baht/rai)

Crop		Difference (OA–CA)	Sig.
Rice 2005	Thailand	77	No
Rice 2006	Thailand	46	No
Banana	Thailand	-851	**
Asparagus	Thailand	-3,294	***

CA = conventional agriculture, OA = organic agriculture, sig = significance.

Note: ** and *** indicate significance levels of 5% and 1%, respectively.

Source: ADBI survey results.

Most cases in our survey revealed the total production cost in conventional agriculture to be higher than in organic agriculture, as shown in Table 1.7. In the cases of banana and asparagus in Thailand, and tea in Sri Lanka, the lower costs of organic production are highly significant. There are cases where costs of organic agriculture were higher, but they were not statistically significantly different. Investigating the reasons for the higher production cost of organic rice production in 2006 in Thailand revealed that organic farmers use imported biopesticides, which are safer but costlier than chemical pesticides. It is noteworthy that in tea growing areas in Sri Lanka, total production costs for organic farmers are far lower than those for conventional farmers despite the fact that conventional farmers receive a government subsidy for their chemical inputs.

Family labor utilization in organic agriculture is higher than in conventional agriculture, except in banana farming as shown in Table 1.8. Where the difference is positive, it indicates a higher utilization of family

**Table 1.7 Total Production Cost**

Crop		Difference (OA–CA)	Sig.
Rice 2005	Thailand (baht/rai)	-68	No
Rice 2006	Thailand (baht/rai)	235	No
Banana	Thailand (baht/rai)	-4,098	**
Asparagus	Thailand (baht/rai)	-6,646	***
Tea	PRC (yuan/ha)	37	No
Tea	Sri Lanka (rupee/ha)	-21,546	***
Horticulture	PRC (yuan/ha)	-472	No
Rice	Cambodia (1,000 riel/ha)	-168	No

PRC = People's Republic of China, CA = conventional agriculture, ha = hectare, OA = organic agriculture, sig = significance.

Note: ** and *** indicate significance levels of 5% and 1%, respectively.

Source: ADBI survey results.

Table 1.8 Comparison of Family Labor (days/ha)

Crop		Difference (OA–CA)	<i>p</i> -value
Rice	PRC	35.8	0.03
Tea	PRC	79.8	0.00
Tea	Sri Lanka	33.9	0.05
Rice 2005	Thailand	3.7	0.28
Banana	Thailand	-25.9	0.43

PRC = People's Republic of China, CA = conventional agriculture, ha = hectare, OA = organic agriculture.

Source: ADBI survey results.

labor in organic agriculture, which may imply limited use of hired labor. In the case of tea farming in the PRC, 80 more labor days per hectare are used in organic agriculture than in conventional agriculture, highly significant at 1%.



1.2.2 Employment Generation

Tackling rural poverty needs a multifaceted strategy. One of the effective ways of combating poverty is through employment generation as rural areas are often characterized by unemployment and underemployment. While the challenge to absorb unskilled and often illiterate labor into nonfarm sectors is immense, this is not the case for conventional agriculture. Farmers in remote areas possess valuable knowledge in traditional agriculture appropriate for the marginal ecosystem and could thus be easily trained to produce organic crops for the market. Moreover, labor is mainly supplied by families in agricultural production. This is reflected in Table 1.9 which shows a general pattern of higher family labor utilization in organic over conventional agriculture. It shows the extent of organic agriculture generating employment opportunities for other laborers, i.e., landless labor. Results show that although the scope is not extensive, there is a tendency for organic agriculture to use more hired labor than conventional agriculture in cultivating similar crops. The fact that it is generally more labor-intensive than conventional agriculture can make organic agriculture an effective employment generation strategy.

With regard to overall labor absorption, Table 1.10 shows that in three of the five case study areas, total labor use is higher in organic than in conventional agriculture. It appears from our analysis that the employment impacts of organic agriculture are highly specific to the crop, the stage of development, and the microenvironment surrounding the farming system.

Table 1.9 Comparison of Hired Labor (days/ha)

Crop		Organic Agriculture	Conventional Agriculture	<i>p</i> -value
Rice	PRC	13.5	18.9	0.29
Tea	PRC	3.2	0.0	0.10
Tea	Sri Lanka	28.4	88.1	0.00
Rice 2005	Thailand	22.6	22.8	0.95
Banana	Thailand	47.3	92.1	0.04

PRC = People's Republic of China, ha = hectare.

Source: ADBI survey results.

**Table 1.10 Comparison of Total Labor (days/ha)**

Crop		Organic Agriculture	Conventional Agriculture	<i>p</i> -value
Rice	PRC	251.88	221.32	0.05
Tea	PRC	232.70	149.77	0.00
Tea	Sri Lanka	259.70	285.67	0.08
Rice				
2005	Thailand	75.80	73.11	0.36
Banana	Thailand	204.57	275.61	0.11

PRC = People's Republic of China, ha = hectare.

Source: ADBI survey results.

In terms of labor distribution by task, the overall pattern does not differ significantly between organic and conventional agriculture. In rice farming, labor-intensive tasks include land preparation, planting, harvesting, and postharvesting. As expected, organic farmers spend more time on land preparation, fertilizer and manure application, and weeding.

Labor distribution patterns by task in tea growing in the PRC and Sri Lanka are markedly different. This is partly due to the different stages of tea growing and the level of processing done at the farm level. In the PRC, organic tea farmers spend significantly more time on land preparation, harvesting, and postharvesting than conventional farmers. Weeding in organic agriculture also has a higher labor absorption capacity, though not statistically significant. Nevertheless, the overall use of labor in organic agriculture is not significantly higher than in conventional agriculture. An exception is in the case of tea harvesting and postharvesting in Sri Lanka, where conventional farmers used significantly more labor in this production stage.

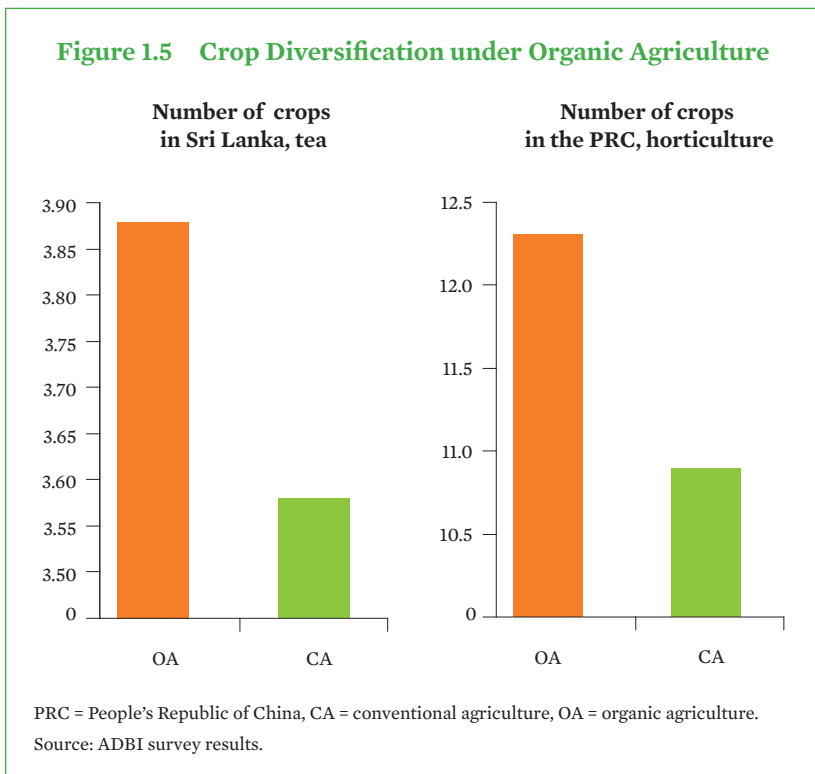
When it comes to herbicide and pesticide application, however, more than twice the number of days was spent in conventional than in organic agriculture. More importantly, in all three cases examined, organic farmers allocate more time for eco-friendly activities such as collection of mulching material, manure and compost preparation, and fertilizer and manure application. Overall, organic agriculture tends to be more labor-intensive than conventional agriculture as typical tasks in organic practices such as mulching, terracing, traps, manure/composting, and the like have to be performed manually.



It is worth noting that in the case study of integrated farmers in Thailand, 44.5% of surveyed households have members who migrated to urban areas in search for employment. Of these migrants, 12.4% have since returned to their own villages suggesting that organic agriculture can in part stem the tide of migration from rural to urban areas.

1.2.3 Income Diversification

Organic agriculture is relatively more diversified than conventional agriculture as shown in Figure 1.5. Crop diversity lessens the risk of income losses associated with seasonal variations and crop failures (FAO 2003). This diversity also allows farmers to derive extra income from the sale of additional produce and non-timber forest products, supporting the findings of Rundgren (2002).





1.2.4 Food Expenditure and Consumption

The surveys show that organic farming households spend relatively less than conventional farming households on food (Table 1.11). This complements the result in Figure 1.5 showing organic farmers to be more diversified, growing a variety of crops that can be sold or consumed, thus lowering their food expenditure. Furthermore, Worthington (2001) reports that organic crops are better at improving dietary quality as they have a higher nutrient value than nonorganic food, hence improving health of organic farming households with the same food intake.

Table 1.11 Food Expenditure in North and Northeast Thailand (baht)

	Organic agriculture	Conventional agriculture	<i>p</i> -value
Total food expenditure	11,922	12,140	0.395
For meat	3,812	3,916	0.399
For vegetables	607	809	0.002

Source: ADBI survey results.

MDG 2: Achieve Universal Primary Education

Target 2A: Ensure that all children will be able to complete primary schooling



In investigating whether improved income in organic agriculture would lead to organic farming households spending more on their children’s education, Table 1.12 reveals this to be the case for rice-growing households in the PRC and Thailand. However, as the figure is calculated based on total expenditure per household, further investigation is required looking into the number of children below school age in the household.

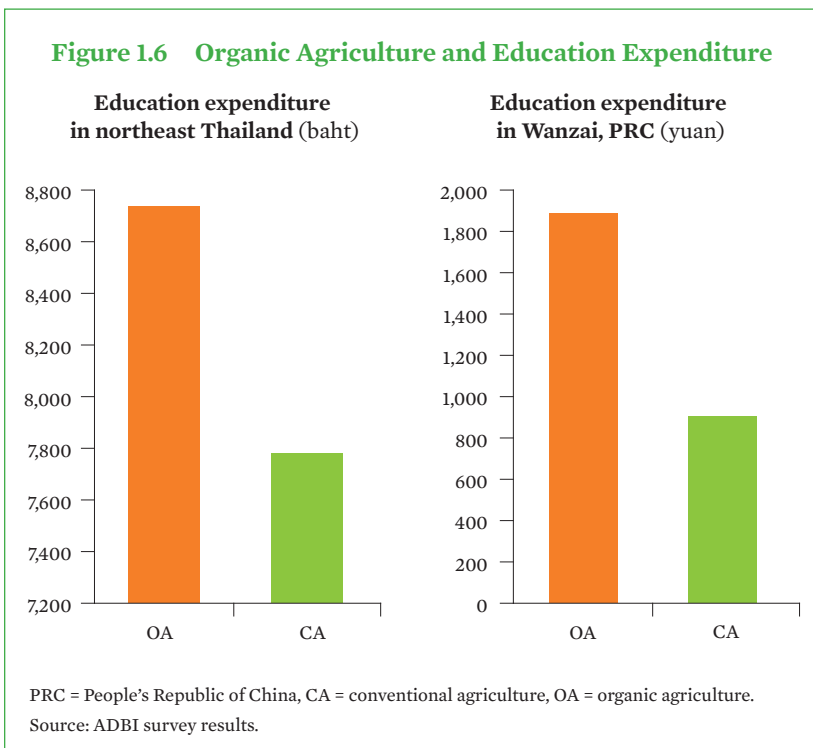
Since organic agriculture is more labor-intensive than conventional agriculture, this heightens concerns about its perverse effects on the education of school-age household members as children may be tapped as a labor source. However, survey results show that higher income from organic agriculture also increases spending on education by rural parents in two of the case studies (Figure 1.6).

**Table 1.12 Comparison of Education Expenditure**

Crop		Difference (OA–CA)	p-value
Rice	PRC (yuan)	1,663	0.079
Rice 2006	Thailand (baht)	983	0.489
Tea	PRC (yuan)	-77	0.935

PRC = People's Republic of China, CA = conventional agriculture, OA = organic agriculture.

Source: ADBI survey results.

Figure 1.6 Organic Agriculture and Education Expenditure

In the case of Thailand, education expenditures by organic farming households are roughly an eighth higher than those of conventional farming households. The difference in rice and tea farming in the PRC is even more pronounced, nearly doubling the amount (Figure 1.6). One factor that may keep children in school is the recognition by household heads that modern organic agriculture requires higher mental skills, such as managerial and marketing skills, acquisition of which can be facilitated in schools.



MDG 3: Promote Gender Equality and Empower Women

Target 3A: Eliminate gender disparity in all education levels



As previously shown, organic agriculture appears promising in generating rural employment. In this section, we investigate gender-specific employment opportunities in organic agriculture. Agricultural tasks by nature are divided by gender. Some are dominated by women, while others are dominated by men. Our findings based on the five cases revealed a highly mixed pattern.

Although employment generated for women in organic agriculture is mainly agricultural, further development of the sector will likely increase demand for managerial, administrative, and technical skills paving the way for their increased participation.

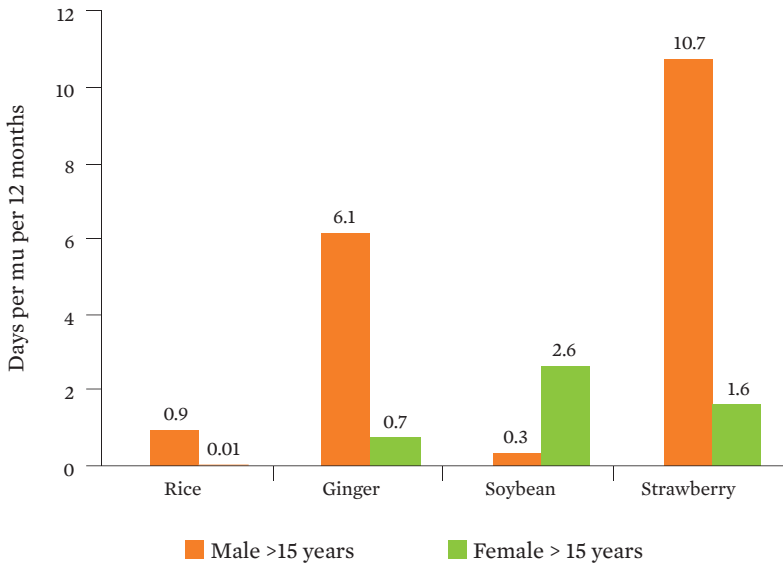
Task-wise, postharvest and weeding employ mainly female labor. In tea growing in the PRC, land preparation, weeding, and harvesting and postharvesting are all dominated by female labor in organic agriculture. In the case of Sri Lankan tea, female participation is significant in the collection of mulching material and in the preparation of manure and compost in organic agriculture.

Since employment for women is influenced by many factors, it may explain why the impact is lower in organic than in conventional agriculture in all cases. Again, the impacts differ by crop, stage of development, and cultural context of work ethic for women. Figure 1.7 compares the amount of labor between the genders based on crops grown. Strawberry and soybean production employs more women than rice and ginger.

Table 1.13 reveals that tea farming in the PRC employs more female labor than conventional agriculture, while the converse is true in Sri Lanka for the same crop, with the latter highly significant at 1%. A close examination of women's social roles in these areas needs to be made as women may perform other tasks aside from those on the farm. If women are already overloaded with other household tasks, the higher labor requirement of organic agriculture may require women to work more and this may not always lead to positive consequences.



Figure 1.7 Hired Labor by Crop in Organic Agriculture in the People's Republic of China



Note: mu = a unit of area in the People's Republic of China, equal to 614.4 square meters.

Source: ADBI survey results.

Table 1.13 Comparison of Female Labor (days/ha)

Crop		Organic agriculture	Conventional agriculture	<i>p</i> -value
Rice	PRC	44.4	49.2	0.53
Tea	PRC	135.1	87.6	0.00
Tea	Sri Lanka	153.7	195.1	0.00
Rice				
2005	Thailand	38.0	36.5	0.35
Banana	Thailand	93.9	123.5	0.18

PRC = People's Republic of China, ha = hectare.

Source: ADBI survey results.



Based on the information from focus group discussions in various survey areas, organic farmers often mention that organic agriculture allows for safe employment opportunities for women, i.e., no exposure to pesticides, and enables women to work within the village rather than having to commute to other towns. In cases where NGOs promote organic agriculture, i.e., in Sri Lanka and Thailand, conscious efforts in engaging women in new organic agricultural activities, i.e., training women as inspectors for certification are observed. Apart from employment, there are other aspects of gender analysis which are yet to be investigated. Further studies are required on gender impacts of organic agriculture.

MDGs 4, 5, and 6: Health and Sanitation

MDG 4: Reduce by two-thirds infant and child mortality rates

MDG 5: Reduce by three-quarters maternal mortality ratio and achieve universal access to reproductive health

MDG 6: Combat and reverse the spread of major diseases



In terms of organic agriculture and general health, the most direct impact on health is through lowering the risk of exposure to toxic agrochemicals, particularly chemical pesticides. Nitrates, an essential source of nitrogen for plants, when carried by rain, irrigation, and other surface water, may contaminate water tables used for drinking. Nitrate levels above 10 parts per million can cause a fatal blood disorder in infants less than 6 months of age, known as “blue baby syndrome.”³ As poor farmers usually do not possess the knowledge on the appropriate use of pesticides, health complications arising from pesticide exposure often prompt farmers who used to practice conventional agriculture to adopt organic farming.

In the case of north and northeast Thailand, Table 1.14 shows that over 90% of respondents noticed an improvement in the overall state of health after conversion to organic agriculture. It is noteworthy that none

³ Environmental Protection Agency. Basic Information about Nitrate in Drinking Water. <http://water.epa.gov/drink/contaminants/basicinformation/nitrate.cfm>



Table 1.14 Family's Perception of Health-Related Symptoms after Conversion

	Northeast Thailand (%)	North Thailand (%)
No change	2.4	7.5
Better off	96.4	91.3
Worse off	0.0	0.0

Source: ADBI survey results.

Table 1.15 Comparison of Chemical Pesticide Expenditure

Crop		Difference (OA-CA)	<i>p</i> -value
Rice 2005	Thailand (baht/ha)	-39.8	0.0704
Rice	PRC (yuan/ha)	-310.0	0.0000
Banana	Thailand (baht/ha)	-344.4	0.0482

PRC = People's Republic of China, CA = conventional agriculture, ha = hectare, OA = organic agriculture.

Source: ADBI survey results.

of them felt worse off, strengthening the claim that organic agriculture has health benefits.

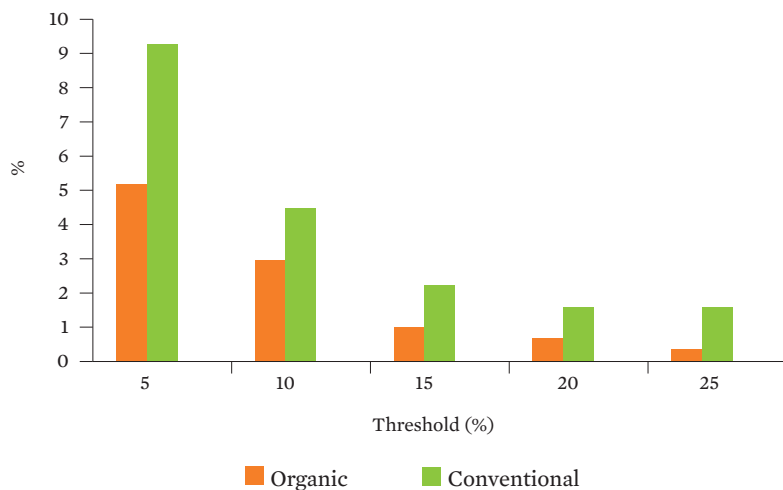
Table 1.15 supports the findings in Figure 1.8 as discussed below that organic farming households indeed spend significantly less than conventional farming households on pesticides. Pesticide expenditure is limited to biological ones that are less harmful to health. The results are statistically significant in the cases of rice and bananas in Thailand and marginally so for rice in the PRC.

Table 1.16 shows that food expenditures in organic farming households are lower than in conventional farming households across a variety of categories, although not statistically significant in all cases. It is highly significant in tea farming in the PRC at 1%, and 10% in the Thai Rice 2006 sample and Sri Lankan tea. As previously discussed, the organic agriculture system is generally more diversified, implying that farmers have more homegrown food for consumption.

Investigating the level of medical expenditures by organic and conventional farming households in Thailand, Figure 1.8 shows that in the same medical expenditure category as a proportion of total household



Figure 1.8 Medical Expenditure as Percentage of Total Household Expenditure



Source: ADBI survey results.

Table 1.16 Comparison of Food Expenditure

Crop	Food Item	Difference (OA-CA)	p-value
Rice 2006*	Thailand (baht) Vegetables	-499	0.0636
Rice 2006	Thailand (baht) Meat	-104	0.3990
Rice 2006	Thailand (baht) All food	-218	0.3950
Tea	Sri Lanka (rupee) Cereals	-5,670	0.0861
Tea	PRC (yuan) Cereals	-297	0.0001
Horticulture	PRC (yuan) Cereals	-53	0.4441

PRC = People's Republic of China, CA = conventional agriculture, OA = organic agriculture.

Note: * Result for Thai vegetables is from propensity score matching.

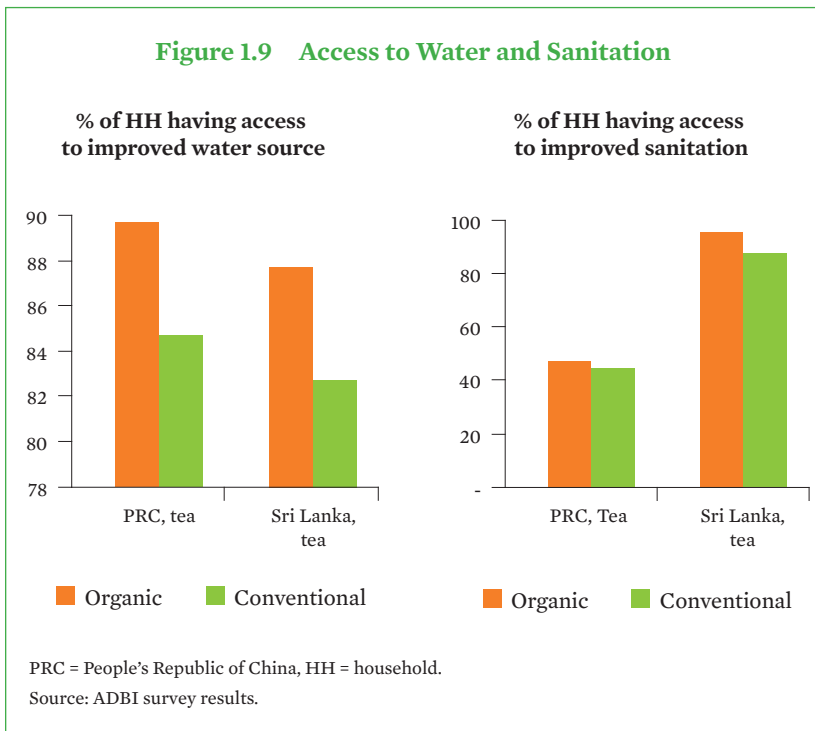
Source: ADBI survey results.



spending, conventional farmers are spending significantly more on catastrophic health expenditure than organic farmers at all expenditure levels. This implies that organic farmers are less likely to incur medical spending beyond their income levels. It could be said, therefore, that the welfare of organic farming households is higher compared to conventional farming households as they have more to spend on other household necessities owing to lower health-related expenditures.

The sanitary conditions in the surveyed villages of the PRC and Sri Lanka were found to be better for organic farmers than their conventional counterparts (Figure 1.9). Most organic farming households had access to improved water sources such as piped water, a borehole, or a protected well. Also, higher percentages of respondents practicing organic agriculture said that they had better sanitation access.

Based on information from change to focus group discussions, farmers who practice organic agriculture tend to adopt a healthier lifestyle, e.g., quit smoking. We investigated this and found interesting results as





presented in Table 1.17 which shows that organic farming households spend less on tobacco than conventional farming households, highly significant at 1% in the case of rice farming in Thailand using the 2006 sample and significant at 10% in the case of horticulture in the PRC. While it may be the case that health-conscious farmers self-select themselves into organic agriculture, the fact that organic farmers are leading healthier lifestyle is a positive development.

Table 1.17 Comparison of Tobacco Expenditure

Crop		Difference (OA-CA)	p-value
Rice 2006	Thailand (baht)	-759	0.0005
Horticulture	PRC (yuan)	-160	0.0849
Tea	PRC (yuan)	-50	0.6439

PRC = People's Republic of China, CA = conventional agriculture, OA = organic agriculture.

Note: Result for Thai rice is from propensity score matching.

Source: ADBI survey results.

MDG 7: Ensure Environmental Sustainability

Target 7A: Integrate the principles of sustainable development into country policies and programs, and reverse the loss of environmental resources

Target 7B: Reduce biodiversity loss

Target 7C: Reduce by half the proportion of people without sustainable access to safe drinking water and basic sanitation

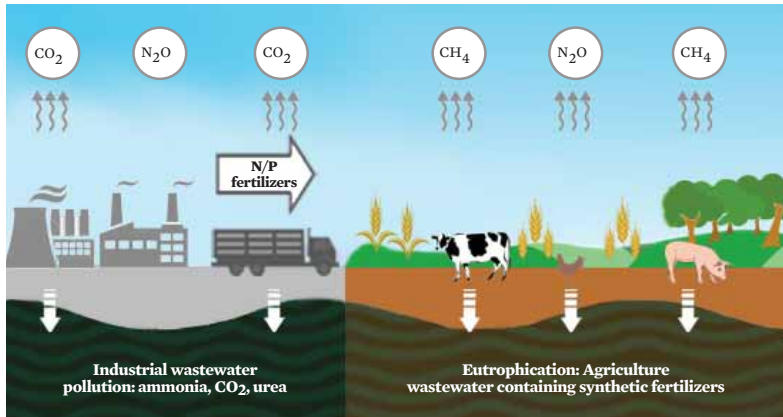


For MDG 7, we looked into evidence of whether organic produce with its premium price is an effective market-based payment mechanism to encourage farmers to adopt climate change mitigation practices and other eco-friendly environmental services.

With regard to climate change, the agriculture sector is estimated to contribute about 14% of global greenhouse gas (GHG) emissions in the form of carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O) in 2004. Conventional agriculture, in particular, contributes over 80% of N₂O and CH₄, with heat trapping capacity 289 times and 21 times higher than CO₂, respectively. As depicted in Figure 1.10, the conventional system is harmful to the environment. Conventional agriculture is prone to soil erosion and degradation of the productive basis, water exhaustion



Figure 1.10 Environmental Hazards of Conventional Agriculture



CH_4 = methane, CO_2 = carbon dioxide, N_2O = nitrous oxide, N=nitrogen, P = phosphorous.

Source: Author's illustration.

and contamination in the face of deforestation and desertification, and loss of biodiversity among others (Hill 2005).

Intensive agriculture's dependence on agrochemicals and nonrenewable fuels accounted for over 20% of global anthropogenic GHG emissions (Scialabba 2003). In particular, agricultural production releases roughly 86% of all food-related anthropogenic GHG emissions, followed by fertilizer production (Gilbert 2012). In Asia, this figure is significant in the PRC as most of the fertilizers used are nitrogen-based and the industrial process of producing nitrogen fertilizer releases nitrogen dioxide. As nitrogen nutrients in crop fertilizer are water-soluble, they are easily drained away and no longer available for plants (runoff and/or leaching). This causes eutrophication, which has contributed to the creation of dead zones, of which there are now about 405 in oceans worldwide. Nitrous oxide also contributes to the greenhouse effect, smog formation, and acidification of soil and water; it also reduces ozone, negatively affecting biodiversity. Organic agriculture, on the other hand, uses farm-produced manure and compost that encourage biological processes so that the productivity of the land and animals is maintained and improved (Raupp et al. 2006).

An important facet of organic agriculture's mitigating effect on climate change is its effect on soil, which is a major carbon reservoir. Organic practices can transfer CO_2 from the atmosphere into the soil through



crop residues and other organic solids. This can be done by adding high amounts of biomass into the soil, limiting soil disturbance, improving soil structure, conserving soil and water, and enhancing soil fauna activity (Sundermeir, Reeder, and Lal 2005); all of which can be facilitated by organic practices. As shown in Figure 1.11, soil has a huge carbon storage capacity, which can be enhanced by organic farming methods.

Figure 1.12 shows the percentage change in soil carbon in farm trials of three farming systems from 1981 to 2005. Hepperly et al. (2008) revealed that conventional agriculture decreased soil carbon content by about 4% while organic farming, with and without animal manure, increased soil carbon by about 25% over a span of 25 years.

According to the Rodale Institute, organically managed soils can store more than 1,000 pounds of carbon per acre while nonorganic systems cause carbon loss. Conversion to organic fertilizers can also increase soil carbon by 15%–28% and nitrogen content of the soil by 7%–15% (Hepperly

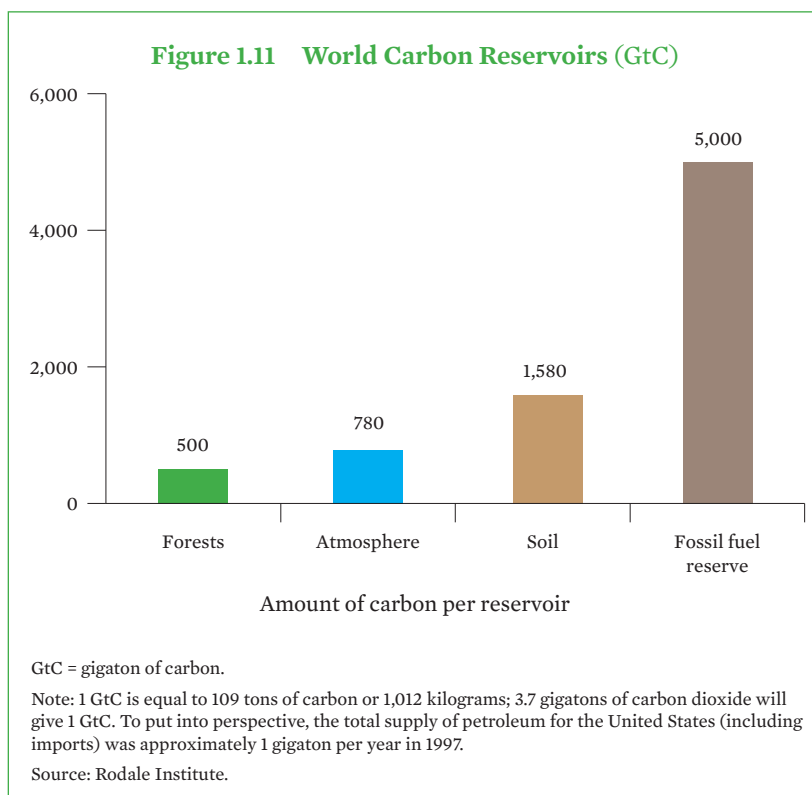
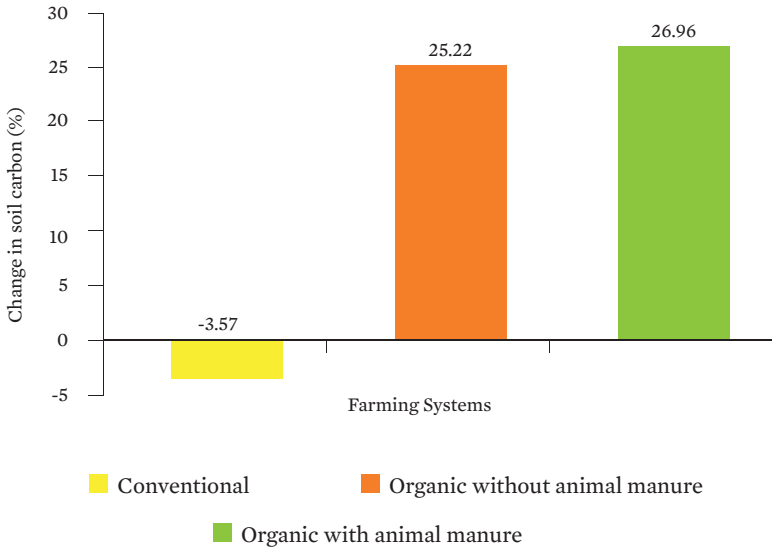




Figure 1.12 Soil Carbon Sequestration by Farming System, 1981–2005



Source: Hepperly et al. (2008).

2003; Cleary 1999). According to Lal (2004), an increase in carbon stocks can improve yields. An increase in the soil carbon pool of 1 ton can increase yields per hectare from 20–40 kilograms per hectare for wheat and 10–20 kilograms per hectare for maize. Moreover, as soil has a huge trapping capacity for carbon from the atmosphere, organic agriculture is perceived as one of the most effective strategies to address climate change. Organic agriculture also enhances soil organic matter, which results in more soil moisture, reduces acid soil toxicity, and increases micronutrient availability. However, this result of the research is based on upland farming systems in a temperate zone so there is a need to verify the findings under other types of farming systems, particularly in the tropics.

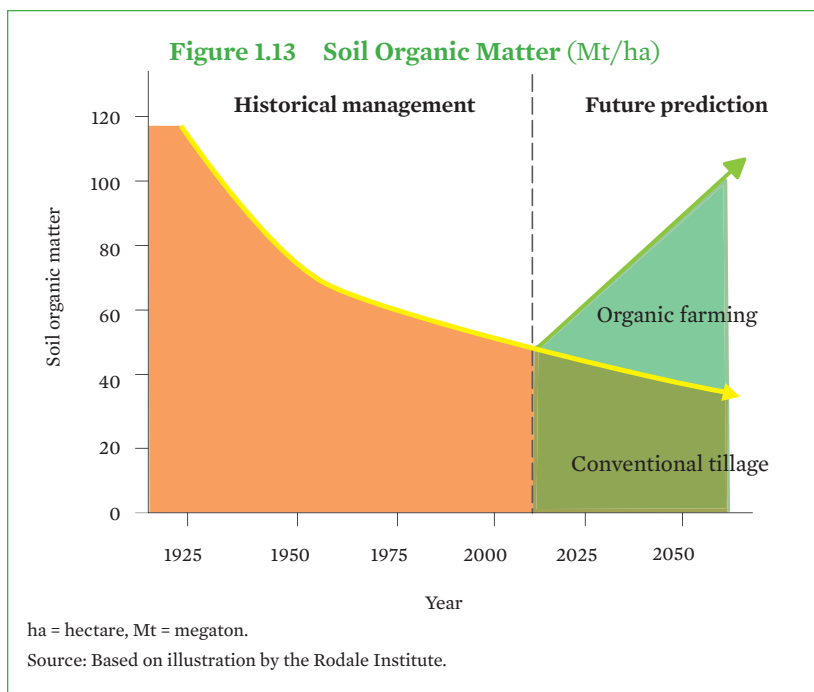
As shown in Figure 1.13, which is a modified version of the Rodale Institute's figure, soil organic matter decreases with conventional tillage over the years. With organic farming, which uses a combination of agro-friendly practices including compost and manure, the soil organic matter content is expected to increase, creating a healthy growth environment for crops. The study shows that organic practices facilitate soil carbon sequestration while leading to improved long-term soil fertility.



To mitigate climate change, there are farm management practices that contribute to sustainability and climate change, which farmers—regardless of whether they practice organic or conventional agriculture—should be encouraged to adopt. These practices include using an appropriate amount of agrochemicals, better use of manure, legumes, and compost. Not only do agroecological methods such as trap cropping, intercropping, mulching, and crop rotation have soil benefits, they also help increase organic matter content, reduce splash, increase soil microbial activities, and preserve soil moisture.

Soil humus, which is organic matter from the decomposition of plants and animals, helps retain moisture and encourages the formation of good soil structure. Increasing the soil humus content is crucial to soil health and long-term soil productivity. However, since these practices often require higher levels of inputs, an incentive system is needed to encourage farmers to use them. Table 1.18 summarizes the organic practices that directly reduce GHG in the atmosphere.

In our case studies in the PRC and Sri Lanka, the findings show that the use of agroecological methods as mentioned has been significantly



**Table 1.18 Organic Agriculture and Greenhouse Gas Emissions**

	CO ₂	CH ₄	N ₂ O
No synthetic nitrogen fertilizers	✓		✓
Best manure recycling	✓		✓
Enhanced use of legumes	✓		✓
Enhanced use of composts	✓		✓
Better crop rotations	✓		
High proportion of hedge rows, field margins, etc.	✓		✓
Careful and reduced soil tillage	✓		✓
Reduced mineral nitrogen concentrations	✓		✓
Less soil compaction	✓	✓	✓
Less erosion	✓		
Enhanced soil carbon stock	✓	✓	

CH₄ = methane, CO₂ = carbon dioxide, N₂O = nitrous oxide.

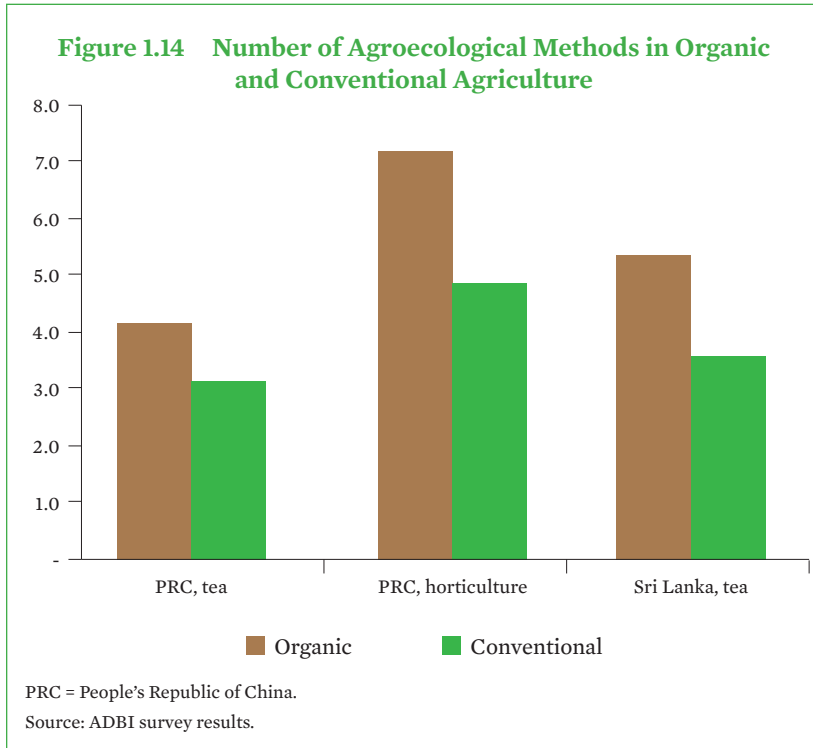
Source: Aubert (2007).

higher for organic farmers than for conventional farmers. Figure 1.14 shows that organic farmers tend to use more agroecological practices than conventional farmers. For tea growing in the PRC, the average number of agroecological methods used was one unit higher, whereas in the case of horticultural crops, organic farmers used seven of the above methods, three more than conventional farmers. In Sri Lanka, the numbers were five versus three in favor of organic agriculture.

Organic farming emphasizes “polyculture,” a system of using multiple crops in the same area, which offers diversity in crops. These practices include trap crops and companion crops, intercropping, mulching, terracing, contour cropping, and crop rotation, among others. These techniques have a wide array of benefits to soil and crops.

The same is true in the case of number of soil conservation practices. Table 1.19 shows that organic farmers use more manure per hectare. The right amount of manure can increase soil organic matter, which is the storehouse of nutrients, promoting plant growth and water flow (Zhang and Stiegler 1998).

Organic farmers in the PRC and Sri Lanka use more soil conservation methods and soil carbon sequestration methods than conventional farmers. Soil conservation practices include mulching, terracing,



contour cropping, crop residue return, green manure, manure and/or compost, and straw residue return after feeding. By doing so, organic farmers mitigate GHG emissions by avoiding chemical fertilizers and adding organic matters back into soil.

Table 1.20 shows that more farmers practicing organic agriculture have better soil quality than those who practice conventional agriculture. Soil quality in turn affects the nutrient content of the produce and the biodiversity in the soil. Improvements in soil health also lead to considerably lower disease incidence (ISP 2003). Soil under organic agriculture is typically medium productivity. This kind of soil induces the highest levels of anti-nutrients⁴ that reduce cancer risks (Brandt 2008).

⁴ Anti-nutrients are substances that inhibit or block important pathways in metabolism, especially digestion. These substances reduce utilization of nutrients by the body, such as proteins, vitamins and minerals. The result is a decrease in the body's ability to use the nutrients, even though they are present in the food. (Plant and Soil Science eLibrary. Available: <http://passel.unl.edu/pages/informationmodule.php?idinformationmodule=1011018530&topicorder=11&maxto=12>)

**Table 1.19 No. of Soil Improvement Practices**

Crop		No. of soil conservation methods			Total manure used (kg per ha)		
		Organic agriculture	Conventional agriculture	Sig.	Organic agriculture	Conventional agriculture	Sig.
Tea	PRC	3.6	2.7	***	3,141	1,772	***
Horticulture	PRC	4.9	4.2	**	21,190	12,656	***
Tea	Sri Lanka	3.9	3.4		1,651	10	***

PRC = People's Republic of China, ha = hectare, kg =kilogram, sig = significance.

Note: ** and *** indicate significance levels of 5% and 1%, respectively.

Source: ADBI survey results.

Table 1.20 Organic Agriculture and Soil Quality in North and Northeast Thailand, 2006

	Organic agriculture	Conventional agriculture	p-value
Rice field with good soil quality (rai)	19.66	13.72	0.000
Ratio of rice field with good soil	84.82%	72.67%	0.000

Source: ADBI survey results.

1.2.5 Organic Agriculture and Biodiversity

Biological diversity or biodiversity refers to the variety of life on Earth and the natural patterns it forms shaped by billions of years of evolution. Its loss is another threat facing humankind today. Nearly a third of 6,000 known amphibian species, 70% of some 380 cone snail species, and 9 species of bear are threatened to extinction (CBD 2008). Species once lost are irrecoverable, depriving us of the opportunity to improve our and future generations.

Intensive agricultural systems, mainly growing monoculture crops using seeds with uniform genetic materials to increase yield on large-scale farm, can adversely affect biodiversity. Organic agriculture for smallholders, on the other hand, is associated with a high level of biodiversity. The remaining crop genetic resources are in the hands of



smallholders in remote areas and this precious resource needs to be protected. For instance, in the northern part of the Lao PDR where farming is mainly organic, sticky rice varieties alone are said to number 3,000. The promotion of organic agriculture in these areas is one strategy that can protect the remaining genetic resources.

In addition to monoculture, the use of agrochemicals in conventional farming has been another major cause of farm biodiversity loss. By introducing organic practices, soil conditions are improved. It also increases the number of beneficial insects and soil microorganisms, thereby increasing local biodiversity. Aside from the economic benefits, as previously discussed, biodiversity also positively affects species abundance and richness, particularly for flora, birds, and some arthropods (Bengtsson, Ahnström, and Weibull 2005).

As shown in Figure 1.15, in northeast Thailand, the survey of 248 organic farming households revealed that more than 80% observed the number of insects, crabs, fish, frogs, rats, and others to have increased with organic agriculture. Only 15% said they remained the same and less than 5% said that the number decreased. The same line of questioning of 80 farmers in northern Thailand shows similar results with 90% of farmers stating that biodiversity has increased.

MDG 8: Global Partnership in Development

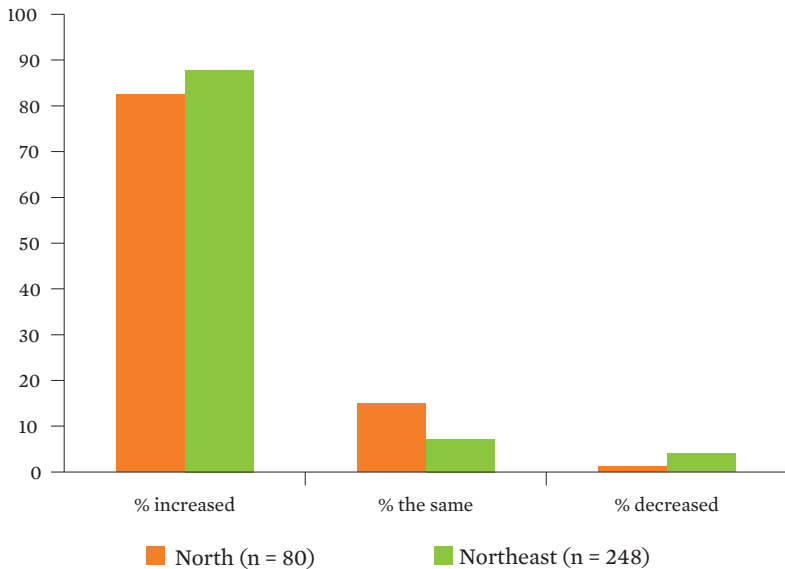
- Target 8A: Develop further a rule-based and nondiscriminatory trading and financial system
- Target 8B: Address the special needs of the least developed countries
- Target 8F: Make available the benefits of new technologies, especially information and communications in cooperation with the private sector



Price premiums offered in export markets have encouraged private firms and NGOs to get into the organic business by assisting farmers to overcome stringent certification and food safety requirements. For the majority of developing countries, a huge portion of organic produce is for export. The liberalization of former socialist states, that is, the Lao PDR and Cambodia, gave them a comparative advantage in organic



Figure 1.15 Change in Biodiversity with Adoption of Organic Agriculture in Thailand



n = number of respondent farming households.

Source: ADBI survey results.

agriculture owing to their less polluted productive bases. Although production is largely export-driven, there is much room for domestic demand to grow as rural areas will be increasingly connected to rapidly growing local urban centers.

Due to organic agriculture's stringent and detailed requirements and standards for farm conversion and obtaining certification, agri-producers who comply have a chance to market their produce in both international and local markets at premium prices. Exporting farmers are aided by organizations, such as Fairtrade, which help small farmers gain bargaining leverage vis-à-vis multinational food processors and suppliers.



1.3 CONCLUSIONS: ORGANIC AGRICULTURE CHALLENGES AND PUBLIC SECTOR ROLES

The Green Revolution undoubtedly raised agricultural productivity and drove away the looming threat of famine in the 1960s. These benefits, however, were not without costs. The intensive use of agrochemicals, monocropping, and hybrid seeds had unintended social, health, and ecological impacts. Farmers have witnessed declining soil fertility, increased water pollution, and biodiversity loss, which negatively affected plants' growth environment. As the majority of farmers are poor, inputs are often unaffordable; this renders Green Revolution technologies biased toward rich farmers in fertile areas. Moreover, a number of farmers who have been exposed to agrochemicals, have witnessed their health deteriorate. The interaction effects of various agrochemicals in soil that bears agri-produce and are ingested as residues by consumers have yet to be understood. Farmers who converted to organic agriculture, however, have improved their health and gained sustainable higher yields at less cost than conventional farming. They also minimize their GHG emissions by doing away with fossil-fuel-based agrochemicals. All these provide a compelling rationale for the promotion and support of organic agriculture by the public sector.

1.3.1 Organic Agriculture and the Millennium Development Goals

With the growing demand for healthy food and the increased awareness of environmental benefits of organic agriculture, the market for organic produce is expected to continue to grow in the coming years. Since organic agriculture works on the comparative advantage of the poor farmers in developing countries, the growth of the organic market opens up a new modality of development where consumers in developed countries, through market mechanisms, can directly transfer payment for environmental services to the poor in developing countries.

In the context of the MDGs, case studies show that organic agriculture contributed to both income and nonincome aspects of the MDGs, although the degree of contribution varies with the context and stage of development of each country. The nature of the contribution may be direct or indirect depending on its quantifiability and immediacy of impacts.

In terms of achieving the MDGs, organic agriculture's direct contribution includes higher incomes (and thus poverty alleviation), improvement



of health owing to less chemical exposure, integration of sustainable principles into development policies, improvement of access to safe water and sanitation, and expansion of global partnerships for development. Organic agriculture's effects on the remaining goals are considered indirect as higher incomes and training in organic agriculture can make farmers more willing to send their children to school. With organic agriculture, more women are provided employment opportunities.

With regard to MDG 1 (reduce by half the proportion of those living under \$1 a day), organic farmers earn higher profits than conventional farmers due to lower production costs and price premiums. As organic agriculture requires lower cash inputs, there is less need for credit. Organic agriculture is also pro-smallholder, as small plot size with utilization of family labor often produces better yields. As organic agriculture is more labor-intensive, it absorbs surplus rural labor. This is shown in the practice of tea growing in the PRC, where use of family labor is as much as 35% higher in organic than in conventional agriculture.

Organic agriculture is suitable for roughly 74% of global arable land (about 1 billion hectares), which is largely rainfed. Since organic farming methods are designed to improve in situ conditions with environment-friendly technologies, such land can be made more productive and resilient, improving food security in the face of climate change. Organic agriculture combines the best adaptive practices to climate change to form a holistic farming approach, utilizing closed cycles of organic matter and nutrients within a farm. As soil productivity and fertility is enhanced in organic agriculture, harvests become more nutritious and sustainable.

In terms of MDGs 4, 5, and 6, organic agriculture positively affects the health of farmers by reducing exposure to toxic agrochemicals as reflected in their lower medical spending.

As for MDG 7, organic agriculture utilizes resources without harming the environment. Benefits of organic agriculture range from increasing biodiversity of farming systems to reducing GHGs in the atmosphere. As revealed in our case studies, organic farmers observed increases in the number and kinds of animal and plant species in their fields. This natural environment, unhampered by organic practices, can act as a gene bank that contributes to long-term food security. As evidenced in



our case studies, organic agriculture, therefore, has myriad benefits to farmers and the ecological environment, and in mitigating the effects of climate change.

1.3.2 Public Sector Roles

The underlying infrastructure and foundations that ensure smooth market operations are often too costly for private entities to provide. As these are public goods, benefits cannot be restricted and there will be free riders; hence, public provision is needed. Governments normally deliver both soft and hard infrastructure to develop an enabling environment for market mechanisms to function. In terms of organic agriculture, governments should particularly address the high transaction costs of working with the poor from marginal areas. It is thus crucial for governments to formulate a comprehensive long-term national development policy for organic agriculture, bringing together stakeholders such as private businesses, NGOs, cooperatives, and farmers with their corresponding responsibilities in each development stage of organic agriculture.

Even as the growth of organic farming continues to accelerate, there remain several obstacles toward its widespread practice. There is a general need for increased awareness among government agencies and marketing institutions about the benefits of organic agriculture. Conventional farmers, in particular, still associate organic agriculture with decreasing yields. With growing concerns over food safety and security, however, the mass media would be needed to popularize organic agriculture in hopes of converting conventional farmers. Raising awareness about the benefits of organic agriculture through education in schools, offices, and the mass media can help shift consumer demand toward organic produce. For instance, an organic agriculture curriculum can be incorporated in general education so that the young generation can gain practical knowledge and experience in organic agriculture and hopefully influence their consumption preferences. Governments can also provide funding for students and educational institutions interested in furthering organic agricultural research and application, which in turn could encourage private universities and donors to support such education and distance-learning programs for organic agriculture enthusiasts. In essence, governments and donors would also do well to support state schools to develop and disseminate homegrown organic farming practices and develop their own organic agriculture experts.



Not only is awareness raising important, but also capacity building of would-be organic farming practitioners. There is a need to develop the knowledge and skills of organic farmers. To this end, extension services should be provided by governments and donors to equip farmers with specific technical know-how, especially in compost making, use of green manure, no-till farming, and natural pest control.

To build and maintain markets, certification of organic produce is necessary. To gain a complete skills set in organic farm management toward achievement of certification, farmers should be trained in input monitoring and traceability systems. A system of mentorship and apprenticeship should be developed between new and experienced farmers. In this regard, the case of the Japanese *meister* system, which facilitated technology transfer in the PRC, could be taken into consideration to ensure continuity and popularization of organic practices among farmers. Moreover, upon conversion, farmers needing assistance in the transition phase of 2–3 years should be supported by governments and donors. Concerns over costly nonchemical inputs must also be addressed.

As farmers make progress in their organic farming system allowing them to export, governments and donors would need to develop the capacity of farmers to add value to their produce, for example, developing an organic agroprocessing industry for fresh produce, as well as support for larger farmers who want to independently sell their products by supporting the organization of distribution and retail systems. Governments should also develop rural infrastructure, such as transportation systems and related facilities for harvest and postharvest, and cold storage.

To further promote organic agriculture, countries without a regulatory agency with its own labeling system should develop and implement its own standards in line with existing international standards, as well as alternative certification systems. Capacities of local inspectors, especially in the utilization of information and communication technology, would be particularly crucial for contract farming arrangements in developing countries that export to ever stricter international markets. Certifiers and exporters could also aid in the development of a database that can help spread best practices and document indigenous farming practices.

A less explored area, which regional cooperation may be able to address, is the attainment of carbon credits for organic farmers or indeed any



farmers that reduce carbon emissions relative to a baseline. Governments and international bodies would need to coordinate and harmonize standards not only to facilitate exports but also to promote best organic farming practices. Similarly, exchanges among farmers from different regions must also be supported to facilitate a national or regional infrastructure supporting organic agriculture. Moreover, governments and NGOs can also help develop the organic market by increasing its demand for organic produce through government procurement for its feeding programs, such as school lunches and hospital meals.

As markets of organic producers are mainly in developed countries, organic producers in developing countries are mainly export-oriented. As concerns over food safety continue to grow, organic produce has a promising future. For small farmers to continue benefiting from organic agricultural trade, governments have a crucial role in promoting their produce in the international markets. Governments should include organic agriculture as part of their trade promotion activities. Given the economic, environmental, and social benefits of organic agriculture, governments have much to lose in undermining the development of the organic agriculture sector. With the private sector leading the way and appropriate policy support from the public sector, the scale of this development strategy could expand tremendously, benefiting millions of small farmers worldwide.

REFERENCES

- Aubert, C. 2007. *Can Organic Farming Mitigate the Impact of Agriculture on Global Warming*. International Conference on Organic Agriculture and Food Security. Italy: Food and Agriculture Organization of the United Nations.
- Bengtsson, J., J. Ahnström, and A. Weibull. 2005. The Effects of Organic Agriculture on Bio-diversity and Abundance: A Meta-analysis. *Journal of Applied Ecology*. 42 (2). pp. 261–269 (9).
- Becker, S., and A. Ichino. 2002. Estimation of Average Treatment Effects Based on Propensity Scores. *The Stata Journal*. 2 (4). pp. 358–377.
- Brandt, K. 2008. Plant Health, Soil Fertility Relationships and Food Quality. Paper presented at the International Society of Organic Agriculture Research (ISOFAR) Conference in the Republic of Korea. March.



- Caliendo, M., and S. Kopeinig. 2005. *Some Practical Guidance for the Implementation of Propensity Score Matching*. Berlin: German Institute for Economic Research.
- Chavas, J.P., J.L. Posner, and J.L. Hedtcke. 2009. Organic and Conventional Production Systems in the Wisconsin Integrated Cropping Systems Trial: II. Economic and Risk Analysis 1993–2006. *Agronomy Journal*. 101 (2). pp. 288–295
- Cleary, A. 1999. Organic Agriculture and Global Warming. *Peace and Environment News*. February. <http://perc.ca/PEN/1999-02/scleary.html>
- CBD (Convention on Biological Diversity). 2008. Biodiversity Loss – It Will Make You Sick. 24 April. <http://www.cbd.int/doc/press/2008/pr-2008-04-24-life-en.pdf>
- Dasgupta, S., C. Meisner, D. Wheeler, N. T. Lam, and K. Xuyen. 2005. Pesticide Poisoning of Farm Workers: Implications of Blood Test Results from Vietnam. World Bank Policy Research Working Paper 362. June.
- FAO (Food and Agriculture Organization of the United Nations). 2003. *Awareness Folder on Organic Agriculture*. Rome.
- Faures, J. M., and G. Santini. 2008. Water and the Rural Poor, Interventions for Improving Livelihoods in Sub-Saharan Africa. Rome: Food and Agriculture Organization of the United Nations. <http://www.fao.org/docrep/010/i0132e/i0132e00.htm>
- Gilbert, N. 2012. One-Third of Our Greenhouse Gas Emissions Come from Agriculture. *Nature News*. 31 October. <http://www.nature.com/news/one-third-of-our-greenhouse-gas-emissions-come-from-agriculture-1.11708>
- Gogoi. 2006. Walmart’s Organic Offensive. *Business Week Online*. 29 March.
- Hepperly P. 2003. *Carbon and Nitrogen Sequestration in Agricultural Systems*. Kutztown, Pennsylvania: Rodale Institute.



- Hepperly, P., J. Moyer, D. Pimentel, D. Douds Jr., K. Nichols, and R. Seidel. 2008. Organic Maize/Soybean Cropping Systems Significantly Sequester Carbon and Reduce Energy Use. In D. Neuhoff, N. Halberg, T. Alföldi, W. Lockeretz, A. Thommen, I.A. Rasmussen, J. Hermansen, M. Vaarst, L. Lueck, F. Caporali, H. Høgh Jensen, P. Migliorini, and H. Willer, eds. *Cultivating the Future Based on Science. Volume 2 – Livestock, Socio-economy and Cross Disciplinary Research in Organic Agriculture*. Proceedings of the Second Scientific Conference of the International Society of Organic Agriculture Research (ISO FAR), held at the 16th International Federation for Organic Agriculture Movement Organic World Congress. 18–20 June 2008. Modena, Italy.
- Hill, S. 2005. *Environmental Sustainability and the Redesign of Agro-systems*. Ecological Agriculture Projects. EAP Publication 34.
- Ho, M.W., E. Goldsmith, L.L. Ching, and S. Burcher. 2008. *Food Futures Now: Organic, Sustainable and Fossil-Free*. Institute of Science and Society, Third World Network.
- IFAD (International Fund for Agricultural Development). 2005a. *Achieving the Millennium Development Goals: Rural Investment and Enabling Policy*. <http://www.un.org/esa/coordination/Alliance/achievingMDG.pdf>
- _____. 2005. *Organic Agriculture and Poverty Reduction in Asia: [People's Republic of] China and India Focus*. http://www.ifad.org/evaluation/public_html/eksyst/doc/thematic/organic/asia.pdf
- _____. 2011. *Rural Poverty Report*. <http://www.ifad.org/rpr2011/>
- IFOAM (International Federation for Organic Agriculture Movement). 2005. <http://www.ifoam.org/en/organic-landmarks/definition-organic-agriculture>
- IFPRI (International Food Policy Research Institute). 2002. *Green Revolution: Curse or Blessing*. <http://www.ifpri.org/pubs/ib/ib11.pdf>



- ISP (Independent Science Panel). 2003. *The Case for a GM-Free Sustainable World*. Institute of Science in Society and the Third World Network. <http://www.indsp.org/A%20GM-Free%20Sustainable%20World.pdf>
- Jeyaratnam J. 1990. Acute Pesticide Poisoning: A Major Global Health Problem. *World Health Statistics Quarterly*. 43 (3). pp. 139–144.
- Lal, R. 2004. Soil Carbon Sequestration Impacts on Global Climate Change and Food Security. *Science*. 304 (5677). pp. 1623–1627 <http://www.sciencemag.org/content/304/5677/1623.abstract>
- Mahoney, P.R., K.D. Olson, P.M. Porter, D.R. Huggins, C.A. Perillo, and R.K. Crookston. 2004. Profitability of Organic Cropping Systems in Southwestern Minnesota. *Renewable Agriculture and Food Systems* 19. pp. 35–46.
- Pimentel, D., P. Hepperly, J. Hanson, D. Doubs, and R. Seidel. 2005. Environmental, Energetic and Economic Comparisons of Organic and Conventional Farming Systems. *BioScience*. 55 (7). pp. 573–582.
- Raup, J., C. Pekrun, M. Oltmanns, and U. Kopke, eds. 2006. *Long Term Field Experiments in Organic Farming*. International Society of Organic Agriculture Research Scientific Series No. 1. Berlin: Verlag Dr. Köster.
- RocSearch Ltd. 2004. *Global Organic Food Market*. London.
- Rodale Institute. www.rodaleinstitute.org (accessed 22 May 2008).
- Rundgren, G. 2002. *Organic Agriculture and Food Security*. Bonn: International Federation for Organic Agriculture Movement.
- Scialabba, N., and C. Hattam, eds. 2002. *Organic Agriculture, Environment and Food Security*. Rome: Food and Agriculture Organization of the United Nations.



- Scialabba, N. 2003. Organic Agriculture: The Challenge of Sustaining Food Production While Enhancing Bio-diversity. Paper presented at United Nations Thematic Group Sub-Group Meeting on Wildlife, Biodiversity and Organic Agriculture in Ankara, Turkey. 15–16 April.
- Soil Association. 2012. *Organic Market Report*. Bristol.
- Sundermeir, A., R. Reeder, and R. Lal. 2005. Soil Carbon Sequestration—Fundamentals. Extension Fact Sheet. Ohio State University. <http://ohioline.osu.edu/aex-fact/pdf/0510.pdf>
- United Nations. 2007. Millennium Development Goals Report. New York.
- USDA ERS (United States Department of Agriculture Economic Research Service). 2012. *Organic Market Overview*. <http://www.ers.usda.gov/topics/natural-resources-environment/organic-agriculture/organic-market-overview.aspx>
- USEPA (Environmental Protection Agency). Basic Information about Nitrate in Drinking Water. <http://water.epa.gov/drink/contaminants/basicinformation/nitrate.cfm> (accessed 2 September 2013).
- Willer, H. and J. Lernoud, eds. 2014. *The World of Organic Agriculture: Statistics and Emerging Trends 2014*. Bonn: International Federation for Organic Agriculture Movement and Frick: Forschungsinstitut für biologischen Landbau.
- Worthington, V. 2001. Nutritional Quality of Organic Versus Conventional Fruits, Vegetables and Grains. *The Journal of Alternative and Complementary Medicine*. 7 (2). pp. 161–173.
- Zhang, H., and J. Stiegler. 1998. Animal Manure and Soil Quality. *Production Technology*. 10 (8). pp. 1–3. February. Extension Publications. Oklahoma State University.



Chapter 2 | **The Costs of Achieving the Millennium Development Goals by Adopting Organic Agriculture¹**

Anil Markandya, Sununtar Setboonsarng, Qiao YuHui, Rachanee Songkranok, and Adam Stefan

2.1 INTRODUCTION

The benefits of organic agriculture to smallholder farmers and to the environment have prompted increased interest and conversion to organic agriculture from conventional chemical-input-intensive farming in the last decades. Yet, documentation of experiences of farmers with organic agriculture and its effects on the ecology has been limited and little is known about the costs of achieving improvements in farmers' lives through the adoption of organic agriculture; specifically, the levels of public and private costs that are incurred. Arguably, organic agriculture has represented good value when compared to the gains in terms of individual incomes and other benefits as defined in the Millennium Development Goals (MDGs) but this needs to be demonstrated.

Studies reveal that while there are strong links between organic agriculture and the MDGs (Rosegrant et al 2005), the relationship can be complex and not always quantifiable. Hence, a comparison of the costs of adopting organic agriculture with the benefits has to be in part a qualitative exercise, but one that still needs to be carried out. This chapter is a contribution to that comparison.

¹ First published as Markandya, A., et al. 2010. "The Costs of Achieving the Millennium Development Goals through Adopting Organic Agriculture." ADBI Working Paper 193. Tokyo: Asian Development Bank Institute. Available: <http://www.adbi.org/working-paper/2010/02/09/3455.cost.mdg.organic.agriculture/>



2.2 THE MILLENNIUM DEVELOPMENT GOALS AND THE COSTS OF ATTAINING THEM

The MDGs represent a major development program, with agreement across the international community to achieve a certain set of targets. There are eight goals and they are defined as follows:

1. Eradicate extreme poverty and hunger
2. Achieve universal primary education
3. Eliminate gender disparity
4. Reduce child mortality
5. Improve maternal health
6. Combat HIV/AIDS, malaria, and other diseases
7. Ensure environmental sustainability
8. Develop a global partnership for development

More details of the associated targets and indicators are given in Appendixes 2.1 and 2.2.

Having signed up to the MDGs, the question arose of how they would be funded. It was clear that additional resources would be needed if these goals were to be met by 2015, the date fixed in the agreement. Estimates made by the World Bank and others indicated an additional cost of around \$40 billion–\$70 billion a year from 2000 to 2015 (Devarajan, Miller, and Swanson 2002). The estimates were derived in two ways: the first was based on the additional investment needed to achieve the growth level necessary to reduce poverty and thereby meet MDG 1 (the poverty reduction target). The calculation is based on a two-gap growth model in which growth depends upon the level of investment and the efficiency with which investment is turned into output. For a given rate of growth of per capita gross domestic product (GDP), the rate of poverty reduction depends upon the shape of the income distribution and the level of average income relative to the poverty line. Working backward from the existing poverty level and distribution of income, the average rate of growth required to reach the poverty reduction goal in 2015 determines the amount of additional investment needed. This yields estimates of \$54 billion–\$62 billion a year.

The second method was based on detailed estimates of the costs of meeting the education, health, and water and sanitation targets, which in the Devarajan, Miller, and Swanson study amounts to



\$35 billion–\$76 billion annually. A more accurate estimate of the costs for the water and sanitation targets, however, is available from Markandya (2006). If we take those figures, the second method gives a cost range of \$84 million–\$109 million a year.

These two approaches do not provide numbers that can be added up to obtain the total cost of meeting the MDGs and it is difficult to know the extent to which they overlap. As stated earlier, the costs of meeting the income poverty goal are calculated by estimating the additional investments needed to increase the growth rate, and thereby increase incomes. This means, however, that achieving the income poverty goals will also result in the other nonincome MDG goals being achieved. Conversely, if specific programs are implemented to meet these nonincome MDG goals, they will also result in overall poverty being reduced substantially. Hence, an overall cost estimate for all MDGs is not available.

Given these limitations, Table 2.1 estimates the costs per person who benefits from the attainment of each specific MDG. The poverty income goal generates a cost per person taken out of income poverty of between \$550 and \$880.² The costs of attaining the education target come to between \$486 and \$1,459 per person. This measures the increase in the number of children that complete primary schooling. For each unit reduction in annual infant mortality, the cost is between \$760 and \$1,064; for water and sanitation, the additional costs range from \$5 to \$11.³

Note that these are additional costs to meeting these goals, and there are already considerable aid funds that indirectly support them. Roughly speaking, existing donor-aided programs in 2000 provided roughly

² The reduction will be permanent as long as the income increases are not reversed. Reversal is unlikely, but not impossible, especially in the current global credit crises.

³ The additional cost per child educated is the present value cost of the education target divided by the increase in the annual number of children educated. One can also measure the increase in cost divided by the total number of children educated during 2000–2015. By that measure, the additional cost is between \$2 and \$6. Likewise the additional cost reduction per child who survives beyond the age of 5 years is the present value cost of the mortality target divided by the decline in the number of child deaths in 2015 compared to 2000. One can also measure the increase in cost divided by the reduction in the total number of deaths during 2000–2015. By that measure, the additional cost is between \$9 and \$12. Note also that we do not have an estimate of the unit cost for maternal mortality or decline in other diseases. This is because of a lack of either or both a baseline or predicted 2015 values for maternal mortality, HIV/AIDS, and other communicable diseases.



Table 2.1 Additional Costs of Attaining the Millennium Development Goals, 2000–2015

	Total Annual Costs (\$ billion)		Population (million)		Change ^a (million)	Cost per Person ^b (\$)	
	High	Low	2000	2015		High	Low
	MDG 1	62	54	2,145		1,382	-763
Other MDGs							
Education ^c	10	30	167	836	668	1,459	486
Under-5 mortality ^d	5	8.5	119	47	-71	1,293	760
Maternal mortality	5	8.5	-	-	-	-	-
HIV/AIDS	4	6.5	-	-	-	-	-
Other communicable diseases	1	1.5	-	-	-	-	-
Access to safe water ^e		15	1,354	4,498	3,144		4.8
Access to improved sanitation ^e		39	3,886	3,465	3,465		11.3

MDG = Millennium Development Goal.

Note: There are insufficient data to estimate the cost per person for maternal mortality, HIV/AIDS, or other communicable diseases.

^a The change is the reduction in the number of people in that category in 2015 less the number in 2000.

^b The poverty cost per person is the cost in net present value terms of achieving universal primary education by 2015.

^c The additional cost per child per year of education is \$1.9–\$5.7.

^d The under-5 mortality cost per person is the additional investment needed to achieve the target reduction in mortality divided by the fall in the annual number of child deaths between 2000 and 2015. The cost per child whose life is saved is between \$8.8 and \$12.3.

^e The cost of access to water and sanitation is the cost in present value terms of providing access to an additional person. Costs are present values from 2000 to 2015 using a discount rate of 5%.

Sources: Costs estimates are from Devarajan, Miller, and Swanson (2002) except safe water and improved sanitation, which are from Markandya (2006); data on persons, and targets are from Bourguignon, Diaz-Bonilla, and Lofgren (2008).

similar amounts of money (i.e., \$60 billion) to developing countries. Hence, the additional aid needed to meet the MDGs is of the order of 100%.

In terms of value for money, a more complex exercise is required in comparing the benefits of the improvement against the costs. It is tricky



to apply on poverty, but it can be done for the other nonincome MDGs, such as calculations for water and sanitation by Markandya (2006), which show that while the health benefits of the safe water goal easily exceeds the costs, the case is less clear for the improved sanitation target.

According to the World Health Organization (WHO), the lack of access to safe water and sanitation is responsible for more than half the disability-adjusted life years (DALYs) lost due to all environmental factors.⁴ But are targets under the MDGs justified in economic terms? To compare targets and costs based on recent ranges of values for impact, the study found that the costs of achieving the targets by 2015 exceed the mid-value of the range of benefits for most of Africa and Asia. For the high mortality countries of the Americas, the costs are less than the lower bound of the benefits. The calculations apply for both the safe water and the sanitation goals taken together. However, when the cost of each goal is separated, the water supply targets are justified for all regions, but the sanitation targets are only unambiguously justified for the Americas. This is the result of two factors: the costs of sanitation connections are about three times those of water supply and the benefits per connection are somewhat lower.

As far as the organic agriculture program is concerned, the costs per person obtained provide markers against which we can compare the costs of the programs relative to the benefits. As the impacts of organic agriculture on nonpoverty MDGs are not quantitatively detailed, a partial comparison of the costs of the organic agriculture program against the global costs yields some insights. We also note the recent food price hikes of 2010/11, which burdened millions of poor people as they spend large shares of their income on food and which have increased undernourishment, negatively affecting the MDGs linked to food and nutrition, such as child mortality (MDG 4) and maternal mortality (MDG 5). Of the 144 monitored countries, 105 are not expected to reach MDG 4, and 94 are off-track on MDG 5. Moreover, urban, nonfarm, and female-headed households are hit the most in the short run. The food price hike also raised the poverty headcount in most developing countries, preventing 48.6 million from escaping poverty in the short run. But in the medium to long term, rising food prices will likely benefit farmers and rural households (World Bank 2012).

⁴ For details, see Driscoll et al. 2005.



2.3 Costs of Organic Agriculture Programs: Conceptual Issues

The costs of adopting organic agriculture programs fall into the following categories: (i) training costs and costs of organizing smallholder groups, (ii) subsidies on inputs to organic farmers, (iii) transition costs, and (iv) inspection and certification costs. In each case, costs borne by the farmers, private sector, donors, and public sector would be delineated to the extent possible.

2.3.1 Training Costs

Farmers need to be instructed in organic methods. Usually, a number of “trainers” are trained who then go on to train the individual farmers. The direct costs consist of building the capacities of trainers, and then paying them to train the farmers. These costs can be borne by the state or by the promoters of the organic program (which may be firms or nongovernment organizations [NGOs], frequently foreign but sometimes domestic).

Calculating the training costs per farmer should take into account attrition rates, which can be as high as 50% or as low as zero. In the Thai experience, the rate has been lower than 5%. Depending on the training methodology and participant selection, overall attrition rates can be maintained at around 20%, particularly if adequate investment is made in the training of trainers and training methodology development. In addition, while being instructed, farmers lose earnings, often valued at the wage rate applicable to the sector in which they are active. However, if the training is organized during the slack season when there is little farming activity, the opportunity costs are much lower than the wage rate. Finally, costs of organizing smallholder groups should be included as part of the training costs under nontechnical-related matters, such as dealing with administrative matters and social functions.

Initial training can be considered a capital investment, followed by additional “top-up training” that is provided every year. The costs would be included in the cost assessment amortized over 10 years to derive an annual cost of the training.



2.3.2 Subsidies on Inputs to Organic Farmers

In many organic agriculture programs, farmers are supplied with seed and other inputs at subsidized prices. These inputs are usually supplied by the contractor who agrees to buy the production from the organic agriculture farmer, but in some cases, the state also provides inputs. In the case studies, input subsidies, which are often provided by private firms that buy the products, can be as low as 10% of all costs to as much as 57%. Where available, a breakdown of the share of the input subsidy coming from each source is provided.⁵

2.3.3 Transition Costs

In moving from conventional farming to organic farming, there can be a period when farmers' incomes decline, before the benefits of organic farming are reaped. Yields are still low and output cannot yet benefit from the premiums tied to organic products before soil conditions are certified as fully organic. These costs are largely borne by the farmers, although even in this instance, promoters may provide some financial support to ease the burden. Transition costs are estimated to be between 6% and 20% of total costs.⁶ The decline in income also comes with reduced production costs and the transition costs measured in terms of loss of net income. Net income need not decline during transition, as shown by rainfed rice production systems.

2.3.4 Inspection and Certification Costs

Costs also arise from inspection and certification of the organic production process. This is most problematic when they have to be borne by the farmer and can act a market-entry barrier. Inspection and certification can be carried out by local agents and/or foreign specialists or their local-based counterparts. Each market may require

⁵ It can be argued that subsidies are not always necessary and are used to attract farmers to the program. It would be less expensive to set up a revolving fund to purchase inputs and distribute them to farmers at the beginning of the planting season. The fund would be reimbursed when the farmers have sold their produce. In this case, the input subsidy would be the interest cost of the fund.

⁶ It is worth noting that the transition cost for farmers converting from chemical to organic farming is higher than those converting to Good Agricultural Practice farming, which is de facto largely organic.



separate certifications, and they could be costly particularly when foreign certification is involved. Inspection and certification costs can be mitigated by produce buyers who generally pay for them and by price premiums of certified produce when farmers bear the initial certification costs. Generally, lower certification costs mean a lower premium on the product.

In large-scale⁷ organic conversion, the inspection and certification costs are often lower as inspectors can combine several inspections in one visit. Organizing farmers into grower groups (with an internal control system) will also reduce inspection and certification costs. Cost reduction is even greater with the development of a local certification body as more farms are converted. In the case studies, the costs of inspection and certification can be as little as 3% to as much as 57% of total costs. Sri Lanka is on the high end, reflecting its high internal control costs. In the People's Republic of China (PRC) and Thailand, these costs are much more modest. From the Thai experience, certification costs do not exceed 5% when the organic project grows to an optimum size. Costs over 10% may be due to bad management or excessively small project size. With large-scale conversion to organic farming, the costs should be between 2% and 10% of total costs.

2.4 COSTS OF ACTUAL ORGANIC AGRICULTURE PROGRAMS IN THE PEOPLE'S REPUBLIC OF CHINA, SRI LANKA, AND THAILAND

2.4.1 Case Studies in the People's Republic of China

The case studies were from Wanzai and Wuyuan counties in Jiangxi Province. In the case of Wanzai County, the organic producers specialize in mixed horticulture crops with ginger, strawberry, and green soybean as main crops. They also grow some organic rice. At the time of the survey, there were 2,400 farmers, covering some 1,950 hectares. As shown in Table 2.2, only the private sector subsidized organic agriculture conversion, while farmers bore most of the training costs.

⁷ Large-scale in this case does not refer to monocrop large-scale farming but village or countywide conversion of collective numbers of smallholder farmers.



Table 2.2 Costs of Adopting Organic Agriculture in Wanzai County, People's Republic of China (\$ per farmer per year)

Cost Category	Farmer	State	Private	Total
Training	5.9	0.5	–	6.4
Subsidies	–	–	17.4	17.4
Transition	4.1	–	–	4.1
Inspection/Certification	–	2.6	–	2.6
Total	10.0	3.1	17.4	30.5

– = data not available.

Notes:

1. Training of trainers is undertaken initially, followed by training of “village leaders,” who in turn train the farmers for 1 day, repeated annually. Lost wages are CNY40 (\$5) per day. The farmer's costs among the total costs are the lost wages. The other costs are borne by the state.
2. Subsidies are given for half the land area under cultivation. Seeds and fertilizer are given 6 months in advance at half price and interest free. The rice yield is prepaid at \$135 per hectare, 6 months in advance of the harvest. The burden of these payments falls on the town company as it is the bridge between farmers and trade companies.
3. Transition costs arise because of the decline in yields of about 300 kilograms per hectare for 3 years.
4. Inspection costs are \$6,250 annually for a foreign certifier, shared equally among the 2,400 farmers.
5. All capital costs are amortized at a rate of 10% over 10 years.
6. The average prevailing exchange rate in 2006, the year of the survey, was used (\$0.125 = CNY1,000).

Source: Data collected by the authors from local sources.

Figure 2.1 shows the breakdown of the costs by category. The total costs of supporting organic agriculture are around \$77 per farmer per year, made up mainly of input subsidies (57%), followed by training (21%), transition (14%), and inspection and certification (8%). Of the total, one-third (33%) is borne by the farmer, 57% by the private company, and the rest (10%) by the state.

In the case of Wuyuan County, the organic agriculture production is exclusively tea. There are 508 farmers engaged in the production at the time of survey. As shown in Table 2.3, the cost figures are considerably lower with total costs per farmer at \$13.5, compared to \$30.5 for Wanzai.

Figure 2.2 shows the breakdown of the conversion costs: training (22%), subsidies (22%), and inspection and certification (56%). There are no expected transition costs as there is no decline in the tea yields. In terms of the shares across different agents, 15% of the costs are borne by the farmer and 85% by the private company. There are no costs to the state, probably a reflection of the high profitability of the program.



Figure 2.1 Share of Costs in Wanzai County, People's Republic of China

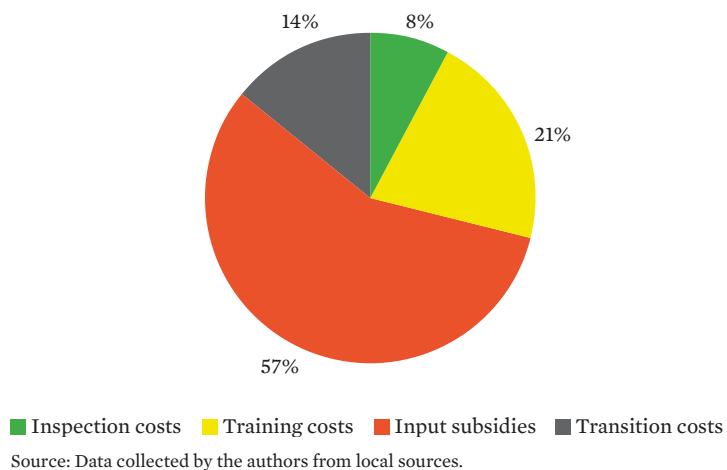


Figure 2.2 Share of Costs in Wuyuan County, People's Republic of China

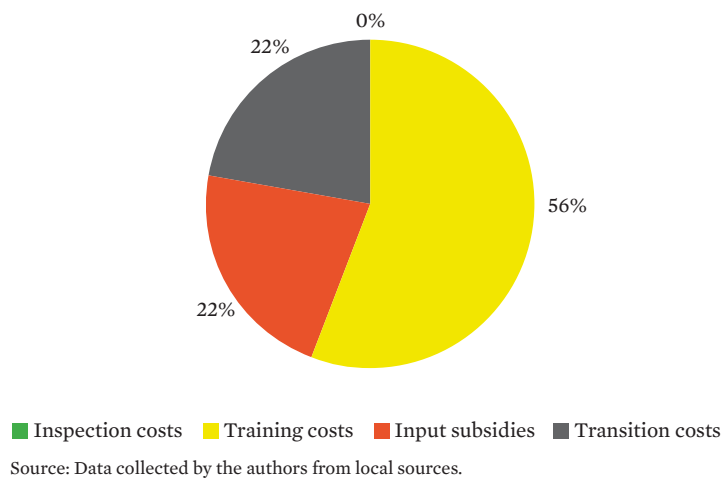




Table 2.3 Costs of Adopting Organic Agriculture in Wuyuan County, People's Republic of China
(\$ per farmer per year)

Cost Category	Farmer	State	Private	Total
Training	2.0	–	1.0	3.0
Subsidies	–	–	3.0	3.0
Transition	0	–	–	0
Inspection/Certification	–	–	7.5	7.5
Total	2.0	–	11.5	13.5

– = data not available.

Notes:

1. Training of trainers is undertaken initially by the certifier. Each year, the private company sends two people to participate in the training course. The cost for trainers from the company is CNY6,000. This is followed by training of “village leaders,” who in turn train the farmers for 1 day, repeated annually. Lost wages are CNY40 (\$5) per day.
2. Subsidies such as inputs for farming are not given to Wanzai farmers. They have, however, received support from the fair-trade fund of the Fairtrade Labeling Organization (FLO) every year since 2005, when this project obtained fair-trade certification. In 2006, they received CNY189,000, of which CNY140,000 was spent. Expenditures covered the following:
 - a. Construction of a primary school (CNY65,000)
 - b. Facility improvements for a tea primary processing factory (CNY11,920)
 - c. Payment of health insurance fee for each organic farmer associate member with CNY7,500
 - d. Donation of CNY5,500 for a member with cancer
3. On transition costs, the tea yield did not decline in this project as farmers converted from traditional farming practices to organic. The tea yield is almost the same as before conversion, so there is no transition cost.
4. Inspection costs are €4,776 or \$3,821 per year for a foreign certifier, shared equally across the 508 farmers. At a rate of €0.80 to €1.00 prevailing in 2006, this amounts to \$7.52.
5. All capital costs are amortized at a rate of 10% over 10 years.
6. The average prevailing exchange rate in 2006, the year of the survey, was used (\$0.125 = CNY1.000).

Source: Data collected by the authors from local sources.

2.4.2 Case Studies in Sri Lanka

There were two cases in Sri Lanka, one run by a private company and another by an NGO. The private company project focused on tea, cloves, and pepper (in order of importance) in the Kandy area. Data were collected in 2005–2006 from 1,000 organic farmers in the surveyed area and the average size of each farm was about one acre (0.45 hectares). Table 2.4 shows the costs of organic agriculture conversion with the private sector bearing most of the inspection and certification costs, and farmers being affected by the transition costs in terms of decline in net income.

As shown in Figure 2.3, the total costs of supporting organic agriculture was around \$174 per farmer per year, made up of costs for inspection and certification (61%), followed by input subsidies (21%), transition



Table 2.4 Costs of Adopting Organic Agriculture in Private Company Project in Sri Lanka (\$ per farmer per year)

Cost Category	Farmer	State	Private	Total
Training	2.8	–	10.9	13.7
Subsidies	–	–	17.9	17.9
Transition	36.8	–	–	36.8
Inspection/Certification	–	–	105.6	105.6
Total	39.6	–	134.4	174.0

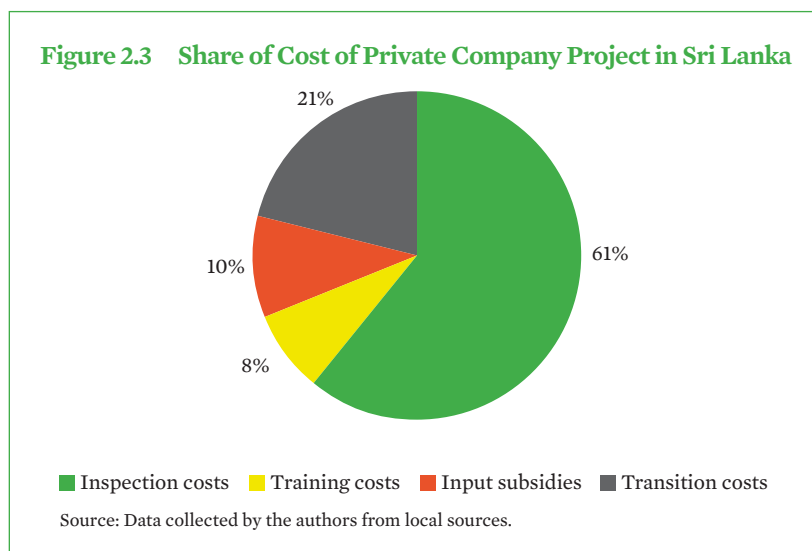
– = data not available.

Notes:

1. Training of trainers is undertaken initially, followed by training of farmers for 1 day, repeated annually. Lost wages are SLRe350 (\$3.4) per day for farmers but SLRe2,813 (\$27.6) for the trainers. There is a 50% attrition rate in the training and each session trains 25 farmers.
2. Subsidies of \$15.7 per acre for organic fertilizer and \$2.2 per acre for planting materials are provided.
3. Transition costs arise because of the declines in yield for 2 years (about 20% lower for that period).
4. Inspection costs are €9,400 (\$7,520) per annum for a foreign certifier, shared equally across the 1,000 farmers. In addition, there are internal controls costing \$98 per farmer.
5. All capital costs are amortized at a rate of 10% over 10 years.
6. The average prevailing exchange rate in 2005 and 2006 was used in this survey (SLRe102 = \$1).

Source: Authors' calculations.

Figure 2.3 Share of Cost of Private Company Project in Sri Lanka



(10%), and training (8%) at the time of study. Of the total, the farmer pays about 23% and the private sector the rest.



The privately run conversion program performed poorly as shown by its high attrition rate and significant yield drops of 20%. The company needed to provide high subsidies for farmers to stay on with the organic project. In addition, internal control costs (ICC) are roughly 13 times higher than the external inspection costs (\$7.52 per farmer). Under optimum circumstances, the ICC should be around \$15 per farmer and, at the maximum, not more than \$25 per farmer.

The other project in Sri Lanka is run by an NGO and focuses on tea, cloves, and pepper (in order of importance) in the Kandy area. The project focused initially on tea, but once the farm was certified as organic, other crops grown also received organic status, adding to income from certified products. The only difference with the privately run project is the administration by an NGO.

The costs of organic agriculture conversion (Table 2.5) are very similar to the private case (\$172 against \$174), but there are differences in the distribution between the different agents. In this case, a donor

Table 2.5 Costs of Adopting Organic Agriculture in Nongovernment Organization Project in Sri Lanka (\$ per farmer per year)

Cost Category	Farmer	State/ Donor	Private	Total
Training	2.8	–	10.9	13.7
Subsidies	–	16.0	–	16.0
Transition	36.8	–	–	36.8
Inspection/Certification	–	–	105.6	105.6
Total	39.6	16.0	116.5	172.1

– = data not available.

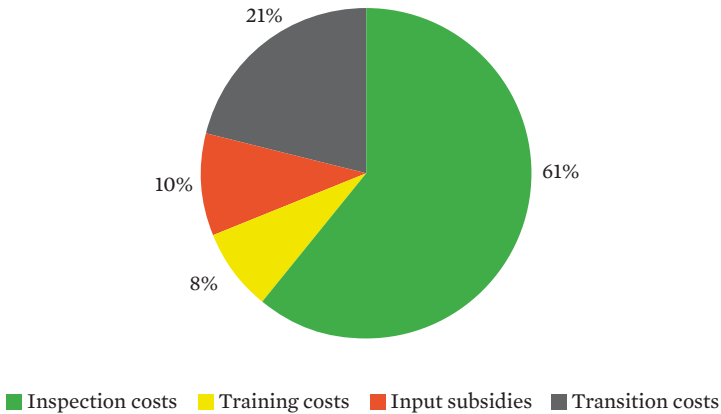
Notes:

1. Training of trainers is undertaken initially, followed by training of farmers for 1 day, repeated annually. Lost wages are SLRe350 (\$3.4) per day for farmers and higher for the trainers at SLRe2,813 (\$27.6). There is a 50% attrition rate in the training and each session trains 25 farmers.
2. An interest subsidy of 6% is given to each farmer on a loan of about \$107 per year. In addition, the NGO receives a subsidy of about \$9.6 for each farmer from the capital budget of \$29,400 provided for a group of 275 farmers.
3. Transition costs arise because of the declines in yield for 2 years (about 20% lower for that period).
4. Inspection costs are €9,400 (\$7,520) per annum for a foreign certifier, shared equally across the 1,000 farmers. In addition, there are internal controls costing \$98 per farmer. This results in a total cost per farmer of \$105.6 per year.
5. All capital costs are amortized at a rate of 10% over 10 years.
6. The average prevailing exchange rate in 2005 and 2006 was used in this study (SLRe102 = \$1).

Source: Data collected by the authors from local sources.



Figure 2.4 Share of Costs of Nongovernment Organization Project in Sri Lanka



Source: Data collected by the authors from local sources.

(Helvetas International, a Swiss NGO) provided the subsidy of \$16 per farmer to the farmer and the NGO (the farmer gets \$6.4 while the NGO takes \$9.6 to defray its expenses). However, the distribution between categories of expenditure is similar (Figure 2.4).

As with the privately run project, the NGO-run case also represents an inefficient example of the adoption of organic agriculture. The attrition rate and yield declines are atypical with very high internal control costs.

2.4.3 Case Studies in Thailand

The Thailand case study was from the northeastern part of the country (Ubon Ratchathani). The program covered 5,000 rai and 300 farmers, with each farmer holding an average of 16.7 rai (2.7 hectares). The products grown are mainly rice and some leafy vegetables. The costs estimates are given in Table 2.6, and the distribution of costs by category is given in Figure 2.5.

At \$26 per farmer, the costs of shifting to organic agriculture in Thailand are the lowest of the three countries; considerably less than in



Table 2.6 Costs of Adopting Organic Agriculture in Ubon Ratchathani, Thailand (\$ per farmer per year)

Cost Category	Farmer	State	Private	Total
Training	9.0	4.0	–	13.0
Subsidies	–	3.0	–	3.0
Transition	5.0	–	–	5.0
Inspection/Certification	–	5.2	–	5.2
Total	14.0	12.2	–	26.2

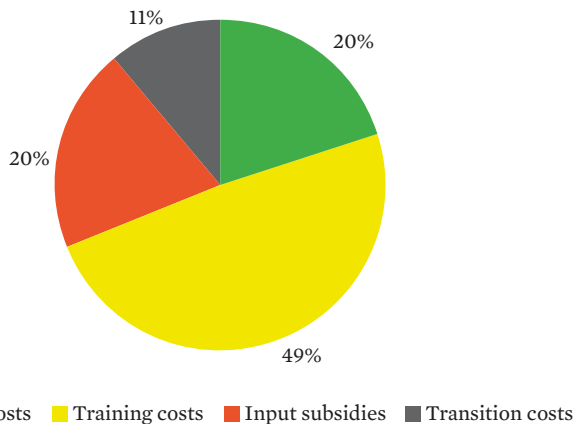
– = data not available.

Notes:

1. Training of trainers is undertaken initially, followed by training of farmers for 1 day, repeated annually. There is also a 1-day meeting for all farmers. Lost wages are B150 (\$3.75) per day for farmers but B555 (\$13.90) for the trainers. There is a 50% attrition rate in the training and each session trains 25 farmers.
2. An interest-free loan of B800 (\$20) is given to each farmer. With prevailing market rates of 15%, this amounts to a subsidy of \$3 per farmer.
3. Transition costs arise because of the declines in yield for 3 years (losses were 55 kilograms per rai for the first 2 years, followed by 25 kilograms per rai for the third year). This is partly offset, however, by higher prices for the produce even in these 3 years. The net result is an amortized loss of \$5 per farmer.
4. Inspection costs are B12.5 per rai (\$0.3) or B208 (\$5.2) per farmer. These are costs of local certification.
5. All capital costs are amortized at a rate of 10% over 10 years.
6. The average prevailing exchange rate in 2005 and 2006 was used for this survey (B40 = \$1).

Source: Data collected by the authors from local sources.

Figure 2.5 Cost Breakdown of Organic Agriculture in Ubon Ratchathani, Thailand



Source: Data collected by the authors from local sources.



Sri Lanka (\$170–\$172) or even in the PRC (\$77). The distribution of the costs is also different. In Sri Lanka, inspection costs dominated; in the PRC, input subsidies dominated; but in Thailand, the main component is training costs. The share of the costs borne by the farmers is 53%.

It is difficult to explain the differences in costs among the case studies but some things stand out. The first is the substantial variation in inspection and certification costs, with those in Sri Lanka being exceptionally high. Differences in the costs of certification may be due to the crop system and the time since the last certification. In the case of Thailand, farmers who converted to organic much earlier than in the PRC or Sri Lanka have lower costs. Second, the large subsidies in Wanzai County in the PRC were largely borne by the private company. Third, there are differences in the share of the costs borne by the farmers—11% in the PRC, 26% in Sri Lanka, and 53% in Thailand. Fourth, the training costs are quite similar in all three country case studies. In the PRC, they are \$6 per farmer, \$14 per farmer in Sri Lanka, and \$13 per farmer in Thailand.

2.5 EVALUATING THE COST EFFECTIVENESS OF ADOPTING ORGANIC AGRICULTURE IN THE PEOPLE'S REPUBLIC OF CHINA, SRI LANKA, AND THAILAND

To evaluate the cost-effectiveness of adopting organic agriculture would require a comparison of the costs with the benefits, particularly in terms of net income and the various MDGs. There are studies that examine income increases of households resulting from the adoption of organic agriculture (Rosegrant, et al. 2005). The range of estimates varies as shown in Table 2.7 under “Gain in net income per annum.”

In order to estimate the cost per household taken out of poverty, the following assumptions hold: (i) the distribution of households below the poverty line is rectangular,⁸ and (ii) incomes of all households are increased by the same proportion. We can estimate the increase in the

⁸ This approximation overestimates the number of very poor households, as almost certainly the underlying distribution will be closer to log-normal but cannot be estimated due to absence of data on the parameters of that distribution. Since the error in taking a rectangular distribution is to underestimate the numbers taken out of poverty, the figures could be considered conservative estimates of the gains in poverty reduction.

**Table 2.7 Costs of Organic Agriculture Compared to Gains**

Case Study (costs in \$)	PRC		Sri Lanka	Thailand
	Wanzai	Wuyuan	Kandy	Ubon Ratchathani
Cost of OA per farmer p.a.	30.5	13.5	173	26
Gain in net income p.a.	541	125	271	254
HH in poverty pre-OA	58%	50%	0%	50%
Increase in Income	370%	100%	105%	62%
Cost per HH (out of poverty)	67	54	–	136
Cost per person (out of poverty)	4.40	4.40	4.61	4.27
No. of persons in each HH	15.2	12.3	–	31.8

– = data not available, PRC = People's Republic of China, HH = household, OA = organic agriculture, p.a. = per annum.

Notes:

1. Costs of adoption of OA are taken from previous tables in this chapter. Averages have been used where more than one estimate was available.
2. Gains in net income are based on estimates in Chapter 1 of this volume, as well as some supplementary analysis in the cases of the PRC and Sri Lanka. For Thailand, the increase is the average for 2005 and 2006, taken from Table 1.1 of Chapter 1.
3. Percentages of households in poverty (defined as less than \$1 a day per person) are taken from the individual case study data.
4. Increases in income are taken from Chapter 1 combined with basic data on incomes from the case studies. For the Thailand case study, the increases in income for farmers with less than 10 rai of land (Table 1.2, Chapter 1 of this volume) were taken on the assumption that poor households will be those with smaller landholdings. For the other case studies, the increases are based on supplementary analysis of the underlying data.
5. Numbers in each household are from the individual case study data.

Source: Based on data collected from local sources in individual case studies.

percentage brought out of poverty (given the percentage that are in poverty).⁹ Table 2.7 reveals some interesting findings:

1. In all four cases, the gains in income per household exceed the amortized cost of adoption of organic agriculture. The margin is greatest for the PRC and smallest for Sri Lanka. In fact, at

⁹ The method is explained in the Appendix 2.3.



the lower end of the range of income increases (particularly for Sri Lanka), the costs of adoption and the gains are similar in value. As noted, however, the costs of adoption of organic agriculture in Sri Lanka are unrealistically high.

2. The cost per household taken out of poverty can only be calculated for the PRC and Thailand cases; in Sri Lanka, no households (conventional or organic) are classified as poor. In the other two cases, the costs of taking one household out of poverty are remarkably similar, ranging from \$136 to \$169. This translates into a cost of \$32–\$38 per farmer.
3. The cost per household taken out of poverty can only be calculated for the PRC and Thailand cases; in Sri Lanka, no households (conventional or organic) are classified as poor. In the other two cases, the costs of taking one household out of poverty are remarkably similar, ranging from \$136 to \$169. This translates into a cost of \$32–\$38 per farmer.

Comparing these costs with those in section 2.2 of this chapter, we find that they are considerably lower. Based on the World Bank study referred to earlier (Devarajan, Miller, and Swanson 2002), the cost of achieving the MDG of halving the percentage of households in poverty comes out to around \$554–\$880 per head. The costs of poverty reduction through the adoption of organic agriculture in these two countries are about one-twentieth of that amount. We need to qualify this, however, by noting that the investment and growth approaches to meeting the MDGs also provide other benefits of growth (e.g., increases in incomes of the nonpoor), which should be taken into account. On the other hand, the organic agriculture program also provides nonincome poverty benefits, which are not measured here.

Based on the cost comparison above, organic agriculture comes out as cost-effective. However, it should be noted that the estimates in both the World Bank study and this chapter's case studies are very rough, as shown in possible ranges for both estimates of adoption costs and net income gains.¹⁰ Nevertheless, the figures indicate that organic agriculture can contribute to poverty reduction in a reasonably cost-

¹⁰ We should be particularly careful of the estimates for Thailand, where the gains in net income showed a very wide range. As noted in the synthesis chapter by Setboonsang and Markandya (2009), these are probably due to special conditions in the market in 2005, when conventional farmers were offered higher than market prices.



effective way. In addition to the direct impact on poverty, there are notable benefits in employment generation and income diversification. Although these cannot be quantified in terms of the MDGs directly, they undoubtedly contribute to income and food security, and thereby also to poverty alleviation, as well as to improving education, health, and environmental sustainability. Table 2.8 summarizes the additional benefits from organic agriculture as far as they are directly related to the other MDGs in the following areas:

- Higher educational spending (Wanzai and Ubon Ratchathani).
- Greater gender equality (Kandy and Ubon Ratchathani)
- Child and maternal health (Wanzai and Kandy)
- Environmental sustainability (all four, but especially Wanzai and Kandy)
- Global partnership for development (all four case studies).

These benefits are difficult to quantify in terms of the MDGs and targets as outlined earlier, but are real and important, and are additions to the gains in net income and the reductions in poverty as described in Table 2.8. The World Bank study described in section 2.2 made the unsubstantiated assumption that an expenditure of \$40 million–\$60 million, if used to finance income growth, would also finance the achievement of the other MDGs; it also added that if a similar amount were used to finance

Table 2.8 Gains from Organic Agriculture in Terms of Other Millennium Development Goals

Case Study	People’s Republic of China		Sri Lanka	Thailand
	Wuyuan	Wanzai	Kandy	Ubon Ratchathani
Universal primary education	There is nothing to separate the two groups of households: organic agriculture (OA) and conventional agriculture (CA) households.	Education-related data favor OA households: (i) education expenses, (ii) number of household members who dropped out of school, and (iii) number of illiterate members.	Same spending on education (OA and CA households).	OA households spend more in per capita terms on education than CA households, but the differences are not statistically significant.

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Table 2.8 *continued*

Case Study	People's Republic of China		Sri Lanka	Thailand
	Wuyuan	Wanzai	Kandy	Ubun Ratchathani
Gender equality	There is nothing to separate the OA and CA groups of households.	Women in OA households are 7% more likely to be involved in decision making concerning farming, but no more likely to decide on how to spend the household's money. Differences in who decides which children will go to school or what should be spent on health care are insignificant between OA and CA households.	A greater percentage of OA husbands share household duties; a greater percentage of women are involved in decisions about schooling and farming practices.	The difference between female-headed households among OA and CA farmers is statistically significant. Income from the main job of women from OA households averaged B6,033 higher than women from CA households. Women from OA households are more likely to attend training courses and be members of outside groups.
Child mortality/ maternal health	In terms of maternal and child health, the two groups are very similar with no statistically significant differences.	More OA mothers go to health centers during the first 3 months of pregnancy and members of OA households have twice as many sick days than CA households. OA households spend about 30% more on health care, but the difference is not statistically significant.	OA households experience shorter travel times to health centers and spend more on children's health. They are also better trained to deal with pesticides.	CA households spend more on direct health care but less on toiletries and water use on a per capita basis than OA households. Thus, the results are mixed on these indicators.

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Table 2.8 *continued*

Case Study	People's Republic of China		Sri Lanka	Thailand
	Wuyuan	Wanzai	Kandy	Ubun Ratchathani
Environmental sustainability	OA households are more aware of health problems associated with pesticide applications and are significantly more likely to have received some training on alternative pest use and pest management.	OA households are much more aware of pesticide risks than CA households. They are also much more likely to use legumes for mulching and household waste for compost.	OA households are more likely to use virtually all methods of environment-friendly farming than CA households.	There is much greater variability in expenditure on water, fuel, and electricity among CA households, which suggests some are using these resources inefficiently.
Global partnership for development	OA households spend more on house expansion than CA households.	The percentage of households that have improved their houses and the expenditures on such improvements are higher for OA households.	OA increases social capital by getting households to join farmer associations and cooperative groups, much more than CA households.	OA households are more likely to be trained, to participate in government projects and to spend more on water pumps, houses, and water tanks.

Source: Authors' analysis.

MDGs 2–8, the required reduction in poverty would result. In contrast, this study quantifies the contribution to poverty alleviation and provides qualitative evidence of its contribution to the other MDGs.

2.6 CONCLUSIONS

This chapter has provided estimates of the costs of organic agriculture programs, and set them in the context of the costs of attaining the MDGs. Data on the global costs of meeting the MDGs were converted into costs per head of poverty alleviation, per child educated, per child



whose death is avoided, etc. This was done to provide cost estimates that could be compared with the costs of the organic agriculture programs in the four case studies of Wanzai and Wuyuan (PRC), Kandy (Sri Lanka), and Ubon Ratchathani (Thailand). A detailed analysis of the programs resulted in cost estimates per farmer per year. These showed considerable variation across the case studies, suggesting that there is no clear structure to the costs of adopting organic agriculture. It also revealed that costs depend on the efficiency with which the organic agriculture adoption programs are run. The lowest-cost programs were more than 10 times less expensive than the highest-cost ones.

A further analysis of the gains resulting from organic agriculture adoption revealed that the costs per person taken out of poverty were much lower than the World Bank's estimates, which are either based on income growth in general, or on the detailed costs of meeting some of the more quantifiable MDGs (education, health, and environment). The respective estimates are \$554–\$880 per head for halving the percentage of households in poverty totals versus \$32–\$38 per head by engaging farmers in organic agriculture. Although the estimates are not directly comparable, the results suggest a role for targeted programs such as organic agriculture in providing a cost-effective solution to meeting the MDG for poverty alleviation (MDG 1).

As for the other MDGs, organic agriculture shows some contribution to them, although not quantifiable. Nonetheless, organic agriculture programs can contribute cost-effectively to poverty reduction in the countries studied. Still, some questions need to be addressed: do costs of organic agriculture conversion borne by farmers effectively impede organic agriculture adoption? If so, what measures can make the change more affordable? For instance, many developing countries in Eastern Europe have programs to subsidize farmers during the conversion period. Developing countries in other regions could learn from this experience.

This study also points out the high certification costs in all but the case of Thailand where the costs have declined over time. This suggests that public intervention to lower certification costs could be an effective strategy to lower the barrier to entry for the majority of farmers who wish to convert to organic agriculture. Capacity building of certification and accreditation bodies, as well as promoting participatory group involvement in training activities by farmers, should be supported.



As private sector firms that engage farmers to implement organic agriculture are effectively providing public services, i.e., reducing poverty while providing environmental services, scaling up such private sector participation by providing public support, such as risk guarantee programs, should be considered. For public support of organic agriculture to increase in a major way, further research is required. There is a need to examine the links between the income impacts of organic agriculture and the other nonincome impacts. For example, do increases in income provide a pathway to higher expenditures on health and education, and better provision of improved water supply and sanitation? We know that these goals are directly influenced by organic farming practices (e.g., organic agriculture benefits health by reducing exposure to pesticides and promotes reuse of agricultural waste, which can improve sanitation). The relative importance of these two pathways, however, and how they interact with each other are still to be established.

REFERENCES

- Bourguignon, F., C. Diaz-Bonilla, and H. Lofgren. 2008. Aid, Service Delivery, and the Millennium Development Goals in an Economy-Wide Framework. World Bank Policy Research Working Paper 4683. Washington, DC: World Bank.
- Devarajan, S., M. J. Miller, and E. V. Swanson. 2002. Goals for Development: History, Prospects and Costs. World Bank Policy Research Working Paper. Washington, DC: World Bank.
- Driscoll, T., D. I. Nelson, K. Steenland, J. Leigh, M. Concha-Barrientos, M. Fingerhut, and A. Prüss-Üstün. 2005. *The Global Burden of Disease Due to Occupational Carcinogens*. http://www.who.int/quantifying_ehimpacts/global/en/dalys.pdf (accessed 27 October 2009).
- Markandya, A. 2006. Water Quality Issues in Developing Countries. In R. Lopez and M. A. Toman, eds. *Economic Development and Environmental Sustainability*. New York, NY: Columbia University Press.
- Rosegrant, MW, C. Ringler, et. al. 2005. *Agriculture and Achieving the Millennium Development Goals*. Washington: Agriculture and Rural Development Department. Washington DC: World Bank.



United Nations. 2004. *World Population Tables*. Department of Economic and Social Affairs, Population Division, ST/ESA/SER.A/236. New York, NY.

World Bank. 2012. *Global Monitoring Report 2012: Food Prices, Nutrition and the MDGs*. Washington, DC: World Bank.



Appendix 2.1 TARGETS AND INDICATORS FOR MILLENNIUM DEVELOPMENT GOALS 1-7

Goal	Targets	Indicators
Eradicate extreme poverty and hunger	Halve between 1990 and 2015 the proportion of people whose income is less than \$1 per day.	<ul style="list-style-type: none"> • Proportion of population below \$1 per day • Poverty gap ratio (incidence × depth of poverty) • Share of poorest quintile in national consumption
	Halve between 1990 and 2015 the proportion of people who suffer from hunger.	<ul style="list-style-type: none"> • Prevalence of underweight children (under 5 years of age) • Proportion of population below minimum level of dietary energy consumption
Universal primary education	Ensure that, by 2015, children everywhere, boys and girls alike, will be able to complete a full course of primary schooling.	<ul style="list-style-type: none"> • Net enrollment ratio in primary education • Proportion of pupils starting grade 1 who reach grade 5 • Illiteracy rate of 15–24-year-olds
Gender equality and empower women	Eliminate gender disparity in primary and secondary education, preferably by 2005, and to all levels of education no later than 2015.	<ul style="list-style-type: none"> • Ratio of girls to boys in primary, secondary, and tertiary education • Ratio of literate females to males of 15–24-year-olds • Ratio of women to men in wage employment in the nonagriculture sector • Proportion of seats held by women in national parliament
Reduce child mortality	Reduce by two-thirds, between 1990 and 2015, the under-5 child mortality rate.	<ul style="list-style-type: none"> • Under-5 mortality rate • Infant mortality rate • Proportion of 1-year-olds immunized against measles
Improve maternal health	Reduce by three-quarters, between 1990 and 2015, the maternal mortality ratio.	<ul style="list-style-type: none"> • Maternal mortality ratio • Proportion of births attended by skilled health personnel
Combat HIV/AIDS, malaria and other diseases	Have halted by 2015 and begun to reverse the spread of HIV/AIDS.	<ul style="list-style-type: none"> • HIV prevalence among 15–24-year-old pregnant women • Contraceptive prevalence rate • Number of children orphaned by HIV/AIDS

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Appendix 2.1 *continued*

Goal	Targets	Indicators
	Have halted by 2015 and begun to reverse the incidence of malaria and other major diseases.	<ul style="list-style-type: none"> • Prevalence and death rates associated with malaria • Proportion of population in malaria risk areas using effective malaria prevention and treatment measures • Incidence of tuberculosis (per 100,000 people) • Proportion of tuberculosis cases detected and cured under directly observed treatment short course
Environmental sustainability	Integrate the principles of sustainable development into country policies and programs and reverse losses of environmental resources.	<ul style="list-style-type: none"> • Proportion of land area covered by forest • Land area protected to maintain biological diversity • Gross domestic product per unit of energy use (as proxy for energy efficiency) • Carbon dioxide emissions (per capita)
	Halve by 2015 the proportion of people without sustainable access to safe drinking water.	<ul style="list-style-type: none"> • Proportion of population with sustainable access to an improved water source
	By 2020 to have achieved a significant improvement in the lives of at least 100 million slum dwellers.	<ul style="list-style-type: none"> • Proportion of people with access to improved sanitation • Proportion of people with access to secure tenure (urban/rural)

Source: United Nations Millennium Development Goals.



Appendix 2.2 MILLENNIUM DEVELOPMENT GOAL 8

Goal	Targets	Indicators
Develop a global partnership for development	<p>Address the special needs of the least developed countries (LDCs).</p> <p>Address the special needs of landlocked countries and small island developing states.</p> <p>Develop further an open, rule-based, predictable, nondiscriminatory trading and financial system.</p> <p>Deal comprehensively with the debt problems of developing countries through national and international measures to make debt sustainable in the long term.</p>	<ul style="list-style-type: none"> • Net official development assistance (ODA) as percentage of the Organisation for Economic Co-operation and Development (OECD) Development Assistance Committee (DAC) donors' gross national product (targets of 0.7% in total and 0.15% for LDCs) • Proportion of ODA to basic social services (basic education, primary health care, nutrition, and safe water and sanitation) • Proportion of ODA that is untied • Proportion of ODA for the environment in small island developing states • Proportion of ODA for the transport sector in landlocked countries <p><i>Market access</i></p> <ul style="list-style-type: none"> • Proportion of exports (by value and excluding arms) admitted free of duties and quotas • Average tariffs and quotas on agricultural products, and textiles and clothing • Domestic and export agricultural subsidies in OECD countries • Proportion of ODA to help build trade capacity <p><i>Debt sustainability</i></p> <ul style="list-style-type: none"> • Proportion of official bilateral debt canceled of heavily indebted poor countries (HIPC) • Debt service as a percentage of exports of goods and services • Proportion of ODA provided as debt relief • Number of countries reaching HIPC decision and completion points
	<p>In cooperation with developing countries, develop and implement strategies for decent and productive work for youth.</p>	<ul style="list-style-type: none"> • Unemployment rate of 15–24-year-olds

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Appendix 2.2 *continued*

Goal	Targets	Indicators
	In cooperation with pharmaceutical companies, provide access to affordable essential drugs in developing countries.	<ul style="list-style-type: none">• Proportion of population with access to affordable essential drugs on a sustainable basis
	In cooperation with the private sector, make available the benefits of new technologies, especially for information and communication.	<ul style="list-style-type: none">• Telephone lines per 1,000 people• Personal computers per 1,000 people

Source: United Nations Millennium Development Goals.



Appendix 2.3 ESTIMATING THE COST PER HOUSEHOLD TAKEN OUT OF POVERTY BY ORGANIC AGRICULTURE

This is an estimate of the increase in income per household as a result of the organic agriculture program, as well as the percentage of households who are poor prior to joining the program. The definition of the variables is as follows:

Variable	Definition
π	Percentage of adopting households who are poor
λ	Ratio of net income after-adoption to before-adoption
P	Total population covered by the program
p	Costs of adoption of program
T	Income below which households is considered poor

The distribution of the poor households below the poverty line is taken to be rectangular. A proportionate increase in incomes for all households changes the distribution as shown in Figure A2.3.1. The share of households taken out of poverty can be written as

$$\left[\frac{(\lambda T - T)(c')}{(T)(c')} \right] = 1 - \frac{1}{\lambda}.$$

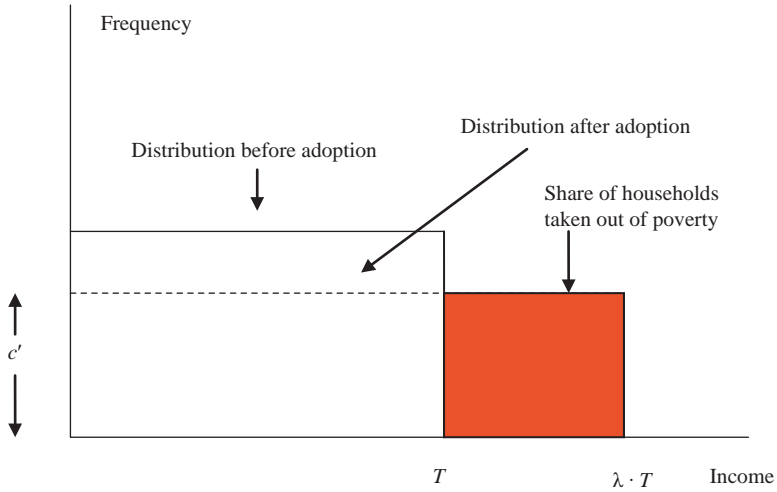
The cost per person brought out of poverty can then be written as

$$\frac{pP}{\pi(1 - \frac{1}{\lambda})(P)} = \frac{p}{\pi(1 - \frac{1}{\lambda})}.$$

Data are available for all the three variables on the right-hand side of the equation.



Figure A2.3.1 Frequency Distribution of Poor Households by Income



Source: Authors' illustration.



Chapter 3 | Can Ethical Trade Certification Contribute to the Attainment of the Millennium Development Goals? A Review of Organic and Fair-trade Certification¹

Sununtar Setboonsarng

3.1 INTRODUCTION

The rise of ethical consumerism, where people are putting their money on healthier, greener, and more social-friendly production systems, has rapidly expanded “ethical trade”² in developed countries. In 2002, ethical consumerism³ in the United Kingdom alone was estimated at £20 billion⁴ (Cooperative Bank 2003, cited in Low and Davenport 2008). In 2009, fair-trade-certified sales, which are part of the ethical trade market, reached approximately £3.4 billion in 2009.⁵ Among “ethical

¹ First published as Setboonsarng, S. 2008. “Can Ethical Trade Certification Contribute to the Attainment of the Millennium Development Goals? A Review of Organic and Fair-trade Certification” ADBI Discussion Paper 115. Tokyo: Asian Development Bank Institute. Available: <http://www.adbi.org/discussion-paper/2008/08/25/2675.organic.fairtrade.certification/>

² Ethical trade means that retailers, brands, and their suppliers take responsibility for improving the working conditions of the laborers who make the products they sell. These workers are often based in poor countries with inadequate or unenforced workers’ rights. Companies with a commitment to ethical trade adopt a code of labor practice that they expect their suppliers to adhere to, such as on issues like wages, hours of work, health and safety, and the right to join free trade unions. (<http://www.ethicaltrade.org/about-eti>).

³ Ethical consumerism can be defined as the practice of purchasing products and services produced in a way that minimizes social and/or environmental damage, while avoiding products and services deemed to have a negative impact on society or the environment (see <http://www.igd.com/our-expertise/Sustainability/Ethical-social-issues/3429/Ethical-Consumerism/>).

⁴ Estimated at \$30.20 billion using the 2013 exchange rate of \$1.51 per £1.00.

⁵ Estimated at \$5.13 billion using 2013 exchange rate of \$1.51 per £1.00 (see http://www.fairtrade.net/facts_and_figures.0.html).



trade” items, organic food has been rapidly growing in the last decades. It started from a small base in the 1980s, and in 2012, global sales of organic food and drinks have approached \$64 billion (Willer and Lernoud 2014). Farmers from the developing world participating in ethical trade stand to gain from this recent market trend.

With increased agritrade comes the development of the agriculture sector, which is a key component in attaining the Millennium Development Goals (MDGs). The majority of the poor worldwide depend on this sector for their livelihood; roughly 730 million are employed in agriculture in Asia, mostly as informal workers (ILO 2013). Although poor farmers can potentially provide environmental services while improving their livelihood, the lack of incentives in the current agriculture trade system, which undervalues the potential social and economic services of agri-products, hampers their involvement. While development assistance projects by governments have traditionally provided support for the poor to protect the environment, results have been mixed and most projects are unsustainable beyond the implementation period. Under ethical agritrade, however, the private sector is engaged using market-based instruments that internalize the externalities of products and provide a sustainable solution that can incentivize small farmers.

The rising demand for organic and fair-trade products has also provided additional income-generating opportunities for poor farmers in developing countries, particularly in the export market. Compliance with certification guidelines of production systems and certification of products is required in order to participate in such trade. In return, agri-producers receive price premiums, ranging from 20% to as much as 300% in case of African organics (Forss and Lundström 2004). The Export Promotion of Organic Products from Africa (EPOPA) project suggests that 44% of the total benefits from organic agriculture come from farmers’ premiums (ESCAP 2002). A study by Harris et al. (2001) revealed that roughly half the farmers’ accrued premiums directly benefited the farmers themselves. In this sense, ethical trade serves as an effective market-based development strategy that incorporates incentives through increased incomes while potentially contributing to the attainment of the MDGs (Setboonsarng 2006).



3.2 ORGANIC AGRICULTURE AND CERTIFICATION: AN OVERVIEW

3.2.1 Demand for Organic Produce

Organic agriculture is a farming system that excludes the use of synthetic chemicals such as fertilizers, pesticides, or antibiotics in both crop and livestock farming. Such a production system is perceived to produce quality crops in an eco-friendly manner. This is particularly important in the age of global agri-food trade where rising concerns over food safety and climate change have led to a growing demand for socially and environmentally produced commodities such as organic food. Despite the global economic downturn since 2008, the organic market continues to grow. In the United States, more households bought organic produce in 2011 (36%) than in 2010 (32%). In the People's Republic of China (PRC), its value quadrupled in the last 5 years and organic sales in Asia are expected to grow by 20% in the next 3 years (Soil Association 2012).

The supply–demand gaps in developed countries generate opportunities for farmers in developing countries to produce and export organic products attracted by the price premiums that organic produce fetch in international markets. More recently, developing countries have begun promoting organic agriculture in view of its other nonincome benefits such as improved household health, food security, and environmental conservation (see Chapter 1).

3.2.2 Types of Organic Certification

For the poor farmers to benefit from the growing trade in organics, they need to comply with the importing standards of target markets abroad. In addition, their produce must be certified by accredited organizations or agencies, particularly those recognized internationally. This ensures that consumers buy real organic products, and not the chemically grown kind falsely labeled as organics. There are three classifications of organic certification systems:

First-party certification: In the 1980s, organic agriculture was promoted by grassroots organizations or nongovernment organizations (NGOs) composed of consumers and farmers who sought alternative methods of food production as well as product distribution systems.



At that time, organic food was sold directly to consumers through community-supported events such as farmers' markets, or through box distribution schemes. This type of arrangement emphasized face-to-face relationships and trust, rather than formal certification, and was critical in building confidence in the integrity of organic products. This arrangement is classified as first-party certification or self-claimed organic certification, done at the community level or by individual groups of farmers. Self-claimed certification can suffice if the market size is small and concentrated in a local area. The group-claimed certification or community-based certification is sometimes known as a "participatory guarantee system." These participatory systems are perceived as more credible than individual ones and are able to deliver a higher volume of produce to a wider market.

Second-party certification: As markets expanded beyond local areas, face-to-face relationships became less feasible. As a result, many NGOs and traders who continued to maintain close contacts with farmers acted as trading agents, and provided consumers with information about farmers and their production processes. This type of arrangement wherein a trading agent ensures product quality is classified as second-party certification. The effectiveness of second-party certification depends largely on the trading agent's reputation. This concept may be compared to the branding of products or the so-called franchising of agriculture. Many supermarkets are using this system for their organic products.

Third-party certification: As trade in organic products expanded across borders, a more standardized system of certification was developed to provide information across borders efficiently and, in so doing, reduce time and costs. Through this arrangement, national and international organic standards were introduced to organic agriculture farmers. An impartial third-party certifier reviews the production process to confirm compliance with standards. This is known as third-party certification.

Today, these three certification systems coexist in the market. However, in the context of international trade and developing global partnerships for large-scale poverty reduction, third-party certification remains the most efficient.



3.1.3 Organic Standards

The earliest organic standards were developed independently by private associations. Some groups started their own certification systems to assure buyers that their organic products were produced according to the supposed standards (FAO 2001; Rundgren 2002). Standardized international guidelines existed only when the International Federation of Organic Agriculture Movements (IFOAM) published its Organic Standards in 1980. The IFOAM Basic Standards (IBS), together with the Codex Alimentarius Guidelines for organic agriculture were adopted in 1999, and have since been the international guidelines used by national and private standard setters (Rundgren 2002).

As the demand for organic products increased and more conventional distribution networks such as supermarkets entered the market, the development of organic standards and certification gained momentum. Many countries have defined their own standards, while certain private associations continue to develop and use their own organic labeling systems.

The current organic certification system requires third-party certification before a product can be labeled organic. Organic certification verifies that the product has been produced, stored, processed, handled, and marketed according to the appropriate organic standards (IFOAM 2005; FAO 2001).

3.3 ORGANIC CERTIFICATION AND THE MILLENNIUM DEVELOPMENT GOALS: LINKAGES AND IMPACTS

National, regional, and private organic standards⁶ imposed by major trading companies must be complied with by producers from developing countries if they wish to acquire a respectable share of the global market for organic products. These standards are more likely to be advanced and extensive with regard to the subject areas covered, including those related to social justice. As such, they have a potentially broader

⁶ For more information on standards that informed this chapter, please see <http://www.organicrules.org>. The website has a comprehensive database and information on the differences between national and private organic standards in Europe, as well as some entries on the United States Department of Agriculture National Organic Program (USNOP). A comprehensive database such as www.organicrules.org facilitates not only a comparison of standards, but also places the groundwork for standardization. Development of similar databases in developing countries would be of great benefit.



impact on poverty reduction and on the MDGs. With the IBS used as the benchmark, the following standards are evaluated vis-à-vis their possible impacts on the MDGs.

National/regional standards:

1. Council Regulation (European Union regulation of the European Council No. 2092/91) No. 2092/91 for organic production (EEC 1991)
2. United States Department of Agriculture National Organic Program (USNOP) regulations (USDA 2004)
3. Japanese Agricultural Standard (JAS) of organic agricultural products (MAFF 2005)

Private standards:

4. Bio Austria
5. Bio Suisse
6. Demeter International (Germany)
7. Naturland (Germany)
8. Soil Association (United Kingdom)

3.3.1 Main Findings on Organic Certification and Millennium Development Goals

Despite variations in specific standards, there was a high degree of concurrence on the basic principles governing crop production, including crop rotation, soil fertilization, and the use of synthetic inputs. There was less concurrence, however, on environmental management issues such as ecosystem management, habitat protection, and energy and water conservation. The above national standards tend to address these issues indirectly through crop production standards related to crop rotation or soil fertilization. By contrast, certain private standards address these issues more directly.

The area of least agreement is on principles and standards for social justice, which is crucial in strengthening the impacts of organic certification on the MDGs in the areas of education and health. Although social justice is covered in the IBS, among the eight national and private standards reviewed, only the Naturland standards discuss it. As expected, private standards tend to be more extensive and stricter compared to national standards. National standards tend to put more stress on the basic treatment of regulations imposed and subject areas covered. Table 3.1 presents the main findings of the review.



In general, the conditions set forth in organic certification on the elimination of agrototoxic use in production systems impacts four MDGs: mainly MDG 1 (poverty and hunger) and MDG 7 (environmental sustainability), and, to a lesser extent, MDGs 4 and 5 (child and maternal health, respectively). The contribution of organic certifications on other MDGs is not specific since national organic standards hardly include provisions for social aspects. Most social impacts of organic certification, such as education improvement due to higher income and increased social capital through organizational activities of farmers' groups, are achieved indirectly.

Based on reviews of the developmental experience of organic agriculture among smallholders, particularly for the export market, it appears that organic farmers often join fair-trade arrangements. As fair-trade arrangements primarily promote social justice and accountability, it satisfactorily supplements organic certification, which deals mainly with the technical aspects of production.

3.4 FAIRTRADE CERTIFICATION AND COMPLEMENTARY ARRANGEMENTS

3.4.1 Fairtrade Certification

Fairtrade certification was developed and reviewed under the informal umbrella of Fairtrade Labelling Organizations (FLO) International, a multistakeholder association including producer networks, labeling initiatives, traders, and experts. The FLO has two strategic objectives: (i) to deliberately work with marginalized producers and workers to relocate them from a position of vulnerability, and help them attain security and economic self-sufficiency; and (ii) to empower both producers and laborers as stakeholders in their own organizations to play a wider and more active role in the global arena to achieve equitable terms of trade.

For a product to be labeled Fairtrade, it must meet the international standards set by the FLO. The certification is done by an independent international certification company under the FLO umbrella. The FLO has two sets of generic producer standards. The first set applies to small farmers or smallholders organized in cooperatives or other



Table 3.1 Organic Certification and the Millennium Development Goals

Area Covered by Standards	Expected Areas of Impact	IFOAM Basic Standards (IBS)	Comparison of National and Private Organic Standards
Crop rotation	<p>MDG 1: Eradicate extreme poverty and hunger</p> <ul style="list-style-type: none"> • Target 1: Halve, between 1990 and 2015, the proportion of people whose income is less than \$1 a day. • Target 2: Halve, between 1990 and 2015, the proportion of people who suffer from hunger. 	<p>The standards state that the diversity of plant production activities shall be assured by minimum crop rotation requirements and/or an array of plantings.</p> <p>For annual crops, minimum rotation practices shall be established, unless the operator demonstrates diversity in plant production by other means.</p> <p>For perennial crops, the certifying body shall set minimum standards for orchard/plantation floor cover and/or diversity of refuge plantings in the orchard.</p>	<p>The EEC Regulation, USNOP, and JAS standards specify the crop to be used in rotation but do not specify the minimal share for each crop in the rotation.</p> <p>Demeter International is more precise regarding methods for the design of adequate crop rotation.</p> <p>Naturland sets the minimum share of legumes in crop rotation at 20% (with exemptions).</p> <p>Soil Association standards provide detailed and specific rules regarding the types of crop and their sequence in the rotation.</p>
	<p>MDG 7: Ensure environmental sustainability</p> <ul style="list-style-type: none"> • Target 9: Integrate principles of sustainable development into country policies and programs and reverse the loss of environmental resources. 		
	<p>Crop rotation contributes to soil fertility by mitigating soil nutrient losses and by encouraging nutrient cycling.</p>		

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Table 3.1 continued

Area Covered by Standards	Expected Areas of Impact	IFOAM Basic Standards (IBS)	Comparison of National and Private Organic Standards
Ecosystem management/habitat conservation	<p>MDG 7: Ensure environmental sustainability</p> <ul style="list-style-type: none"> • Target 9: Integrate principles of sustainable development into country policies and programs and reverse the loss of environmental resources. • Target 25: Increase the proportion of land area covered by forest. • Target 26: Increase the ratio of protected surface areas to maintain biological diversity. 	<p>The standards recognize that the quality of ecosystems benefits from organic agriculture, and thus, further specified measures for ecosystem management that go beyond simple production methods. This is reflected in the following standards:</p> <ul style="list-style-type: none"> • Operators shall take measures to maintain and improve landscape and to enhance biodiversity quality. • Clearing of primary ecosystems is prohibited. 	<p>No specific recommendations or requirements relating to environmental management or habitat conservation are included in the EEC Regulation, USNOP, or JAS. However, the USNOP indirectly addresses this issue in their standards on wild crop harvesting, i.e., “A wild crop must be harvested in a manner that ensures that such harvesting or gathering will not be destructive to the environment and will sustain the growth and production of the wild crop.”</p>
			<p>As with the USNOP, a number of private standards likewise refer to this issue through regulations on the harvesting of wild crops. Demeter International requires extensive diversification within the farm. They further require that at least 7% of farmland be dedicated to ecologically diversified areas.</p>

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Table 3.1 continued

Area Covered by Standards	Expected Areas of Impact	IFOAM Basic Standards (IBS)	Comparison of National and Private Organic Standards
<p>Energy use/ production of greenhouse gases (climate change)</p>	<p>MDG 7: Ensure environmental sustainability</p> <ul style="list-style-type: none"> • Target 9: Integrate principles of sustainable development into country policies and programs and reverse the loss of environmental resources. • Target 27: Regulate energy use (kilograms of oil equivalent) per \$1 of GDP (PPP). • Target 28: Reduce CO₂ emissions (per capita) and consumption of ozone-depleting CFCs (ODP tons). 	<p>The standards did not specifically address energy use and production of greenhouse gases, although their standards governing soil fertilization could have an impact.</p> <p>More specifically, the standards that promote the recycling of plant and animal wastes could also help by minimizing the use of nonrenewable resources (for details, see “Soil fertility and fertilization”).</p>	<p>Natural and ecosystems state that structuring elements of the landscape, such as hedges, borders, humid areas, and oligotrophic grasslands, must be preserved or recreated if required.</p> <p>Soil Association standards contain detailed recommendations and requirements concerning environmental management and the conservation of landscape features, semi-natural habitats, and wild species on the farm.</p>
<p>Energy use/ production of greenhouse gases (climate change)</p>	<p>MDG 7: Ensure environmental sustainability</p> <ul style="list-style-type: none"> • Target 9: Integrate principles of sustainable development into country policies and programs and reverse the loss of environmental resources. • Target 27: Regulate energy use (kilograms of oil equivalent) per \$1 of GDP (PPP). • Target 28: Reduce CO₂ emissions (per capita) and consumption of ozone-depleting CFCs (ODP tons). 	<p>The standards did not specifically address energy use and production of greenhouse gases, although their standards governing soil fertilization could have an impact.</p> <p>More specifically, the standards that promote the recycling of plant and animal wastes could also help by minimizing the use of nonrenewable resources (for details, see “Soil fertility and fertilization”).</p>	<p>Bio Austria and Bio Suisse regulate the heating of greenhouses to address the environmental aspects of saving energy.</p>

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Table 3.1 continued

Area Covered by Standards	Expected Areas of Impact	IFOAM Basic Standards (IBS)	Comparison of National and Private Organic Standards
Soil fertility and fertilization	<p>MDG 7: Ensure environmental sustainability</p> <ul style="list-style-type: none"> • Target 9: Integrate principles of sustainable development into country policies and programs and reverse the loss of environmental resources. • Target 27: Regulate energy use (kilograms of oil equivalent) per \$1 of GDP (PPP). • Target 28: Reduce CO₂ emissions (per capita) and consumption of ozone-depleting CFCs (ODP tons) • MDG 4: Reduce child mortality (indirect) • MDG 5: Improve maternal health (indirect) <p>Organic agriculture eliminates the health risks associated with pesticide use or exposure.</p>	<p>The standards state the following:</p> <ul style="list-style-type: none"> • Material of microbial, plant, or animal origin shall form the basis of the organic fertilizers. • Nutrients and fertilizers shall be applied in a way that protects soil, water, and biodiversity. • Restrictions may be based on amounts, location, timing, treatments, methods, or choice of inputs applied. 	<p>The EEC Regulation restricts the use of farmyard manure to not more than 170 kg N/ha/year. There are no other restrictions. The USNOP identifies approved fertilizers but does not specify any limits to their application. Bio Austria's standard is stricter than the EEC Regulation; it requires a limit of 170 kg N/ha for organic manure in general, and not only for farmyard manure. It also prohibits the use of some products permitted under the EEC Regulation.</p> <p>Bio Suisse standards limit the amount of nitrogen and phosphorous input per hectare to a maximum of 2.5 LSU/ha. Individual limits are also set by Demeter International for each crop.</p>

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Table 3.1 continued

Area Covered by Standards	Expected Areas of Impact	IFOAM Basic Standards (IBS)	Comparison of National and Private Organic Standards
<p>Water management/conservation</p> <p>MDG 7: Ensure environmental sustainability</p> <ul style="list-style-type: none"> • Target 10: Halve, by 2015, the proportion of people without access to safe drinking water and basic sanitation. • Target 30: Increase the proportion of population with sustainable access to an improved water source, urban and rural. <p>MDG6: Combat HIV/AIDS, malaria, and other diseases (indirect)</p> <p>Better water management reduces the risk of waterborne diseases such as malaria.</p>	<p>The standards provide the following:</p> <ul style="list-style-type: none"> • Grazing management shall not degrade land or pollute water resources. • Relevant measures shall be taken to prevent or remedy soil and water salinity. • Operators shall seek to preserve water quality and shall not deplete or excessively exploit water resources. They shall, where possible, recycle rainwater and monitor water extraction. 	<p>The USNOP states that organic practices must maintain or improve the natural resources of the operation, including soil and water quality. Naturland has standards on the use of water resources.</p>	
<p>Social justice</p> <p>MDG 3: Promote gender equality and empower women</p> <p>MDG 4: Reduce child mortality (indirect)</p> <p>MDG 5: Improve maternal health (indirect)</p> <p>MDG 8: Develop global partnerships for development</p> <p>Other aspects of poverty reduction, such as the right to organize and bargain collectively.</p>	<p>The standards provide the following:</p> <ul style="list-style-type: none"> • Operators shall have a policy on social justice. Operators who hire fewer than 10 laborers and those who operate under a state system that enforces social laws may not be required to have such a policy. • A product cannot be declared as organic in cases where production involves violation of basic human rights and clear cases of social injustice. 	<p>Only Naturland specifies standards for social responsibility. The standards are fairly extensive, covering employment, human rights, forced labor, freedom of association, access to trade unions, equal treatment and opportunities, child labor, and child labor, health, and safety. These standards came into force in 2005.</p>	

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Table 3.1 continued

Area Covered by Standards	Expected Areas of Impact	IFOAM Basic Standards (IBS)	Comparison of National and Private Organic Standards
		<ul style="list-style-type: none"> • Operators/producers should not use force or involuntary labor. • Employees and contractors of organic operations have the freedom to associate, the right to organize, and the right to bargain collectively. • Operators shall not be discriminatory, and shall provide their employees and contractors equal opportunities and treatment. • Employed children shall be provided with educational opportunities. 	

CFC = chlorofluorocarbon, EEC = European Union Regulation of the European Council, GDP = gross domestic product, IFOAM = International Federation of Organic Agriculture Movements, JAS = Japanese Agricultural Standard, kg N/h = kilogram of nitrogen per hectare, LSU/ha = livestock unit per hectare, MDG = Millennium Development Goal, ODP = ozone-depleting potential, PPP = purchasing power parity, USNOP = United States Department of Agriculture National Organic Program. Sources: United Nations MDGs, IFOAM, Council Regulation (EEC) No. 2092/91 for organic production 1991, USNOP regulations 2004, JAS of organic agricultural products, Bio Austria, Bio Suisse, Demeter International (Germany) 2005, Naturland (Germany) 2007a and 2007b, Soil Association (United Kingdom), Organic Rules Database; www.organicrules.org



organizations with a democratic, participative structure; and the second set applies to organized workers on plantations and in factories.⁷

The generic standards specify “*minimum requirements*” to obtain Fairtrade certification, which include conditions that producers are encouraged to improve over time. Progress requirements cover working conditions, product quality, environmental sustainability, and investments in the development of the organizations and their producers and/or workers (FLO 2006).

FLO trading standards stipulate that producers have to (i) pay laborers a salary that is enough to cover the costs of sustainable production and living, (ii) pay laborers a premium so that they can invest in development, (iii) allow partial advance payments when laborers ask for it, and (iv) use contracts that allow long-term planning and sustainable production practices (FLO 2006; Fairtrade Foundation 2006).

Fairtrade-labeled products are mostly related to specific commodities, such as coffee, cocoa, bananas, and tea. As of 2011, there were 991 certified producer organizations in 66 countries involving 1.24 million farmers and workers (FLO 2012).

Evidence suggests that organic certification together with Fairtrade certification can be a feasible and optimal combination for meeting the multiple objectives of the MDGs. Based on FLO case studies, impacts of Fairtrade certification include narratives on how it doubled farmers’ income, how it taught farmers better resource management procedures and raised school attendance of their children, and how farmers were consulted on current and future projects, among others.⁸ However, further empirical investigation is needed, particularly concerning the additional costs that may be involved with Fairtrade labeling.

⁷ For details, see

<http://www.fairtrade.net/pdf/sp/english/Generic%20Fairtrade%20Standard%20SF%20Dec%202005%20EN.pdf> and

<http://www.fairtrade.net/pdf/hl/english/Generic%20Fairtrade%20Standard%20Hired%20Labour%20Dec%202005%20EN.pdf>

⁸ More case studies reported in FLO International are at <http://www.fairtrade.net/sites/impact/stories.html>



3.4.2 Combination of Organic and Fairtrade Certification

Organic certification mainly involves the technical aspects of production, with the main objective of producing safe food while improving the environment. Since organic certification standards originated and evolved based on the existing conditions of farmers in developed countries, they are likely to favor farmers from temperate regions and developed countries, and may be biased against farmers from the South or from tropical zones. For instance, one of the major constraints identified by European importers of organic fruit and vegetables when it comes to trade with developing countries is organic certification issues. Similarly, in Japan and the United States, the introduction of national organic regulations made international trade with organic food products a bit more complicated and was sometimes seen as a trade barrier (UNCTAD 2003).

On the other hand, fair-trade certification has strong pro-poor features, having been developed based on the needs of small farmers in developing countries. fair-trade certification strives for long-term benefits for poor communities. For example, Fairtrade requires that producers organize themselves into democratic groups and/or associations, which allow them a higher level of collective action and bargaining power. Fairtrade also provides a guaranteed Fairtrade price premium that must be reinvested at the community level and not at the individual household level. In addition, it addresses the challenge of high certification costs for small-scale farmers by providing financial support during the start-up period. These unique features under fair-trade certification directly contribute toward Target 12 (develop open, rule-based, predictable, nondiscriminatory trading and financial systems) and Target 13 (address the needs of the least developed countries) of MDG 8.

One of the key benefits of this market-based instrument is that certification brings about the formation of smallholders' groups. Beyond facilitating information dissemination and collective bargaining, groups can help smallholders overcome marginalization and social exclusion, and can lead to the accumulation of social capital.

Organic and fair-trade certification seem to complement each other, and the combination of certain aspects of each could more effectively contribute to the achievement of the MDGs. Moreover, the potential for achieving the highest premiums is maximized when farms have both organic and fair-trade certification (ESCAP 2002). Table 3.2 outlines the



Table 3.2 Organic and Fairtrade Certification

Organic Certification	Fairtrade Certification
<p>Objectives of certification</p> <ul style="list-style-type: none"> • Concentrates on agricultural production methods, particularly the production of high-quality food while minimizing the environmental impacts. • Although social justice is included in the IFOAM Basic Standards, very few national and/or private standards have followed suit. 	<ul style="list-style-type: none"> • Issues are centered on social justice, dealing with multiple issues that can lead to improvements in the producers' quality of life. • The FLO has two sets of generic standards: one applicable for small farmers and another for plantations and factories. • The generic standards distinguish between "minimum requirements," which producers must meet in order to be certified, and "progress requirements" that encourage producer organizations to continuously improve working conditions and product quality, to increase the environmental sustainability of their activities, and to invest in the development of the organizations and their producers and/or workers (FLO 2006).
<p>Price premium</p> <p>Generally exists, but there is no guarantee that producers will get a significant share of the price premiums.</p>	<ul style="list-style-type: none"> • Guaranteed trade price premium; additional premium is given in the case of organic products. • Laborers are entitled to partial advance payments, when they ask for it.
<p>Long-term supply contracts</p> <p>No guarantee.</p>	<p>Guaranteed; trade relations are meant to have a long-term perspective.</p>
<p>Support given to the community</p> <p>No guarantee, given the absence of standards governing social justice.</p>	<p>Part of the premium is reinvested in the community and, in some cases, helps in the transition of the community from conventional production to organic production.</p>
<p>Formation of farmers' groups/associations</p> <p>Not required, although typically producers voluntarily establish one in order to reduce compliance costs.</p>	<p>Required; producers must be organized into democratic groups/associations.</p>

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Table 3.2 continued

Organic Certification	Fairtrade Certification
<p>Scope for “special and differential treatment”</p> <ul style="list-style-type: none"> Standards are uniform for producers from both developed and developing countries. Since standards were developed based on existing conditions of farmers in developed countries, it is partial toward organic agriculture in temperate zones. 	<p>Standards favor the situation in developing countries.</p>
<p>Cost of certification</p> <ul style="list-style-type: none"> No support mechanisms for producers. Generally shouldered by firm or producer. 	<p>Shouldered by the producer, although the producer can apply for financial assistance from the FLO Certification Fund or from a national FLO member (Fairtrade Foundation 2006).</p>
<p>Main benefits</p> <ul style="list-style-type: none"> Empirical evidence is strongest in the case of MDGs 1 and 7: Improved profitability/income Gains in productivity Gains in marginal areas where low-input traditional farming is the norm Improved environmental impact Empirical evidence is weaker and/or has mixed results for other MDGs (Markandya et al. 2010) 	<ul style="list-style-type: none"> Case studies reported by the FLO suggest that Fairtrade certification can have substantial impacts on multiple objectives of the MDGs (see http://www.fairtrade.net/sites/impact/stories.html) Meanwhile, Dankers (2003) reports that the Fairtrade price premium represents only a small part of the benefits, and that the success in farmers’ self-organization is far more important, and ultimately results in better bargaining positions, better credit worthiness, and economies of scale. A study prepared by Rotherham (2005) for UNEP further suggests that long-term supply contracts, which are a main feature of Fairtrade, may be a more important determinant of project sustainability than the price premium.

FLO = Fairtrade Labelling Organizations International, IFOAM = International Federation of Organic Agriculture Movements, MDG = Millennium Development Goal, UNEP = United Nations Environment Programme.

Sources: United Nations MDGs, IFOAM, Council Regulation (EEC) No. 2092/91 for organic production, United States Department of Agriculture National Organic Program (USNOP) Regulations, Japanese Agricultural Standard (JAS) of organic agricultural products, Bio Austria, Bio Suisse 2006, Demeter International (Germany) 2005, Naturland (Germany), Soil Association (UK).



key differences between organic certification and fair-trade certification, and how fair-trade could complement parts regarding social objectives where organic certification is lacking.

3.5 CHALLENGES

For poor farmers in marginal areas, improvements in natural resource management can lead to increased sustainable productivity and reduced poverty. While certification can potentially facilitate improvements in natural resource management, and contribute toward the achievement of the MDGs, there remain several problems that need to be solved. Small-scale farmers live in remote areas with minimal infrastructure, rampant market and institutional failures, and unsecured land tenures. They often lack the technical knowledge needed to comply with complex certification requirements and need external facilitation.

3.5.1 Organic Certification: “One Size Fits All”

As mentioned earlier, organic certification evolved in developed countries, where farmers are relatively well-educated and generally involved in large-scale agricultural production. These farmers are relatively well-equipped to comply with the intensive documentation needs, starting from farm history to production plans and to onerous day-to-day record-keeping of farm inputs and activities. By contrast, farming systems of the poor are small-scale and diverse which makes compliance with certification standards challenging. Given the small plots, the required buffer area separating chemical farms from organic farms makes it difficult to receive organic certification without support from the public sector. As ecosystems in developed and developing countries differ, scientific research is required to make the certification requirements more appropriate for each particular ecosystem. Nevertheless, there have been successful cases where NGOs or local governments have effectively facilitated the certification processes of organic farms providing lessons to be disseminated.

3.5.2 Who Pays for Third-Party Certification?

Organic certification requires third-party inspectors to visit the field to verify compliance. These are often inspectors from importing countries, making the total certification cost unrealistically high for farmers,



ranging from \$1,000–\$4,000 per year, depending on location, size of operation, and export destination requirements. In cases where products are to be exported to multiple countries, more than one certification is required. Thus, the potential profit from premium prices may be insufficient to cover the process of obtaining certification. Hence, the initial certification costs are usually covered by

- (i) *private sector firms*: international trading firms or retailers usually pay for the certification;
- (ii) *governments*: recognizing that organic certification offers positive externalities, the Government of Bhutan and the Government of Thailand have either partly or fully covered the cost of certification for farmers;
- (iii) *NGOs with external support*: many development projects provide funding through NGOs to support certification costs, including training costs; and
- (iv) *producer groups*: after the initial externally supported period, many farmers' groups are enabled to collectively pay for certification costs.⁹

In the case of Fairtrade certification, there are provisions supporting the setting up of certification systems for small-scale farmers. Before 2004, importers paid the cost of Fairtrade certification; since then, the FLO introduced a certification fee for producers. Producers can apply for financial assistance from the FLO's Certification Fund or from a national FLO member (Fairtrade Foundation 2006). These added costs are normally passed on to consumers in the form of higher prices for organic and Fairtrade products.

3.5.3 Transition Period and Land Tenure

For a conventional farm to be certified organic, a transition period of 2–3 years is required when yields may drop; hence, farmers would need external financial support. For marginal and small farmers in chemical-free areas, the transition period can be shortened, or even avoided as most of their farms are “organic by default,” facilitating their certification.

⁹ The certification cost is deducted from collective funds of the farmers' group, so individual farmers may not have even been aware that they are paying for the costs of certification.



Organic certification is also less likely to be obtained by farmers without secure land tenure, mainly because the return on investment only becomes apparent in the medium- to long-term. In the Philippines, farmers on leased land reported that they were forbidden by their landlords to convert to organic agriculture, as it could lead to difficulties in terminating lease contracts if the tenant had extensively invested in land improvements (author's field visit in 2003). This shows the importance of land tenure in using organic certification to achieve the MDGs.

3.6 CONCLUSIONS AND RECOMMENDATIONS

The growth of ethical consumerism has expanded the market for environmentally and socially certified products. Given rising demands, imports from developing countries rapidly increased to meet the growing demand. With the support of NGOs, donors, and governments of developing countries, a sizable portion of poor farmers in remote areas have benefited from organic and ethical trade.

While many wealthy farmers practice organic agriculture, the practice is mainly considered pro-poor, as it builds on the comparative advantages that poor farmers have, such as the relatively chemical-free land, the abundance of labor, and the traditional knowledge of chemical-free production methods. Recognizing these comparative advantages of the poor farmer, private sector firms have become engaged in contracting small farmers in remote areas to produce certified organic products for export and for local urban markets (Setboonsarng 2008). This development appears promising in contributing toward the achievement of the MDGs.

Yet, for small farmers to fully participate in a globalized trade in agriculture, they must comply with certification systems to guarantee the quality and production process of organic products. Certification has become a norm in international trade. While certification could act as a trade barrier for small farmers, it could also, when effectively facilitated, provide opportunities for farmers to participate in an open, rule-based, nondiscriminatory trading system, which is one of the targets of the MDGs.



As discussed, organic certification most directly contributes to MDG 1 (poverty and hunger) and MDG 7 (environmental sustainability, including climate change), and indirectly contributes to health-related MDGs through the elimination of the risk of exposure to toxic agrochemicals. Organic certification also enhances health and living conditions by improving sanitation and water quality. In addition, certified organic farmers are better equipped to claim carbon credit payments than noncertified farmers, as they have undergone the process of detailed farm monitoring and record keeping. This can be an added incentive for farmers to adopt certified sustainable practices that contribute to global public goods. Organic certification, however, does not directly address social aspects, so its contribution to the nonincome aspects of MDGs is indirect.

In terms of social justice and community strengthening, the conditions under fair-trade certification mainly address these aspects, as well as complement organic certification, which mainly deals with production process technicalities. fair-trade also contributes directly to MDG 8 (global partnerships for development), in particular targets 12 and 13 on open trade regimes. Thus, a combination of organic and fair-trade certifications would contribute to the comprehensive achievement of the MDGs.

While the evidence shows some benefits from organic certified production are being realized in terms of the MDGs, there are still a number of constraints that need to be addressed. While certification has a significant poverty reduction potential, the high costs, particularly for organic certification, which does not have built-in mechanisms to assist smallholders, need to be addressed.

Less expensive certification alternatives of “trust-based” certification arrangements should be explored, particularly by NGOs and donors, such as extending face-to-face communication through information and communication technology. Community-based certification and franchising of agriculture are other options. However, given limited public support, large food retailers emerge as the most effective actors in expanding the international trade potential of organic products as they are positioned to facilitate certification for poor farmers. The private sector also holds the key to translating effective demand and technical solutions into practical advice for poor farmers to adopt certified organic agriculture. The scale of poverty reduction impacts of



organic certification mainly rests on the entry of large food retailers in the organic sector of developing countries.

In order to increase the impact of “ethical trade” on poverty reduction, the public sector needs to play an active role in bringing down the costs of working with the poor, and join forces with the media to create a demand shift for “ethical trade” products, particularly on the following: (i) harmonizing standards and/or developing pro-poor regional standards; (ii) developing alternative marketing and certification systems; (iii) building up the private sector’s capacity as a certifying body; (iv) strengthening the capacity of the local government to oversee certification bodies and standards; (v) developing rural infrastructure, i.e., road, cold storage, etc.; (vi) addressing land tenure issues; (vii) supporting farmers’ organizations; (viii) strengthening institutional arrangements that are inclusive of the poor, i.e., various forms of direct and nondirect contract farming; (ix) supporting research and extension of organic agriculture for marginal ecosystems; (x) supporting the carbon credit process for organic agriculture and support organic agriculture to be included under the Clean Development Mechanism; (xi) providing incentives to firms, i.e., risk guarantee; and (xii) creating a competitive environment for the private sector to work with the poor, e.g., promoting organic contract farming.

As reflected in this chapter, the task of achieving the MDGs through the use of ethical trade certification, such as organic and Fairtrade, will require further cooperation among all stakeholders; that is, farmers, committed private entities, national and local governments, donors, NGOs, and academic communities.

REFERENCES

- Bio Suisse. 2006. *Bio Suisse Standards for the Production, Processing and Marketing of Produce from Organic Farming*. Edition as of 1 January 2006. Basel, Switzerland.
- Demeter International. 2005. *Demeter Production Standards as of June 2005*. Darmstadt, Germany.



- Dankers, C. 2003. *Environmental and Social Standards, Certification and Labeling for Cash Crops*. Technical Paper 2, Food and Agriculture Organization of the United Nations (FAO), Commodities and Trade. Rome.
- EEC (Council Regulation). 1991. *Council Regulate (EEC) No 2092/91/EEC of 24 June 1991 on Organic Production of Agricultural Products and Indications Referring thereto on Agricultural Products and Foodstuffs*. Consolidated text produced by the CONSLEG system of the Office for Official Publications of the European Communities. Luxembourg.
- ESCAP (United Nations Economic and Social Commission for Asia and the Pacific). 2002. *Organic Agriculture and Rural Poverty Alleviation*. Bangkok, Thailand.
- Fairtrade Foundation. <http://www.fairtrade.org.uk> (accessed in 2006).
- FAO (Food and Agriculture Organization of the United Nations). 2001. *World Markets for Organic Fruit and Vegetables – Opportunities for Developing Countries in the Production and Export of Organic Horticultural Products*. Rome.
- FLO (Fairtrade Labelling Organizations) International. 2012. *Monitoring the Scope and Benefits of Fairtrade. 4th Edition*. http://www.fairtrade.net/fileadmin/user_upload/content/2009/resources/2012-Monitoring_report_web.pdf
- _____. <http://www.fairtrade.net/index.html> (accessed in 2013).
- Forss, K., and M. Lundström. 2004. An Evaluation of the Program “Export Promotion of Organic Products from Africa,” Phase II. Commissioned by the Swedish International Development Cooperation Agency (Sida). <http://www.grolink.se/epopa/Publications/EPOPA-Phase-2-Evaluation-04.pdf>
- Harris, P.J.C., A.W. Browne, H.R. Barret, and K. Cadoret. 2001. *Facilitating the Inclusion of Resource-Poor in Organic Production and Trade: Opportunities and Constraints Posed by Certification*. A study for the Rural Livelihoods Department, Department for International Development (DFID) of the United Kingdom.



- IFOAM (International Federation of Organic Agriculture Movements). 2002. *IFOAM Basic Standards for Organic Production and Processing*. Approved by the IFOAM General Assembly, Victoria, Canada. August.
- ILO (International Labour Organization). 2013. *Global Employment Trends: Recovering from a Second Jobs Dip*. Geneva. http://www.ilo.org/global/research/global-reports/global-employment-trends/2013/WCMS_202326/lang--en/index.htm
- Low, W., and E. Davenport. 2008. Organizational Leadership, Ethics and the Challenges of Marketing Fair and Ethical Trade. *Journal of Business Ethics*. 86. pp. 97–108. <http://cftn.ca/sites/default/files/AcademicLiterature/organisational%20ethics.pdf>
- MAFF (Ministry of Agriculture, Forestry and Fisheries), Government of Japan. 2005. *Japanese Agricultural Standard of Organic Agricultural Products* (Notification No. 1605 of the MAFF of 27 October 2005) (Provisional Translation) Established: 20 January 2000, partial revision: 18 November 2003, full revision: 27 October 2005. Tokyo.
- Markandya, A., S. Setboonsarng, Y.H. Qiao, R. Songkranok, and A. Stefan. 2010. The Costs of Achieving the Millennium Development Goals by Adopting Organic Agriculture. ADBI Discussion Paper No. 193. <http://www.adbi.org/files/2010.02.09.wp193.cost.mdg.organic.agriculture.pdf>
- Naturland. 2007a. Naturland Standards on Production. Chapter III. Part A. May. <http://www.naturland.de/standards.html#c1443>.
- _____. 2007b. Naturland Processing Standards. Chapter IV. Part C. May. <http://www.naturland.de/standards.html#c1443>
- Organic Rules Database. *Analysis of EEC Regulation 2092/91 in Relation to Other National and International Organic Standards*. Organic Rules and Certification. Database of the EU Project, Organic-Revision. http://www.organic-revision.org/pub/D_3_2_final%20report_low.pdf



- Rotherham, T. 2005. *The Trade and Environmental Effects of Ecolabels: Assessment and Response*. Geneva: United Nations Environment Programme (UNEP). <http://www.unep.ch/etb/publications/Ecolabelpap141005f.pdf>
- Rundgren, G. 2002. *History of Organic Certification and Regulation*. First published in The Organic Standard. Issue No. 14. June. <http://www.grolink.se/Resources/studies/History%20of%20organic%20certificationL.pdf>
- Setboonsarng, S. 2006. Organic Agriculture, Poverty Reduction and the Millennium Development Goals. ADBI Discussion Paper No. 54. <http://www.adbi.org/discussion-paper/2006/09/07/2000.mdgs.organic.agriculture/>
- . 2008. Global Partnership in Poverty Reduction: Contract Farming and Regional Cooperation. ADBI Discussion Paper No. 89. <http://www.adbi.org/discussion-paper/2008/02/25/2491.global.partnership.poverty.reduction/>
- Soil Association. 2012. Organic Market Report 2012. <http://www.soilassociation.org/LinkClick.aspx?fileticket=5QS24GNSZTA%3d&tabid=116>
- UNCTAD (United Nations Conference on Trade and Development). 2003. *Organic Fruits and Vegetables from the Tropics: Market, Certification and Production Information for Producers and International Trading Companies*. Geneva.
- USDA (United States Department of Agriculture). 2004. *The National Organic Program – Regulatory Text* USDA NOP: 26 November.
- Willer, H. and J. Lernoud., eds. 2014. *The World of Organic Agriculture: Statistics and Emerging Trends 2014*. Bonn: IFOAM and Frick: FiBL.

PART II: Country Case Studies on Organic Agriculture



Chapter 4 | **Market-Based Certification and Management of Non-Timber Forest Products in Bhutan: Organic Lemongrass Oil, Poverty Reduction, and Environmental Sustainability¹**

Karma Yangzom, Irmela Krug, Kesang Tshomo, and Sununtar Setboonsarng

4.1 OVERVIEW OF NON-TIMBER FOREST PRODUCTS IN BHUTAN

Nestled between the Himalayan Range in the north and the Indian plains in the south, the Kingdom of Bhutan harbors tremendous biodiversity in ecosystems, ranging from glacial to subtropical. The forest, which covers 72% of the country's area, is home to many endangered and endemic species. It is a vital resource for rural communities, providing food, medicine, and other household necessities. Beyond subsistence, products extracted from forests are also an important source of cash income for many rural households.

Due to its complex geography and topography, only 7.8% of Bhutan's land area is arable. As a result, nonagricultural activities are a significant source of livelihood for rural people, who comprise 75% of the population. Of the nonagricultural activities, collection of non-timber forest products (NTFPs) is one of the most important livelihood activities in rural communities of Bhutan. This is evident from the array of NTFP-based items (e.g., cooking utensils, containers, food products, and medicine) that exist in Bhutanese farmhouses. The quantities and

¹ First published as Yangzom, K., I. Krug., K. Tshomo, and S. Setboonsarng, S. 2008. "Market-based Certification and Management of Non-Timber Forest Products in Bhutan: Organic Lemongrass Oil, Poverty Reduction, and Environmental Sustainability". ADBI Discussion Paper 106. Tokyo: Asian Development Bank Institute. Available: <http://www.adbi.org/discussion-paper/2008/05/22/2541.bhutan.millennium.development.goals/>



number of sellers of NTFP-based food and nonfood products in the vegetable markets in urban areas show that NTFPs are an important source of income for farmers. However, due to the lack of adequate quantitative data on the benefits of NTFPs, it is difficult to determine statistically how important these products are for the lives of rural farmers. Among the few quantitative studies, one conducted in western Bhutan found that NTFPs account for 21% of the household diet and 19% of household income (Namgyel 1996).

Bhutan's forests contain a wealth of NTFPs. In a single *gewog*² in southern Bhutan, 120 species were identified, including 22 edible mushrooms, 4 tea plants, 13 medicinal plants, 15 vegetables, as well as edible oil plants, dyes, cane, bamboo, fruits, incense, yeast, and gum (Namgyel 2005). Of the large variety of products used by the local people, only a few are traded on a commercial basis. Examples of NTFPs traded are listed in Table 4.1.

Table 4.1 Name and Use of Commercial Non-Timber Forest Products

Species	Name	Product
<i>Cymbopogon flexuosus</i>	East Indian or Cochin lemongrass	Oil
<i>Cordyceps sinensis</i>	Cordyceps	Medicinal
<i>Piper pedicellatum</i>	Pipla	Medicinal
<i>Swertia chirata</i>	Chirayta	Medicinal
<i>Tricholoma matsutake</i>	Matsutake mushroom	Edible mushroom

Source: Authors' field studies.

The export of these products demonstrates the great potential of NTFPs to generate income for rural communities in Bhutan. For example, exports of Cordyceps generate an annual income of \$4 million and exports of matsutake mushrooms generate over \$45,000 in income in one community in western Bhutan alone.

Although there are many forest policies and regulations, very few address specific NTFP issues. Currently, local trade in NTFPs is carried

² A *gewog* or block is the smallest administrative unit in Bhutan. The area of a *gewog* ranges from about 4 square kilometers (km²) to 1,650 km². In 2005, there were 201 *gewogs*. A number of blocks form a district or *dzongkhag*. There are a total of 20 districts in the country.



out on an informal basis, with only limited monitoring of the resource base and volumes harvested. The Department of Forest and Park Services has carried out a few studies on specific NTFPs and developed management guidelines to promote sustainable harvesting. However, the lack of quantitative data on potential areas and volumes of NTFP growth is a major obstacle to promoting sustainable trade and export in NTFPs. It is anticipated that the recent drafting of the national strategy for the development of non-wood forest products (NWFPs) in Bhutan will pave the way for the further promotion of sustainable and informed NTFP trade.

In light of the current situation of high potential for income generation and need for sustainable harvesting of NTFPs, organic certification is one tool that can contribute to the conservation and management of forest resources and at the same time offer incentives to rural households through premium prices and increased market access. With similar goals, Bio Bhutan, a private enterprise based in the country, initiated organic certification of two NTFPs in 2005 and is currently successfully trading organic certified lemongrass oil (LGO), one of the main sources of nonfarm income for farmers in eastern Bhutan.

This chapter is a contribution from Bhutan to this book, initiated by the Asian Development Bank Institute (ADBI) in Tokyo, Japan in 2005, on the impact of organic production on the Millennium Development Goals (MDGs) in five Asian countries: Bhutan, the People's Republic of China, the Philippines, Sri Lanka, and Thailand. It documents the innovative undertaking of introducing certification schemes to improve the resource management and processing of lemongrass, encouraging income generation of poor households in Dozam, Drametse Gewog in eastern Bhutan.

4.2 SETTING THE SCENE

The National Statistics Bureau (NSB) of Bhutan established the national poverty line at a minimum monthly earning of Nu1,096 (\$28)³ per person, with an estimated food requirement of Nu688 (\$17) and

³ The dollar equivalent of Bhutanese currency (ngultrum or Nu) used the January 2008 exchange rate (Nu1.0000 = \$0.0254), unless otherwise specified.



nonfood requirement of Nu408 (\$10).⁴ The bureau estimated that 146,100 people out of a population of 630,000 (23.2%) lived below the national poverty line in 2007; this percentage has been significantly reduced to 12% in 2012 (World Bank 2012). Poverty incidence is high in the rural areas and the rates are found to be particularly high in the eastern districts of Zhemgang, Samtse, Mongar, Lhuentse, and Samdrup Jongkhar (Kuensel 2008) for a complex set of reasons, including the lack of off-farm income opportunities. Several authors point out that the distillation of lemongrass (*Cymbopogon flexuosus*) has become a major source of income for rural communities for these poverty-stricken eastern districts, with a contribution of up to 30% to the annual income (Prommegger et al. 2005; Lama 2003; Mukhia 2006; Namgyel 2005).

Initiated in 1981 by a private firm, Bhutan Aromatic & Phytochemicals, an affiliate of Tashi Commercial Corporation, and later supported by the Ministry of Economic Affairs through the Essential Oil Development Programme (EODP), the industry produced 115 tons of LGO from 1998 to 2007 and is the first example of the industrial use of NWFPs in Bhutan. It is important to note that Bhutan is an exceptional case where LGO is collected from the wild, as opposed to cultivation for the production of essential oil.

In 2008, the industry contributed seasonal cash income to about 2,000 people in four of the eastern districts (Mongar, Trashigang, Lhuentse, and Trashiyantse) where lemongrass occurs abundantly in association with the chirpine forest.

Among the governmental agencies, the Social Forestry Division (SFD) of the Department of Forests, which is responsible for the provision of technical support, establishment, and implementation of the community forest programs, has played a key role in supporting NWFPs for income generation of the rural population and support for the collection and marketing of NWFPs within the boundaries of community forests through the establishment of small-scale enterprises (Ministry of Agriculture 2006a).

The focal agency for the promotion, establishment, and coordination of activities concerning organic agriculture in Bhutan is the National Organic Program (NOP) of the Department of Agriculture (Ministry of Agriculture 2006b). Together with the Agricultural Marketing

⁴ Currency equivalent used: \$1 = Nu39.



Section (AMS) and the Bhutan Agricultural and Food Regulatory Authority (BAFRA), NOP identifies potential export markets for organic commodities and is working toward the establishment of a national certification agency. In accordance with its mandate, NOP along with the Social Forestry Division and Helvetas under the Swiss Agency for Development Cooperation (SDC), supported Bio Bhutan in contracting INDOCERT, an India-based internationally recognized certification agency, for the first inspection of lemongrass in Dozam Community Forest in October 2005.

In relation to product development and marketing, the United Nations Development Programme (UNDP) supported the EODP. This program has been the main development partner for the LGO industry of Bhutan. With support from EODP and UNDP, the Lemongrass Cooperative, of which Dozam Community Forest Management Group (CFMG) is a member, was established by the distillers of four eastern districts (Ministry of Economic Affairs 2006). The cooperative is expected to gradually take over responsibility for the marketing of LGO from EODP.

The main drivers for the certification of LGO are the private enterprise Bio Bhutan (Box 4.1) and the Dozam CFMG in Drametse Gewog (Box 4.2).

Box 4.1 Bio Bhutan

Bio Bhutan is a private enterprise established in 2005 which focuses on product development and marketing of products based on organic certified natural resources for national and international markets. The company collaborates with farmer groups and/or cooperatives in eastern, central, and southern Bhutan. It introduced organic certification in Bhutan for two non-wood forest products: lemongrass (*Cymbopogon flexuosus*) in Drametse, Mongar and Pipla (*Piper pedicellatum*) in Nangkor, Zhemgang. It had an annual turnover in 2007 of Nu6.6 million (\$170,000). The strict competition in the international market has made the company turn its focus to the local market. In 2010, domestic sales rose to 44% of the total, up from only 16% in 2008. The rising demand comes from middle class Bhutanese and the growing tourism industry.

Source: Authors' field study, Dosch (2011).



Box 4.2 Profile of Drametse Gewog

Drametse Gewog had a population of 3,369 (710 households) at the time of survey in 2006, covering an area of about 79 square kilometers. The *gewog* is connected to the highway by an 18-kilometer feeder road. Two community schools and one lower secondary school render education services to over 600 children. The *gewog* has one basic health unit. Over 60% of the population has access to piped drinking water. Because of poor soil fertility, farm productivity is low.

Over 900 acres (364 hectares) of land are under dry land cultivation. Maize is the major cereal crop. Paddy is cultivated in about 180 acres (73 hectares) of wetland. Potatoes are the main source of cash income for the people in the *gewog*. Oranges and other fruits are also grown. Resin tapping and essential oil extraction are important income-generating activities among the people in the *gewog*.

Source: Authors' field study.

4.2.1 Dozam Community Forest Management Group

The Dozam CFMG is the oldest community forest in Bhutan with an established management plan for 358 hectares of chirpine forest. The management plan was first approved in 1997 for a period of 5 years, and renewed in 2003; it is approved until 2013 (Temphel and Beukeboom 2006).

Drametse Gewog forms part of Mongar District. Though originally conceptualized for the management of timber, the already available management plan and resource assessment, the bylaws, the excellent community organization in Dozam, and the interest of the distiller group provided an ideal platform for the Bio Bhutan enterprise to venture into the organic certification of LGO.

Dozam CFMG has been part of the essential oil-producing community since 1981. With five distillers in a community forest with a total area of 358 hectares, the Dozam group represents 0.7% of the potential area of 50,000 hectares of chirpine forests with associated lemongrass in the eastern districts. The production of 1.2 tons of oil from Dozam Community Forest accounts for 14% of the average production of 8.9 tons in 2007.⁵

⁵ Interview conducted on 5 January 2008 by an official of the Essential Oil Development Program (EODP) from the Ministry of Economic Affairs.



4.2.2 Development of the Lemongrass Oil Industry

A complex mix of environmental and economic factors, including the decrease of grass and firewood resources brought about by unsustainable resource management and price competition from cheaper Indian oil, has led to a decline in LGO production from 17.6 tons in 1999 to 8.9 tons in 2007. The major share of the world's production of LGO is based on cultivation with high yields per production unit and consequently low production costs, as opposed to the high production costs in Bhutan due to the labor requirement for the collection of the grass.

Prommegger et al. (2005) point out that if clear management guidelines are not put into place, the industry will suffer if not disappear within a number of years and thus take away income opportunities for approximately 2,000 people, including the distillers, firewood collectors, and the mostly female grass collectors.

4.2.2.1 Resource management

Frequent disputes over land resources among private distillers have been a staple of the lemongrass industry, and forest fires are a common occurrence. While the local people believe that forest fires stimulate the growth of lemongrass, research findings indicate that they favor the growth of weeds such as *Lantana spp.* and *Stipa spp.* leading to declining yields of lemongrass (Dungyel 2002; Prommegger et al. 2005). At the same time, forest fires accelerate the decline of firewood resources needed for the distillation process. Firewood is sourced through the collection of chirpine and broad-leaved trees based on permits issued by the Department of Forests, or through supplies from forest management units by government-appointed contractors.

The establishment of the community forest management plans has led to a reduction of both disputes and forest fires. In the management of lemongrass, organic producers must adhere to international guidelines on wild collection (WHO 2003; ISSC-MAP 2007), and the requirements of importing countries such as those in the European Union and the United States. The most important requirements are the following:

- Resource assessment and definition of the botanical species that will be collected, including time of harvest.



- Definition of maximum harvestable quantities and annual records of harvesting volumes according to the area defined in the management plan.
- Locally defined good collection practices to ensure the long-term survival of the species.
- A clear description of postharvest practices: These practices include an assurance that no chemicals have been used over a period of the 3 previous years. A record must be made of all substances used for cleaning, disinfection, and pest control.
- Assurance that commingling with conventional produce is avoided.
- Clear records of training extended and supervision of procedures.
- In order to assure fair distribution of duties and benefits for producers, organic management requires a clearly structured management group indicating the name, address, and function of the respective members.
- Transparent records of harvest volume, processing, and sales.

Most of these criteria are described in the community forest management plan. Therefore, if the CFMG has a plan for the implementation, the most essential criteria for organic LGO production will be met.

Once the documentation is prepared and the external inspector is satisfied with the situation in the field, the inspector submits a report to the certification agency as the base document for the issuance of the organic certificate. This certificate is the assurance for the customer that collection and postharvest management have been carried out in accordance with the standards set for organic wild collection.

4.2.2.2 Lemongrass oil production and income opportunities

The somewhat negative scenario for the LGO industry in Bhutan because of its dwindling share in the world markets due to price competition with cheaper Indian oil is that income opportunities of rural communities in eastern *dzongkhags* have been reduced. By contrast, organic production of lemongrass is on the rise, offering export opportunities in international niche markets. The aromatherapy and perfume industry appreciate the unique composition of oil from wild collection with a high content of limonene⁶ in addition to the main component of LGO, citral. Premium

⁶ Limonene: chemical compound (terpene) of aromatic oils, particularly of the citrus family but also found in lemongrass, commonly used in cosmetic products.



prices are offered for high-quality organic certified oil. The total demand for Bhutanese certified LGO is expected to increase to 3–5 tons in 2008, providing income opportunities for 22 distillers and 260 people.

4.3 STUDY METHODOLOGY

ADB I and the Rural Enterprise Development Programme (REDP) supported three surveys of a total of 96 persons, including owners of distillation units, operators employed at distillation units, and grass and firewood collectors from organic and conventional management groups in Drametse Gewog. The surveys were based on structured questionnaires developed in collaboration with ADB I, NOP, and Bio Bhutan.⁷ A total of eight enumerators were deployed for a period of 2 weeks to conduct the first survey in June 2006. Two follow-up surveys to complement the results of the first round were carried out with the involvement of a national consultant employed by the REDP in October 2007 (Trumps International Consultancy Services 2006).

In addition to examining income generation and sustainable management practices through LGO production, the survey also included questions on the impact on overall household income and expenditure, food security, migration, empowerment of women, maternal health and child mortality, and the occurrence of malaria and other diseases. Where relevant, the evaluation and findings from the secondary data have been included in the presentation and discussion of results of this study.

Out of a total of 41 distillers in Drametse Gewog,⁸ 12 distillers (9 conventional distillers and 3 distillers applying organic standards) were selected through random sampling, meaning that the survey covered 29% of the distillers of Drametse Gewog and 7% of the estimated 172 distillers in eastern Bhutan.

⁷ Gie Surato, ADB I, Tokyo; Kesang Tshomo, National Organic Program, Ministry of Agriculture, Bhutan; and Karma Yangzom, Bio Bhutan, Bhutan were responsible for the development of the questionnaire. The questionnaire was based on earlier experiences of the International Fund for Agricultural Development (IFAD) Survey on Impacts of the Agriculture Marketing and Enterprise Promotion Programme carried out in six eastern districts of Bhutan by the IFAD/SNV Project Facilitation Office, Ministry of Agriculture, Khangma.

⁸ Information provided by EODP, Ministry of Economic Affairs, January 2008.



4.4 PRESENTATION AND DISCUSSION OF RESULTS

4.4.1 Demographic Profile of Respondents

There were 48 respondents from each group (organic and conventional). Of the 96 participants, over 50% were female, with the majority of the female workers engaged in grass collection. Of the participants, 13% owned distillation units, 5% were operators of distillation units (hired labor), and 8% owned and operated distillation units. A total of 63% of the participants were grass collectors and 10% were firewood collectors (Table 4.2).

Table 4.2 Role and Function of Respondents by Gender

	Organic		Conventional		Total		
	Female	Male	Female	Male	Female	Male	Total
Distiller	0	3	1	8	1	11	12
Operator	1	2	0	2	1	4	5
Distiller and operator	0	2	0	6	0	8	8
Grass collector	27	13	20	1	47	14	61
Firewood collector	Not included		0	10	0	10	10
Total	28	20	21	27	49	47	96

Source: Survey results and authors' field visits, 2006–2007.

4.4.2 Employment and Wage Rates

The distillation of lemongrass provides seasonal income for a maximum of 6 months beginning with the onset of the monsoon rains in May and ending with the decline of vegetation in October. During these 6 months, the industry employs up to 12 skilled and unskilled laborers per distillation unit, including 2 operators of distillation units (one of which is usually the owner of the unit), 6–7 grass collectors, and 3 firewood collectors. The wage rates paid to operators and grass and firewood collectors are similar, irrespective of organic or conventional management practices.



Operators are paid Nu50 per drum⁹ of lemongrass. Considering that on average five drums of lemongrass can be distilled over 24 hours, the total wage paid to operators amounts to Nu250 per 24 hours and Nu125 per 12 hours (one shift). The distillation units are run day and night.

Wage rates for *grass collectors* are based on the number of loads carried per day. The weight per load ranges from 25 kilograms (kg) for women to 45 kg per men. The number of loads carried per day differs depending on the grass yield and intensity of grass occurrence per area. The survey findings show that men carry on average 3.3 loads of grass per day while women carry 4.9 loads. As a result, the total weight of grass collected per day amounts to approximately 122 kg for women and 148 kg for men. Considering a male/female ratio of 1:1 among the grass collectors, the estimated average lemongrass collected per day is 135.5 kg. The wage rate for grass collectors is Nu150 per day irrespective of gender. The lower weight carried by women is compensated by the better quality of the grass, as women are more careful in rejecting unwanted weeds. Therefore, the higher quality of the grass collected justifies the lower quantity collected.

Likewise, with this difference in grass loads carried per day, the amount of firewood collected per day depends on the distance between firewood collection places and the location of the distillation unit. On average, one *firewood collector* collects and carries up to four backloads¹⁰ or 180 kg of firewood for an average wage rate of Nu150.

4.4.3 Cost of Lemongrass Oil Production

The cost of production is calculated based on costs per kilogram of oil. Costs include the depreciation of the distillation unit¹¹ over 10 years, operating costs including wage rates of operators, grass and firewood collectors, and the purchase of firewood for distillers located at the roadside. Table 4.3 shows the total labor cost for the distillation of 1 kg of LGO at Nu371(\$9.4).

Only owners of distillation units that are located away from the road are allowed to collect firewood within the community forest. Distillers

⁹ One distillation drum holds 150 kilograms (kg) of grass.

¹⁰ A man can carry 45 kg per backload. A woman can carry 25 kg per backload.

¹¹ Based on a purchase price of Nu30,000 and annual production of 230 kg of LGO.

**Table 4.3 Labor Costs per Kilogram of Lemongrass Oil (Nu)**

	Wage per Day	Wage per 5 drums distilled over 24 hours*	Wage per kg of LGO
Operator	125	250	67
Grass collector	150	830	221
Firewood collector	150	312	83
Total labor costs	425	1,392	371

kg = kilogram, LGO = lemongrass oil, Nu = ngultrum.

* Five drums require approximately 750 kg of grass and 375 kg of firewood with a ratio of 100 kg of firewood required to distill 1 kg of oil.

Source: Survey results and authors' field visits.

located next to the road are required to purchase it from allotted forest management units through firewood contractors appointed by the Forest Development Corporation. One truckload comprising 12 cubic meters, or 3–4 tons of wood, costs approximately Nu4,000 (\$101.6) and is sufficient to distill between 30 kg and 40 kg of LGO. As shown in Table 4.4, costs of production are higher by Nu22 (5%) per kilogram of oil for those distillers who depend on the supply of firewood from government-appointed contractors.

On average, five drums of grass each are distilled over a period of 24 hours, resulting in 3.75 kg of LGO per five drums or 0.75 kg of LGO per drum. Each drum requires 150 kg of grass and 75 kg (1.7 backloads) of wood.¹²

As shown in Table 4.4, organic producers pay a royalty for the LGO and a water fee into the CFMG fund (benefiting the entire community). Costs for barrels, transportation charges of the oil to the dry port in Phuentsholing, and handling fees of Nu 46 (\$1.2) are paid to EODP as the government marketing agent, although Bio Bhutan facilitates the marketing of the certified oil. This double charge increases the production price unnecessarily.

While the CFMG members bear all costs related to the production of LGO (Table 4.3), additional costs of Nu121 for Bio Bhutan handling

¹² Prommegger et al. (2005) report an average consumption of 99 kg of fuelwood for the production of 1 kg of oil.



Table 4.4 Cost of Lemongrass Oil Production Borne by Distillers—Different Scenarios (Nu per kg of LGO)

	Organic Management		Conventional Management	
	Roadside Distillers	Remote Distillers	Roadside Distillers	Remote Distillers
Depreciation of distillation unit	13	13	13	13
Labor costs incl. firewood collection	0	371	0	371
Labor costs excl. firewood collection	288	0	288	0
Purchase of firewood through Forest Development Corporation	114	0	114	0
Royalty for firewood	0	6	0	6
Royalty for lemongrass	5	5	0	0
Water fees paid to CFMG	1	1	0	0
Transportation to the collection point of EODP	3	6	3	6
EODP and STCB handling charges*	46	46	50	50
Total cost of production	470	448	468	446
Average cost of production	459 (\$11.7)		457 (\$11.6)	

CFMG = Community Forest Management Group, EODP = Essential Oil Development Programme, kg = kilogram, LGO = lemongrass oil, STCB = State Trading Corporation of Bhutan.

* Includes insurance, royalty for lemongrass, transport from Mongar to Phuntsholing, barrels, STCB, and other charges.

Source: Survey results and authors' field visits 2006–2007.

charges (Table 4.5) and Nu177 per kilogram of LGO (Table 4.6) arise for the marketing agent Bio Bhutan for training, for the salary of the field supervisor, and for the actual certification costs (as shown in Table 4.5).

The estimated costs of Nu95,000 for the establishment of the community forest management plan (including inventory and farmer group formation) are not included in the cost calculation in Table 4.5 since the management plan is approved by the government until 2013.

As shown in Table 4.6, the costs for annual inspections of Nu155,000 (\$3,974) are borne by Bio Bhutan (based on 2007 costs). Since there is no



Table 4.5 Handling Charges Borne by Bio Bhutan for Organic Certified Lemongrass Oil

Item	Nu per Year	Nu per kg of Oil (based on 1.2 tons per year)
Transportation from Dozam to Thimphu	12,000	10
Cost of food grade barrel	30,000	25
Store rental at Dozam	7,200	6
Shipping costs to Europe	96,000	80
Total	145,200	121

kg = kilogram.

Source: Survey results and authors' field visits.

Table 4.6 Costs Related to Organic Certification Borne by Bio Bhutan

Item	Nu per Year	Nu per kg of Oil (based on 1.2 tons per year)
Training	35,000	29
Field supervisor	22,500	19
Certification and/or annual inspections	155,000	129
Total cost in Nu	212,500	177

kg = kilogram.

Source: Survey results and authors' field visits.

Table 4.7 Total Cost of Production: Organic vs. Conventional Management

Item	Borne by	Organic	Conventional
Average cost of production (Nu, Table 4.4)	Distillers	459	457
Handling charges (Nu, Table 4.5)	Bio Bhutan	121	**
Cost related to certification (Nu, Table 4.6)	Bio Bhutan	177	
Total cost of production (Nu)		757	457
Total cost of production (\$)		19.4	12.0

** Included in cost of production, see Essential Oil Development Programme and State Trading Corporation of Bhutan handling charges in Table 4.3.

Source: Survey results and authors' field visits.



certification agency in Bhutan, inspectors must be invited from abroad and expenses have to be paid for the air travel, daily allowances, and fees for certification.

The study shows that with Nu757 (\$19.4) per kilogram of organic certified LGO, the total cost of production increases by 66% in comparison to Nu457 (\$12.) for conventionally produced oil.

4.4.4 Bio Bhutan Sales and Payment Schemes

Over 2 years, Bio Bhutan's exports of organic certified LGO increased from 306 kg (2006) to 1,200 kg (2007), which was mainly due to rising interest of customers in Asia, Europe, and the United States for Bhutanese certified LGO. The CFMG distillers have been encouraged to opt for organic management practices by attractive payment schemes, including advance payments of Nu20,000 per distiller at the beginning of the distillation season; a higher price of Nu600 compared to Nu550 and Nu531 per kilogram of LGO paid by EODP in 2006 and 2007, respectively; and the cash down payment at the time of delivery.

The EODP scheme with an initial payment of Nu300 per kilogram of LGO at the time of delivery and the payment of the balance 5 months after the end of the distillation season, when the customers of the oil in Europe settle accounts with the EODP, lacks incentives.

4.4.5 Income and Employment

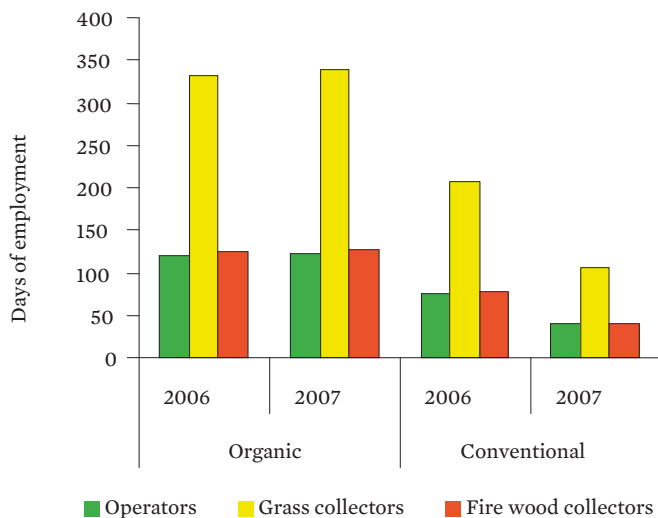
Over the 2 years of observation, the seasonal income of distillers of the organic management group was around Nu32,000 compared to Nu9,300 for the distillers of the conventional group (Table 4.8).

Figure 4.1 and Table 4.9 show that organic management significantly lengthens the duration of employment. Although the daily wage rate does not differ between the management groups (except for the distillers), the duration of employment increases as a direct result of the higher prices and attractive payment schemes offered for organic products.

However, as shown by Table 4.9, the seasonal income earned by the individuals (operators, and grass and firewood collectors) is low given the hard work of often 11–12 hours a day and reflects an imbalance of benefit shares for the stakeholders. This is of even more concern



Figure 4.1 Duration of Employment for Hired Labor



Source: Survey results and authors' field visits.

Table 4.8 Seasonal Income of Distillers Based on Production Figures, 2006 and 2007

	Organic		Conventional	
	2006	2007	2006	2007
Average production (kg LGO/distiller)	225	230	140	73
Prices paid (Nu per kg of LGO)	600	600	550	531
Gross income of distillers: average production × price (Nu)	135,000	138,000	76,945	38,922
Cost of production: average production cost (Table 4.4) × production volume (Nu)	103,275	105,570	63,980	33,361
Net income of distillers: gross income – cost of production (Nu)	31,725	32,430	12,965	5,561

kg = kilogram, LGO = lemongrass oil.

Source: Survey results and authors' field visits 2006–2007.

**Table 4.9 Employment and Seasonal Income of Employed Labor**

	Organic		Conventional	
	2006	2007	2006	2007
Average production (kg LGO/distiller)	225	230	140	73
Average number of drums distilled (kg LGO/0.75)	300	307	187	97
Operators:				
Based on 5 drums per 24 hours				
Days of employment	120	123	75	39
Total income (Nu)	15,000	15,375	9,375	4,875
Individual income (Nu, based on 2 operators)	7,500	7,688	4,688	2,438
Grass collectors:				
Based on 150 kg of grass per drum divided by 135.5 kg (average collection quantity per day)				
Days of employment	332	340	207	107
Total income (Nu)	49,800	51,000	31,050	16,050
Individual income (Nu, based on 6 grass collectors)	8,300	8,500	5,175	2,675
Firewood collectors:				
Based on 75 kg of firewood per drum and an average collection quantity of 180 kg (4 loads)				
Days of employment	125	128	78	40
Total income (Nu)	18,750	19,200	11,700	6,000
Individual income (Nu, based on 3 firewood collectors)	6,250	6,400	3,900	2,000

kg = kilogram, LGO = lemongrass oil.

Note: Refer to Table 4.3 for daily wage rate “wage per day.”

Source: Survey results and authors’ field visits 2006–2007.

in regard to female workers. In comparison to male collectors, they must compensate for the lower weight carried per backload through an increased frequency of trips from the grass collection site to the distillation unit. Yet, the lack of other income opportunities, especially for women who have to attend to their families, obliges them to abide by the current payment system.



4.4.6 Sustainable Management of Lemongrass Resources

Through intervention and regular training by Bio Bhutan, guidelines for the sustainable management of lemongrass have been established and now form part of the community forest management plan in Dozam. The lemongrass guidelines limit the annual harvest to one cut per area and consider the maintenance of the reproductive capacity of the plant through higher cuts at 10–15 centimeters above ground. Forest fires must be (and have been) prevented under the CFMG management plan since 1997.

While the management of lemongrass has certainly improved through the inclusion of guidelines into the CFMG management plan, the issue of critically high firewood consumption of about 75 kg per kilogram of LGO requires urgent action by the government and nongovernment organizations as it puts pressure on forest resources in general. Trials for improving the efficiency of existing distillation units, the identification of alternative energy sources through the recycling of distilled grass, and the introduction of alternative energy sources (electricity from hydropower, solar energy) in collaboration with UNDP-Global Environment Facility (GEF) Bhutan and Bio Bhutan will be initiated in 2008.

4.5 ORGANIC CERTIFIED LEMONGRASS OIL CONTRIBUTES TO THE MILLENNIUM DEVELOPMENT GOALS IN BHUTAN

Bhutan's Tenth Five-Year Plan (2008–2013) focuses on the MDGs and has poverty reduction as its key development theme and objective.

MDG 1 (eradicate extreme hunger and poverty): To achieve this goal, the government aims to raise agricultural productivity and promote other rural income.

In this context, the present study shows that organic certification of lemongrass-producing areas under the community forest program has a direct impact on the promotion of off-farm activities in rural areas. Over the past 2 years, Bio Bhutan has opened niche markets in Asia, Europe, and the United States and sold organic LGO at CIF¹³ rates of

¹³ CIF stands for cost, insurance, and freight, meaning that the shipping costs are included.



\$20–\$23 per kilogram of oil. The higher price offered for organic certified oil from wild collection in 2007 made it possible to increase the profit shares of organic distillers to \$3.6 per kilogram of LGO with a 30% profit, as compared to \$2.4 per kilogram with a 13% profit for conventional distillers that are paid by the EODP.¹⁴ Along with incentives such as advance payments at the onset of the season and cash down payments at the time of delivery, oil production has increased from an initial 500–600 kg produced by the CFMG to 1.2 tons in 2007. However, the profit increase has not yet resulted in higher daily wages for the workers.

The total demand for organic certified LGO in Bhutan is estimated at 3–5 tons for 2008. At current production rates of 230 kg of oil per unit, the potential demand would provide greatly improved income for 22 distillers and 264 associated workers (operators, and grass and firewood collectors). Given the current production of 10 tons of oil in Bhutan, the share of organic oil would then constitute 40%–50% of the annual LGO production and increase gross income from the industry by \$55,000. To tap into this potential, more area under lemongrass needs to be put under community forest management. At the moment, at least two more lemongrass-based community forests are in preparation.

However, income shares are not equally distributed among the stakeholders of the industry. While the owners of the distillation units benefit to a great extent from increasing prices, the daily income of the operators, and grass and firewood collectors has remained at the same level as that of conventional producers. As shown in Table 4.9, although the income of the operators and grass and firewood collectors increases only due to the longer working season, it is still important in reducing poverty. It will be desirable for the recently formed lemongrass cooperative to address the issue of raising the income of the collaborating groups in order to distribute benefits more evenly among the stakeholders and to improve the working conditions.

The costs for external certification are presently borne by Bio Bhutan and are relatively high. With an expansion of the area under certification, costs for certification per kilogram of LGO would fall and thus enhance the benefits for the Dozam CFMG and new groups who opt for the management of lemongrass under the government's community forest

¹⁴ Figures derived from Table 4.4 and prices paid to distillers.



program. With the expected establishment of a national certification agency in Bhutan, the costs of certification could be reduced even more and thus further benefit the communities.

MDG 7 (ensure environmental sustainability): The Bhutan Millennium Development Goals Needs Assessment and Costing Report (2006–2015) (Planning Commission 2007) stipulates a direct link between environmental conservation and people’s livelihoods. Based on the findings of this report, the Tenth Five-Year Plan foresees increasing participation by local people in the management and governance of natural resources through community forestry and community-based forest management. In this line, the study has demonstrated the capacity and willingness of Dozam CFMG to adhere to national legislation (Ministry of Agriculture 2006a) and international standards (WHO 2003; ISSC-MAP 2007) on good agricultural and collection practices for the sustainable management of medicinal and aromatic plants through the development, application, and monitoring of guidelines for the sustainable management of lemongrass resources.

Regular training of communities in the application of overall concepts of organic production, and the provision of technical expertise for the management of natural resources by the private sector, which illustrates the training provided by Bio Bhutan for CFMG members) has heightened public awareness of the importance of sustainable resource management based on economic and environmental considerations.

However, ensuring the sustainable supply and use of fuelwood requires further research into how to improve the current distillation system in collaboration with government and nongovernment agencies.

Reducing inputs (labor and resources, mainly firewood) will lower production costs and thus increase the returns of those communities who are willing and able to participate in the organic certification process. As such, organic certification can become a promising tool for transferring payments for environmental services by farmers, thus contributing further to poverty reduction.

In the medium and long term, the improvement of the current technology combined with the awareness program initiated by the private sector will result in efficient and sustainable management of firewood resources with a reduced burden on the public sector in terms of environmental protection.



MDG 2 (achieve universal primary education): The Tenth Five-Year Plan will focus on improving enrollment from the present 79% at the primary level and the quality of education at the primary and secondary levels, and raising the adult literacy rate from the current 53%. The direct impact of the introduction of organic management practices on the achievement of universal primary education cannot be expected over just 2 years of observations. However, increased cash income from off-farm activities such as the distillation of LGO will contribute to raising living standards, enabling families to release their children from farm and household chores to attend school.

MDG 3 (promote gender equality and empower women): The Bhutan Millennium Development Goals Needs Assessment and Costing Report (2008–2013) (Planning Commission 2007) states that “women in farming communities are highly vulnerable as they comprise a large portion of poor rural households as many of them are unpaid family workers or earn very low wages.” In this regard, the study shows that women constitute over 50% of employed labor and thus are indispensable stakeholders in the LGO industry. Women are mostly employed as grass collectors and are almost as efficient as their male colleagues. We have shown, however, that women carry less weight than men and must compensate for the lower weight of their backloads through a higher number of loads carried per day, which places a heavier burden on their shoulders so in total in a day they carry only 12.5 kg less. However, there is an element of gender equality in that wages are the same irrespective of gender. At the same time, women, who have fewer alternatives for income generation through off-farm activities than men, adjust to the difficult working conditions as grass collectors, and make significant contributions to overall household income, thus strengthening their position within the family.

No direct impact of organic practices can be demonstrated on MDG 4 (reduce child mortality), MDG 5 (improve maternal health), or MDG 6 (combat HIV/AIDS, malaria, and other diseases). However increased income, particularly for women, contributes to better living standards and consequently to an improvement of the overall health status (but the difficult working conditions contradict this). The Ninth Five-Year Plan of Drametse (Mongar Dzongkhag 2002) foresees the construction of two outreach clinics and six water schemes for the supply of safe drinking water for the benefit of 308 households. The rehabilitation of an existing water scheme in Zhangkhar community is under way. As plans are made in a participatory manner, it can be foreseen that people will invest part



of the income earned from the production of organic certified oil into the development of health services and public water schemes.

International trade in innovative products such as certified organic LGO from wild collection requires adherence to international standards of certification and contributes thus to achieving MDG 8 (develop a global partnership for development), with a particular focus on landlocked and small countries. With Bio Bhutan, EODP, and Lemongrass Cooperative as partners of the community, this will ensure a durable and sustainable relationship and enhance development.

4.6 RECOMMENDATIONS

The results directly relate to MDGs 1 and 7. The high employment rate of women as grass collectors is related to MDG 3 and indirectly fosters MDGs 2, 4, 5, and 6. The establishment of partnerships with internationally accredited certification agencies contributes to achieving global partnerships for a small landlocked country and thus contributes to MDG 8.

The following recommendations can be derived from the conclusions of this study:

1. **Establish a national certification agency** to reduce the costs of certification with the aim of strengthening the bargaining power of the private sector. Until the certification agency is in place, state subsidies for the certification of community forests concerned with lemongrass distillation will be required to foster the development of this sector.
2. **Raise the scale of organic production of NWFPs collected in the wild**, including lemongrass by increasing the number of community forests to a level that is still sustainable, in collaboration with the Social Forestry Division and the private sector represented by producer groups and marketing agencies.
3. **Raise competitiveness.** Firsthand experience proves that prices paid for organic certified LGO must be competitive with neighboring countries (India and Nepal). Major efforts must be put into (i) technology improvement to reduce firewood consumption and to make distillation more efficient,



- (ii) product development, and (iii) marketing of products based on organic certified oil.
4. **Identify alternative and renewable energy sources** for the distillation oil through further research for the distillation of oil and to enhance the overall efficiency of distillation equipment.
 5. **Share benefits** and improve the working conditions through increased attention from further attention from the communities and their partners.
 6. **Address pressing issues** on resource management (and community forest management plans) and equality of workers by the Lemongrass Cooperative.

REFERENCES

- Dosch, E. 2011. Validating the Culture of Agriculture: Farmers Groups and Organic Agriculture Mitigating Rural to Urban Migration in Bhutan. *Independent Study Project (ISP) Collection*. Paper 1064. http://digitalcollections.sit.edu/isp_collection/1064
- Dungyel, D. 2002. *Conservation and Sustainable Use of Lemongrass in Eastern Bhutan*. Khangma, Bhutan: Renewable Natural Resource Research Center, Ministry of Agriculture.
- ISSC-MAP (International Standards for Sustainable Wild Collection of Medicinal & Aromatic Plants). 2007. Medicinal Plant Specialist Group, Species Survival Commission. International Union for Conservation of Nature–The World Conservation Union. Version 1.
- Kuensel. 2008. One Out of Four below the Poverty Line. 16 January. <http://www.kuenselonline.com/one-in-eight-is-poor/#.UdBIir6mrIU>
- Lama, B. 2003. Essential Oils Industry of Bhutan: A Perspective. Thimphu, Bhutan: Essential Oils Development Programme, Department of Industry, Ministry of Trade and Industry.
- Ministry of Agriculture, Government of Bhutan. 2006a. *Forest and Nature Conservation Rules of Bhutan*. Thimphu.



_____. 2006b. *National Framework for Organic Farming in Bhutan*. Thimphu.

Ministry of Economic Affairs, Government of Bhutan. 2006. *Lemongrass Cooperative By-laws*. Thimphu.

Mongar Dzongkhag, Bhutan. 1997. Dozam Forestry Management Plan.

_____. 2002. Drametse Gewog Ninth Plan (2002–2007).

Mukhia, P. 2006. Role of Non-Wood Forest Products (NWFPs) in Socio-economic Development of Rural People. Paper presented at Annual Renewable Natural Resources Conference, Samtse, 6–8 February, NWFP Section, Forest Resource Development Division, Department of Forests, Government of Bhutan, Bhutan.

Namgyel, P. 1996. Beyond Timber – What Value of the Forest? A Rapid Rural Appraisal Study on Non-Timber Forest Products in the Nahi Gewog, Wangdue Phodrang Dzongkhag, Western Bhutan. FRC/BG-IFMP Occasional Paper No. 1. Forest Research Centre in collaboration with Bhutan–German Integrated Forest Management Project, Bhutan.

_____. 2005. Forest Policy and Income Opportunities from NTFP Commercialization in Bhutan. PhD dissertation, International and Rural Development Department, University of Reading, United Kingdom.

Planning Commission, Bhutan. 2007. Bhutan Millennium Development Goals Needs Assessment and Costing Report (2006–2013). Thimphu.

Prommegger, W., K. Budur, Dorji, and P. B. Chhetri. 2005. *Lemongrass Distillation in Eastern Bhutan: A Scenario Analysis*. A collaborative research study by the Research Center–Wengkhar, Conifer Research and Training Partnership (CORET) and the Social Forestry Division of the Ministry of Agriculture, Royal Government of Bhutan.



Tempel, K.J., and H.J.J. Beukeboom. 2006. Community Forestry Contributes to the National and Millennium Development Goals without Compromising the Forestry Policy! A Series of Case Studies on Community-Based Forest and Natural Resource Management in Bhutan. Thimphu: Social Forestry Division, Ministry of Agriculture.

Trumps International Consultancy Services. 2006. Final Report, General Overview of Baseline Survey Study of Organic Farming in Bhutan. Rural Enterprise Development Programme, Ministry of Agriculture.

WHO (World Health Organization). 2003. *WHO Guidelines on Good Agricultural and Collection Practices (GACP) for Medicinal Plants*. Geneva.

GLOSSARY

dzongkhag: District (second level of administration)

gewog: Subdistrict (third level of administration)

lemongrass oil: essential oil extracted from lemongrass (*Cymbopogon spp.*) through water distillation



Chapter 5 | What Motivates Farmers to Adopt Organic Agriculture? A Case of Rainfed Organic Rice in Thailand

Sununtar Setboonsarng and Bhim Nath Acharya

5.1 INTRODUCTION

Farmers can play a positive and constructive role in conserving the natural environment when appropriate incentives are in place for sustainable farming practices. This recognition is timely as public concerns on some of the harmful effects of conventional agriculture to the environment and health of producers and consumers have been growing in recent decades. High levels of fertilizer runoff in the form of nitrates have been found in waterways, including drinking water supplies in rural communities. Inappropriate use of pesticides and excessive levels of pesticide residues in food have also been of great concern to the general public, particularly in developing countries.

Under the current agricultural trading system, farmers are rewarded only for crops and produce sold in the market. Hence, there is a tendency to maximize short-term benefits at the expense of long-term sustainable natural resource management. Farmers face a trade-off between financial gain and environmental quality. Internalization of the externalities of agricultural practices is necessary to reward farmers appropriately for their full services; otherwise, the undervaluation of health, as well as environmental, and social consequences will continue.

One promising agricultural development strategy—organic agriculture—has emerged in recent decades as a potential solution to



address the environmental and health concerns, as well as to improve the financial position, particularly of poor farmers in developing countries (Setboonsarng 2006). Organic agriculture is based on the use of renewable resources in the production and processing system, and on the avoidance of pollution and waste. It is perceived that organic farming systems can overcome some of the inefficiencies associated with modern agriculture (Pimentel et al. 2005).

With the recognition that an organic agricultural trading system could potentially reward farmers, particularly poor farmers, for their environmental and health services, interest among governments and donors has been growing to scale up this market-based poverty reduction strategy. To better promote organic agriculture, there is a need to understand farmers' perceptions toward organic and conventional agriculture, identify factors that motivate them to convert to and continue practicing organic agriculture, and explore solutions to the challenges they face.

5.2 FARMERS' GROUPS AND MOTIVATIONS IN ORGANIC AGRICULTURE ADOPTION

There are two groups of organic farmers. The first comprises highly progressive farmers producing certified organic products that cater to market demands using modern agricultural technologies. The second comprises traditional or the so-called "backward farmers" producing largely noncertified organic agriculture using indigenous technologies, mainly for consumption. The latter are mainly supported by numerous nongovernment and government bodies in order to produce organic crops for the market. The progressive organic farmers, such as those in the European Union (EU), have urban backgrounds with high levels of education and tend to be relatively young (Duram 1999). In a survey conducted in Norway, 73% of organic farmers in the sample had an agricultural and/or university education (Koesling, Flaten, and Lien 2008). This confirms studies in various countries revealing that organic farmers tend to be better educated than their conventional counterparts (Padel 2001).

A study by Canavari, Lombardi, and Cantore (2008) investigated the factors explaining the behavior and attitudes toward organic practices among progressive farmers. It revealed that the adoption of



organic agriculture is explained by ideological motivations, such as environmental protection, health care, and crop and/or animal welfare. Financial resources and technical know-how, along with management skills and an attitude toward innovation also influence the adoption or rejection of organic practices. Meanwhile, bureaucratic procedures regarding certification are considered the major challenge among conventional farmers who did not adopt organic agriculture. In a few cases, social pressure influenced the conversion to organic practices, while little education sometimes cause a reverse conversion trend, i.e., from organic to conventional agriculture.

According to Padel (2001), farmers who adopt organic agriculture are motivated by both financial and technical reasons. They convert owing to financial considerations associated with conventional farming, particularly high input costs, as well as being able to sell organic produce at premium prices. Technical reasons, on the other hand, are related to the desire to secure farms' sustainable existence and productivity.

Several noneconomic factors play important roles in farmers' decision to actually convert or plan to convert to organic agriculture. While financial motives rank high in the list of motivation, they do not necessarily mean profit maximization. Koesling, Flaten, and Lien (2008) revealed that the most important motive for nonconversion to organic agriculture is the recognition that the current conventional farming practice is a "more effective production system." Studies of African farmers showed similar motivations to those of developed nations. They are: (i) the desire to produce wholesome chemical-free food in a sustainable manner; (ii) the wish to reduce reliance on expensive and increasingly scarce carbon-based energy intensive-farming methods; and (iii) the need to produce food commodities that will find a ready market and to ensure good incomes for farmers (Lockie et al. 2006 cited in Lyons and Burch 2008). These reasons resonated with the case studies of four African countries—Egypt, Ghana, Kenya, and Uganda—by Lyons and Burch (2008). They found that high premiums for organic produce, greater opportunities for communities to become more self-reliant, and new education and economic opportunities are among the key factors. In addition, organic agriculture offers new opportunities to maintain soil quality, enhance the productive base of agriculture, and maintain biodiversity as well as better control inputs such as seeds by farmers.

Motivations to convert to organic agriculture in developing countries are often driven by farmers' negative experiences with conventional



farming such as deteriorating natural assets, continuous disease and pest problems, high cost of external farm inputs, and health problems, as revealed in a case study in India by Lukas and Cahn (2008). The study also revealed that the factors facilitating the adoption of organic agriculture resembled those in developed countries. These were (i) education and information on organic agriculture; and (ii) material assets such as land holdings, savings, and off-farm income. Meanwhile, Setboonsarng, Leung, and Cai (2006) found that external support to the farmers is crucial during the initial and transition stages of organic agriculture, and nonprofit organizations appear to be the most effective institutional partner to adopt organic agriculture.

5.3 ORGANIC AGRICULTURE IN THAILAND

The rainfed regions of northeast and northern Thailand are home to the country's majority of poor farmers. As early as the 1960s, modern conventional farming was introduced to these farmers but was of limited success as many farmers became heavily indebted, experienced deteriorating health conditions, and were confronted by environmental issues. With pioneering efforts of nongovernment organizations (NGOs) in the 1980s, organic agriculture was introduced as a development strategy to assist these poor farmers. In most cases, organic farmers were engaged to produce certified organic¹ rice under contract farming arrangements. Under the arrangement, farmers followed strict certification guidelines of the NGOs and were rewarded with a price premium for their outputs. By the late 1990s, organic agriculture was a clear success and the Thai government supported organic agriculture through its organic programs which provided farmers free seeds for green manure and training programs on compost making.

¹ Organic certification is a process by which agricultural operations, retailers, distributors, and food processors are inspected and reviewed to verify compliance with organic standards. There is a certain procedure to get an organic agriculture certificate from the authorized agency. Organic products without certification are noncertified organic agriculture.



5.4 THE SURVEY AND ITS RESULTS

In 2006, a survey was conducted on 328 organic and 304 conventional rice farming households in the same agroecosystems and socioeconomic setting in eight provinces in northern and northeast Thailand in collaboration with the Asian Development Bank Institute (ADBI) in Tokyo and the Office of Agricultural Economics of the Government of Thailand. Among the 328 organic farmers, 238 had a contract farming agreements. Farmers from the north were engaged by private firms while those from the northeast were engaged by NGOs under similar arrangement. A structured questionnaire was used and the questions on perceptions included open questions, multiple choice, single choice, yes/no answers, and rankings. Statistical analysis of the dataset included simple tabulation and descriptive statistics; logistic regression was used in the data analysis. Using data from 328 organic rice farmers and 304 conventional rice farmers from northeast Thailand, this chapter revolves around a spatial and practice-based analysis of rice farmer attitudes toward organic agriculture.

5.4.1 Farmers' Socioeconomic Characteristics

Farmers in the survey grow rice in rainfed ecosystems with some small-scale household-level irrigation facilities, i.e., pond and pump wells. The communities are relatively well-connected to transportation system, and chemical farming has been introduced to them since the 1970s. Both organic and conventional farmers have similar characteristics in terms of land size, household members, and household head (Tables 5.1 and 5.2).

The average land size is around 24.7 rai for organic farmers and 21.0 rai for conventional farmers. However, organic farmers use more rented land than conventional farmers and allocate more land for other crops than conventional farmers.

Detailed information on the households is given in Table 5.2. The family size for both groups is about 4.5 and the majority of the household heads are male. The household heads of both groups have 3 years of education on average. The household head in the organic case also has a notably higher income. Participation of household heads in farmers' organizations is also significantly higher at 42% in organic farming households than in conventional farming households at only 14%.

**Table 5.1 Landholding and Ownership Status (N = 632)**

Variables	Organic	Conventional
Total land (rai) [*]	24.68	21.04
Own land (rai)	23.32	20.31
Rented land (rai)	1.36	0.74
Ratio of owned land	96%	96%
Organic land (rai)	19.94	0.66
Conventional land (rai)	4.74	20.39
Ratio of organic land	0.82	0.02
Rice field (rai)	22.16	19.38
Nonrice field (rai)	2.51	1.67
Ratio of rice field to total land	91%	92%
Organic rice field (rai)	19.94	0.66
Conventional rice field (rai)	2.23	18.72
Ratio of organic rice field	90%	2%
Rainfed rice field (rai)	21.59	18.16
Ratio of rainfed rice field	97%	93%

N = sample size.

*1 hectare = 6.25 rai

Source: 2006 field survey result.

The survey revealed that farmers in the study areas started organic farming in 1985, but the bulk of the farmers converted to organic agriculture in the late 1990s and early 2000 (Figure 5.1). The success of the earlier converters and the expansion of the markets attracted more farmers to adopt organic agriculture, with the numbers peaking in 2001.

Conversion to a new farming practice is often a complex system change. The conversion decision of the individual farmer cannot be explained on the basis of traditional personal characteristics alone, but other factors need to be considered. These include policy support, level of market development, attitude toward farming in the agricultural community, and the institutional development. The interplay of various social, financial, environmental, and production factors also affect the adoption of organic agriculture.



Table 5.2 Household and Household Head Characteristics
(N = 632)

Variables	Organic	Conventional
Household members		
Total household members	4.4	4.7
Female household members	2.1	2.4
Male household members	2.2	2.2
Ratio of female household members	48%	51%
Ratio children (younger than 14 years)	16%	21%
Household head		
Male household head	91%	82%
Age of household head (years)	52.6	52.5
Education of household head (years)	3.2	3.1
Household head in farmers' group	42%	14%
Household head in cooperative	14%	13%
Household head with main job in agriculture	80%	77%
Average income of household head (baht per year)	67,034	46,516

N = sample size.

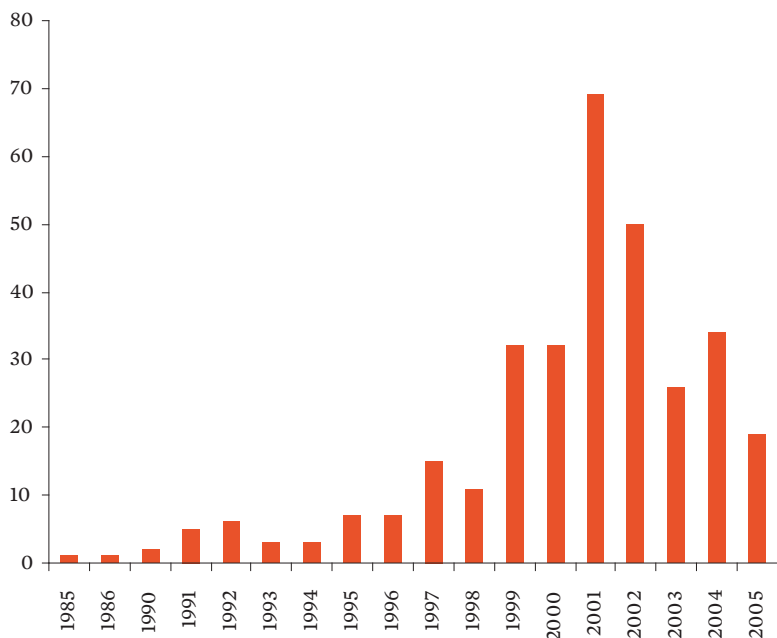
Source: 2006 field survey result.

5.4.2 Motivations in Adopting Organic Agriculture

Based on survey information and focus group discussions with stakeholders, the motivations to adopt organic agriculture are summarized in Figure 5.2. There are five main kinds, broadly classified into financial, production, health, institutional and/or social, and environment. On financial grounds, the farmers were attracted to organic agriculture because of the price premium, lower production cost, assured market, reduced credit need, and utilization of family labor. On production-related factors, farmers were motivated, among others, by soil fertility improvement, resilience to flood and drought, reduced diseases and pests, availability of improved organic seed, and technical support provided by contracting partners. Health was another strong motivating factor for farmers to adopt organic agriculture. Organic agriculture farmers were motivated by the fact that they could avoid



Figure 5.1 Farmers Who Converted to Organic Agriculture by Year of Conversion

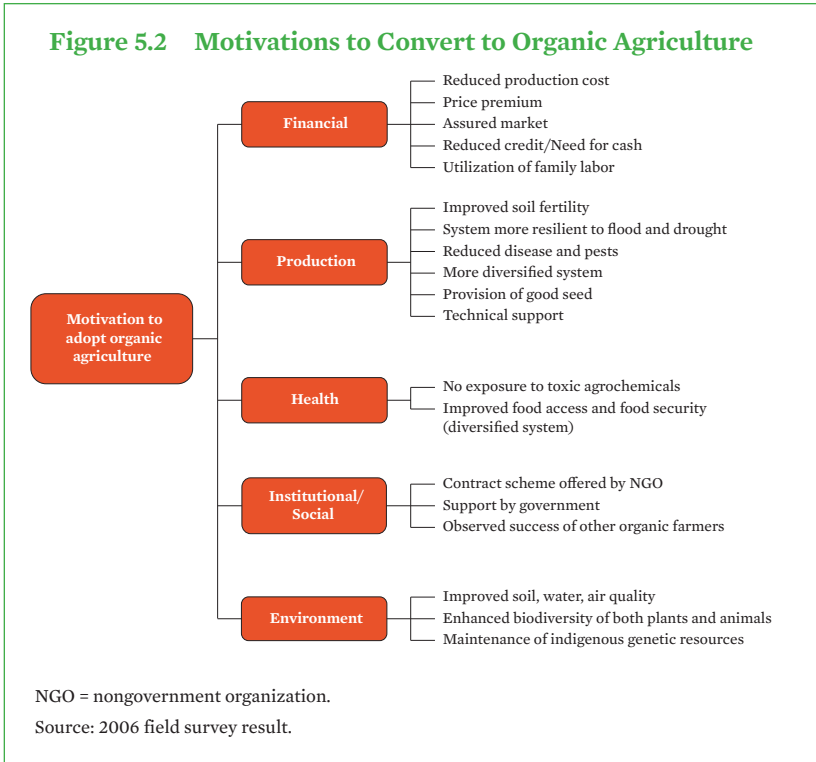


Source: 2006 field survey result.

exposure to toxic agrochemicals. At the same time, they have improved food access and food security because of organic agriculture’s diversified production systems. Some of the social factors included membership to a community organization set up under contract farming schemes with government support, such as soil amendment subsidies, as well as success of other neighboring organic farmers. On environmental grounds, farmers cited improved soil, water, and air quality; improved biodiversity of both plant and animal species; and maintenance of indigenous resources.

5.4.3 Constraints in Adopting Organic Agriculture

On the other hand, some of the factors mentioned—financial, production, and institutional—also constrain farmers from adopting organic agriculture. These constraints are presented in Figure 5.3. Financial factors that make farmers reluctant to go for organic agriculture include



the low price premium, low yields during the transition period, and slow payments under contract. Weed problems, lack of labor (family and hired), unavailability of raw materials for compost, and difficulty of removing rice stumps are some production-related constraints. Institutional setup and insufficient support from the government also curtail the adoption of organic agriculture. Very strict conditions for organic certification, and limited market and bargaining power are among the constraints of conversion to organic agriculture.

5.4.4 Relative Importance of Factors Affecting Adoption of Organic Agriculture

In assessing the perceived degree of importance of the different factors, farmers were asked to rank their motivation on a scale of 1 to 5. The succeeding subsections tabulate the rankings of the various factors as reported by farmers of both groups. The top three most frequently stated factors that motivate farmers to convert to organic agriculture are



reported, as well as the frequency and percentage of farmers who gave the rankings. Most farmers regarded reduction of production cost, promotion by private groups, and government support as top reasons for conversion. As shown in Table 5.3, the second and third reasons were rather similar: health reasons, price premiums, and reduction of production costs.

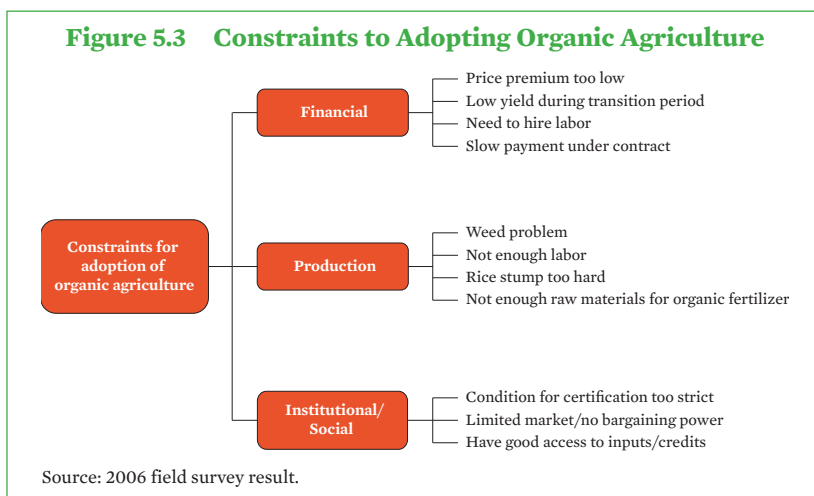


Table 5.3 Reasons for Adopting Organic Agriculture (N = 328)

Reasons	Frequency	%
First rank		
Want to reduce production cost	102	44.5
Promotion by private groups	70	30.4
Government recommendation and promotion	30	17.2
Second rank		
Want to reduce production cost	99	55.3
Health reasons	53	29.0
Higher selling price of product	35	20.9
Third rank		
Health reasons	52	36.2
Higher selling price of product	50	30.3
Want to reduce production cost	49	29.9

N = sample size.

Source: 2006 field survey result.



Table 5.4 Reasons for Continuing Organic Agriculture (N = 328)

Reasons	Frequency	%
First rank		
High selling price in the last season	105	48.3
Price premium for next year	55	23.0
Yield is increasing over time	30	12.1
Second rank		
Price premium	75	37.0
High selling price in the last season	44	20.3
Availability of family labor	44	32.1
Third rank		
Same price as conventional rice (but lower cost of production)	67	39.7
Availability of family labor	51	31.6
Price premium	43	21.6

N = sample size.

Source: 2006 field survey result.

It is worth noting that not all farmers who adopted organic agriculture continued with the practice. To understand the factors affecting sustainable adoption, a question was asked on reasons for continuing with organic agriculture (Table 5.4). The findings reveal that the price premium particularly received in the previous year is the main motivation to continue with organic agriculture in the next season, a response given by 48% of the farmers. Of the total, 23% of farmers stated the price premium as another important reason to convert to organic agriculture or continue with organic agriculture. Other associated reasons included production factors such as increasing yield over time, availability of labor, and the fact that in cases where a price premium does not exist, the production cost is lower in organic than in conventional agriculture.

5.4.5 Problems Farmers Faced in Converting to Organic Agriculture

The majority (68%) of the farmers who adopted organic agriculture reported no problems in converting to organic agriculture from conventional agriculture, while 32% of farmers reported otherwise; the key issues were the low yields during the transition period, difficulties

**Table 5.5 Problems Converting to Organic Agriculture (N = 328)**

Problems	Frequency	%
First rank		
Low yield during transition period	31	13
Difficult to plow rice stumps	27	12
Certification-related problems	21	11
Weed problems	9	5
Second rank		
Certification-related problems	24	14
Lack of family labor	10	5
Price premium too low	9	5
Seed quality, availability, and price	9	5

N = sample size.

Source: 2006 field survey result.

with plowing rice stumps, and problems related to strict requirements of certification bodies² (Table 5.5). Other issues with organic agriculture included frequency of weeding needs, limited family labor, and low price premiums (particularly for uncertified organic produce).³

5.4.6 Areas for Government Support

Farmers request government support in a number of areas, as presented in Table 5.6. Since there was a government program that provided seeds for green manure⁴ in 2005 but that was discontinued in 2006 when this survey took place, the overwhelming majority of farmers requested that the provision of green manure seeds be continued. Coming in

² Certification-related problems include problems with neighboring land and/or farm, changing checking and/or inspection standards, costly annual inspections, complicated rules for joining organic agriculture groups, very high inspection standards, payment of annual fees, and complicated postharvest inspection process.

³ As an overwhelming majority of the farmers reported only two problems, rank 3 and beyond are not included in Table 5.5.

⁴ Green manure is a type of cover crop grown primarily to add nutrients and organic matter to the soil. Typically, a green manure crop is grown for a specific period, and then plowed under and incorporated into the soil. Green manures usually perform multiple functions, including soil improvement and soil protection.

**Table 5.6 Areas Needing Government Support (N = 282)**

Areas	Frequency	%
First rank		
Supply production inputs (i.e., green manure)	149	60.1
Market identification/creation	62	34.3
Managerial/technical knowledge	36	30.6
Certify organic agriculture standard	26	22.3
Second rank		
Market identification/creation	83	41.1
Managerial/technical knowledge	72	46.9
Certify organic agriculture standard	70	40.9
Third rank		
Managerial/technical knowledge	147	80.4
Market identification/creation	55	37.4

N = sample size.

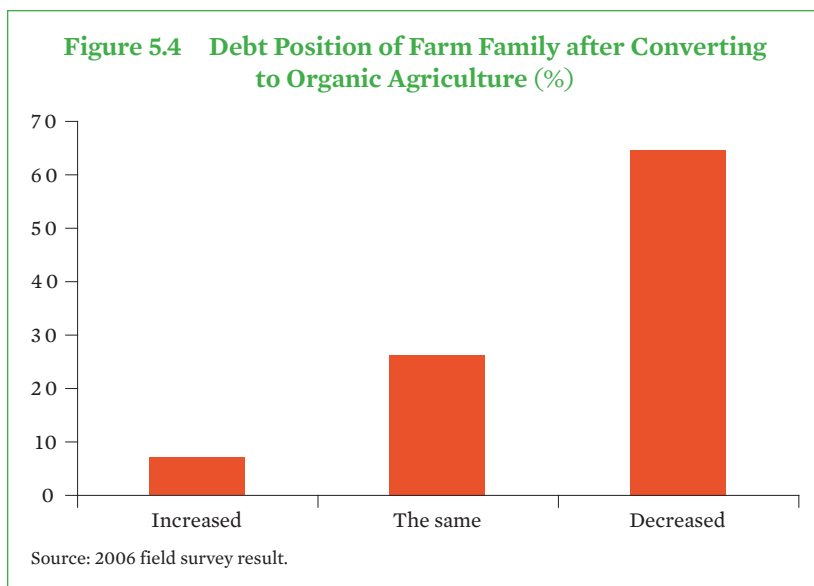
Source: 2006 field survey result.

second, which might have been the first in normal circumstances, is the request for market information and support for market expansion. This was understandable as most farmers sell their products to only one contractor who purchased a fixed amount of the organic products; farmers who wish to expand cultivation of various crops with organic agriculture were not able to find markets for produce so they requested marketing assistance. Requesting technical knowledge for managing organic farms and fulfilling requirements of certification bodies are also significant, reflecting the need for government interventions.

5.4.7 Quality of Life after Organic Agriculture Conversion

An overwhelming majority of organic farmers surveyed (95%) perceived themselves to be better off with organic farming in terms of quality of life⁵ after conversion from conventional agriculture. Only 5% of farmers reported that their quality of life was the same as before. This

⁵ Quality of life in this study refers to the absence of disease and presence of physical, social, and mental well-being, as well as economic betterment.



indicates that the impact of organic agriculture is largely positive. In terms of family debt position, farmers reported an improvement as well (Figure 5.4) and more than 50% of the farmers who were practicing organic agriculture were planning to expand their organic farming area. Focus group discussions further revealed that the majority of organic farmers wished to expand their areas but due to lack of market dropped their plans. This is consistent with the findings that one of the main requests for government support is to provide market information and assistance in expanding the market.

5.4.8 Motivation to Expand Area for Organic Agriculture

While the higher price of organic products is the main reason for farmers to expand organic farming practices to other produce, other motivations include environmental improvement, improvement of soil quality, and increased price of chemical inputs (Table 5.7).

Of those who stated that they did not have plans to expand organic agriculture, the reasons offered were insufficient land, scarcity of family and/or own labor, and insufficient raw materials for organic fertilizers. Other less important reasons were low production in the transition period, and disease and insect problems in a few cases (Table 5.8). It is interesting to note that declining yields during the transition period,



Table 5.7 Reasons for Expanding the Planting Area of Organic Agriculture (N = 328)

Reasons	Frequency	%
First rank		
High selling price	52	22.7
Better environment and improved soil	28	24.0
Chemical inputs are expensive	19	10.2
Second rank		
Better environment and improved soil	38	23.9
Chemical inputs are expensive	29	18.5
To produce more	26	11.4
Third rank		
Better environment and improved soil	51	30.7
Chemical inputs are expensive	25	16.9
High selling price	18	11.5

N = sample size.

Source: 2006 field survey result.

Table 5.8 Reasons for Not Expanding Planting Area of Organic Agriculture (N = 328)

Reasons	Frequency	%
First rank		
No more land	98	56.5
Not enough labor	42	25.4
Not enough raw materials for organic fertilizers	9	4.5
Second rank		
Production too low	21	11.0
Others: no labor, not enough	18	9.0
No more land	14	7.3
Third rank		
Disease and insect problems	12	5.7
Not enough raw materials for organic fertilizers	10	4.9

N = sample size.

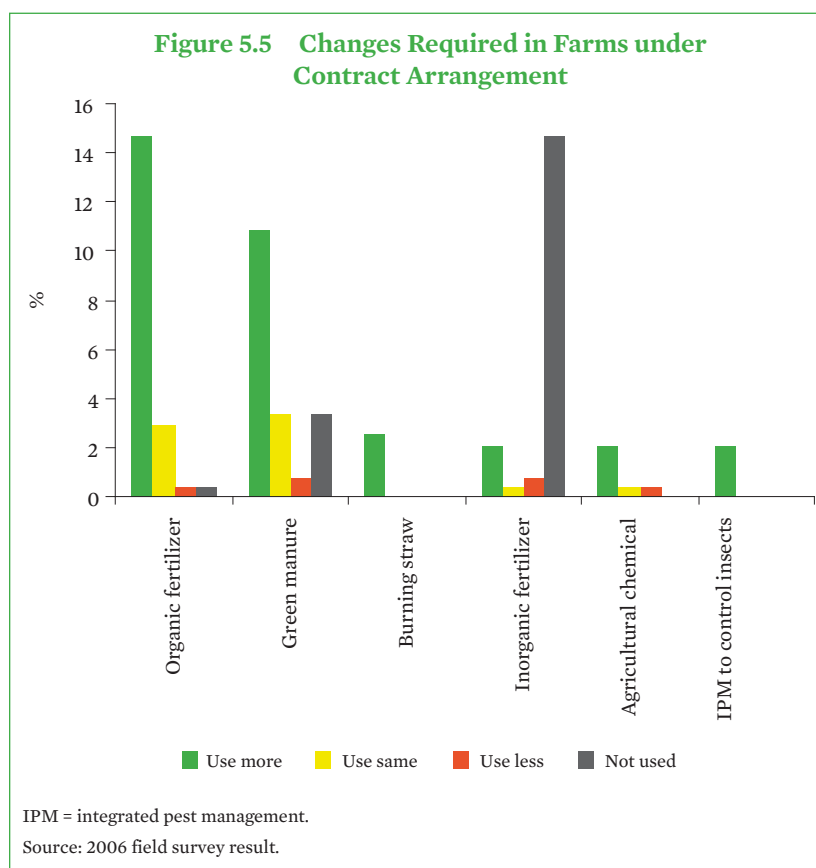
Source: 2006 field survey result.



which was expected to be a major barrier to conversion to organic agriculture, was not an important reason among these farmers. This may suggest that the rainfed conditions of the tropics do not necessarily lead to decline in yield as these areas often have limited improvement through conventional farming practice (Delate and Cambardella 2004).

5.4.9 Impact of Certification under Contract Farming

For certified organic farmers under contract farming arrangements, contractors provided support in production techniques, marketing, and technical services. To obtain certified organic agriculture status facilitated by contract farming agents, farmers are required to make changes to their farming system, which included using only organic fertilizers and use of green manure (Figure 5.5).





It is noted, however, that the burning of rice straw which contributes to greenhouse gas emissions increased after adopting certified organic agriculture. Certification conditions should consider addressing this issue as this practice is detrimental to the environment.

5.4.10 Perception of Conventional Farmers toward Organic Agriculture

Among the 304 conventional farmers in the survey, about 82% knew about organic agriculture prior to the promotion of the program and almost half of them wanted to convert their farm into an organic farm. Figure 5.6 shows the farmers' evaluation of the reasons for conversion. Farmers were asked to categorize the reasons into very much, moderate, and not much. The most important motivation is to reduce production cost (90% of surveyed conventional farmers reported that they were much motivated to convert) as fertilizers and chemical inputs are expensive in cases where organic agriculture was not practiced. Next, farmers wanted to improve their farms' soil fertility as prolonged use of chemical fertilizer and pesticide resulted in decreased production.

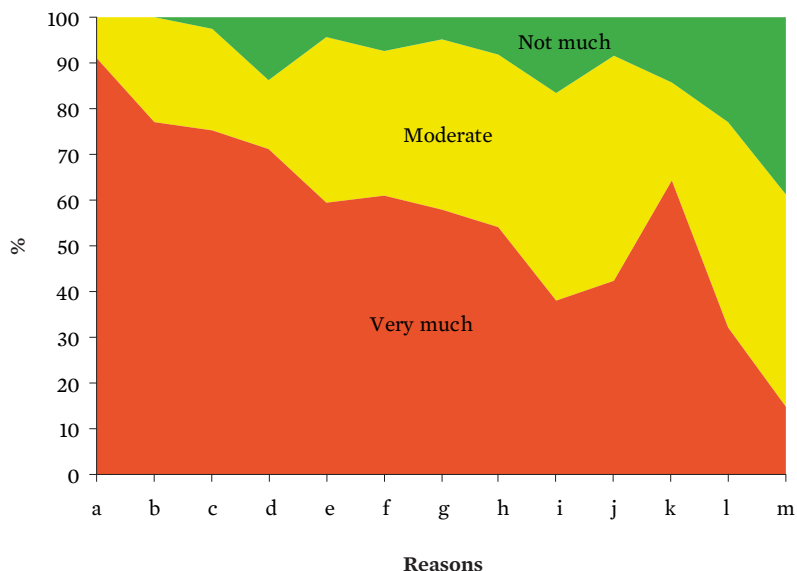
In the case of conventional farmers who did not want to convert to organic agriculture, the main reasons were lack of labor, use of chemicals in neighboring farms, and lack of raw materials for organic fertilizers. Other reasons included the perceived high risk of organic production, fear of low yield, difficult-to-understand certification system, and lack of technical knowledge (Figure 5.7). Interestingly, ownership of land, market access, and technical know-how are perceived as minor constraints.

5.5 CONCLUSION

As mentioned, the various reasons farmers adopt organic agriculture can be grouped into five categories: financial, production, health, institutional and/or social, and environmental. The price premium, lower production cost, assured market, reduced credit need, and utilization of family labor dominate the financial factors. Increasingly, awareness of environmental and health issues of conventional farming have also attracted farmers to convert to organic agriculture. Production and environmental factors are closely related in motivating farmers'



Figure 5.6 Reasons for Conventional Farmers Wanting to Convert to Organic Agriculture (degree level of motivation)



Notes:

- a = reduce input cost as they are expensive (fertilizer, pesticide)
- b = soil conditions deteriorated due to prolonged use of fertilizer and pesticide resulting in lower production
- c = need to have safe products to consume/sell
- d = good product price
- e = extension officer suggested to do it
- f = environmental conservation
- g = neighbor/relative changed, so also want to try it
- h = friend/relative introduced the method
- i = market is guaranteed
- j = want to receive inputs for production
- k = afraid of toxicity from chemical
- l = can sell products nearby
- m = used to be sick or allergy from pesticide

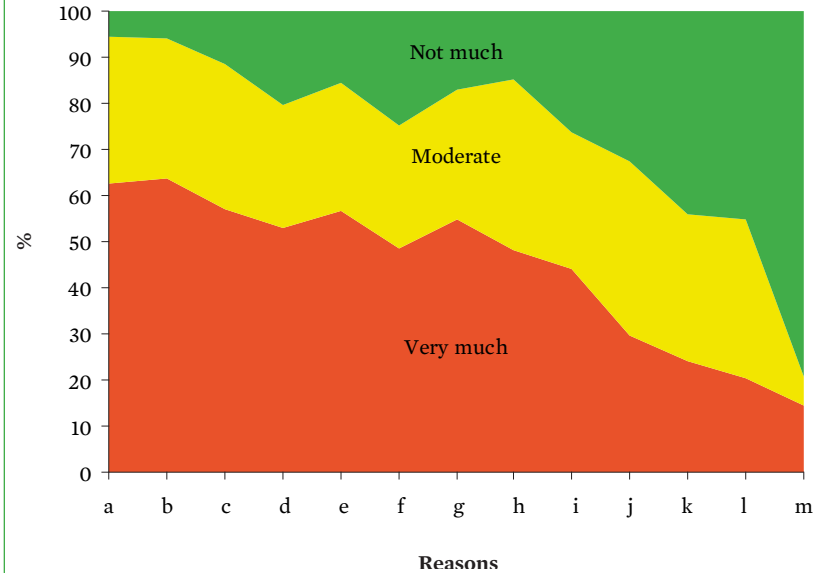
Source: 2006 field survey result.

organic agriculture adoption. As organic farmers are often members of community organizations, this facilitates engagement in contract farming schemes that allow farmers to receive and utilize support from contracting firms and the government more effectively.

Financial factors figure dominantly in motivating farmers to adopt organic agriculture, i.e., reduced production cost. However, promotion



Figure 5.7 Reasons for Conventional Farmers Not Wanting to Convert to Organic Agriculture (degree level of motivation)



Notes:

- a = not enough labor
- b = neighboring areas using chemicals
- c = already used to chemical agriculture
- d = not sure if good production can be achieved without inorganic fertilizer
- e = risk in organic agriculture is high
- f = afraid to get lower income
- g = land area is too small
- h = don't have material to produce organic fertilizer
- i = don't understand certified organic agriculture system
- j = don't believe biological method can control pest/disease
- k = don't know how to do organic agriculture
- l = don't know where to sell organic product
- m = only renting the farmland

Source: 2006 field survey result.

by private groups and government support are also most frequently ranked as top motivations, indicating the importance of a support system to farmers. The financial factor again tops as the reason farmers decide to continue with organic agriculture: prices of produce, i.e., the high price received in the previous year and the expected price premium, which will determine profitability.



The results discussed in this chapter support the case for conversion to organic agriculture by poor farmers in low-input systems compared to farmers in intensive systems. As the former cultivate crops in rainfed ecosystems and use minimal chemical inputs, if any, a great majority would not face a drastic yield decline during the transition year. This suggests that organic agriculture could be regarded as a low-cost rural development strategy for governments of developing countries.

The attractiveness of organic agriculture may also be influenced by conventional farmers who convert to organic agriculture. An overwhelming majority of organic farmers (95%) in the study perceived that their quality of life has improved significantly. This may have affected conventional farmers who have become interested in converting to organic agriculture upon learning more about it, particularly its reduced production cost and its effect on long-term soil fertility. However, conversion to organic agriculture is not without hurdles. Conventional farmers are hindered by lack of labor as organic agricultural systems are more labor-intensive, the possibility of contamination by neighboring conventional farms, and the lack of raw materials for making compost.

Descriptive statistics are supported by the regression results that financial factors are a very important motivating factor, along with public institutional and training support. These factors motivate rice farmers to convert to organic agriculture in north and northeast Thailand. These results are largely consistent with experiences of other developing countries. As farmers witness deteriorating soil fertility, high cost of external inputs, and worsening health, they are moved to alternative farming systems. Reflecting the positive findings in other countries, organic farmers experienced improvement in farm income, reduced risks of pesticide poisonings, improved food security, and improved access to information through participation in farmers' organizations set up under certification systems. An important implication of the results is that further promotion of trade inorganic products could not only lead to poverty reduction but also allow farmers to play a major role in providing environmental and health services to themselves and to their communities. To expand this alternative rural development strategy, public support for market expansion is perceived by farmers as the most important factor.



REFERENCES

- Canavari, M., P. Lombardi, and N. Cantore. 2008. Factors Explaining Farmers' Behaviours and Intentions about Agricultural Methods of Production: Organic vs. Conventional Comparison. *Proceedings of the Second Scientific Conference of the International Society of Organic Agriculture Research (ISO FAR) Volume 2*. 18–20 June. Italy.
- Delate, K., and C.A. Cambardella. 2004. Organic Production: Agroecosystem Performance during Transition to Certified Organic Grain Production. *Agronomy Journal*. 96. pp. 1288–1298.
- Duram, L.A. 1999. Factors in Organic Farmers' Decision Making: Diversity, Challenges and Obstacles. *American Journal of Alternative Agriculture*. 14 (1). pp. 2–9.
- Koesling, M., O. Flaten, and G. Lien. 2008. Factors Influencing the Conversion to Organic Farming in Norway. *International Journal of Agricultural Resources, Governance and Ecology*. 7(1/2). pp. 78–95.
- Lukas, M., and M. Cahn. 2008. Organic Agriculture and Rural Livelihoods in Karnataka, India. *Proceedings of the Second Scientific Conference of the International Society of Organic Agriculture Research (ISO FAR) Volume 2*. 18–20 June. Italy.
- Lyons, K., and Burch, D. 2008. *Socio-Economic Effects of Organic Agriculture in Africa. Proceedings of the Second Scientific Conference of the International Society of Organic Agriculture Research (ISO FAR) Volume 2*. 18–20 June. Italy.
- Padel, S. 2001. Conversion to Organic Farming: A Typical Example of the Diffusion of an Innovation. *Sociologia Ruralis*. (1). pp. 49–61.
- Pimentel, D., P. Hepperly, J. Hanson, D. Douds and R. Seidel. 2005. Environmental, Energetic, and Economic Comparisons of Organic and Conventional Farming Systems. *Bioscience*. 55. pp. 573–582.



Setboonsarng, S., PS Leung, and J. Cai. 2006. Contract Farming and Poverty Reduction: the Case of Organic Rice Contract Farming in Thailand. ADB Institute Discussion Paper No. 49. Tokyo: Asian Development Bank Institute.



Chapter 6 | **Organic Crops or Energy Crops? Options for Rural Development in Cambodia and the Lao People’s Democratic Republic¹**

Anil Markandya and Sununtar Setboonsarng

6.1 INTRODUCTION

More than 2 billion people in the world today depend on agriculture for their livelihood. In Asia, where poverty is largely a rural phenomenon, governments are in a constant search for effective agricultural development strategies. In recent years, two important new developments have emerged strongly: the growth of organic agriculture, and the increased use of land to grow energy crops (biofuels). While both activities are still relatively small, they are expanding rapidly due to the growing demand for safe food and the high price of oil. Because both developments are taking place largely in marginal areas where the majority of the poor reside, poverty and environmental implications from these two activities appear significant.

Using the cases of the Lao People’s Democratic Republic (the Lao PDR) and Cambodia, this chapter compares the two options for the development of organic agriculture and biofuel with respect to a set of development goals—the focus of which includes not only the narrow economic benefit to the farmers, but also their impact on health, poverty reduction, the environment, and sustainable development overall. There is considerable interest in both these farming enterprises in the two countries, and the public and private sectors are already engaged in a range of activities related to them. The discussion below provides a description of these activities and looks at how effective they are—or can be in the future—in promoting sustainable rural development.

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6.2 ORGANIC AGRICULTURE IN DEVELOPING COUNTRIES

The interest in organic agriculture is growing worldwide as disillusionment is rising on the sustainability of conventional agriculture. The so-called Green Revolution may have increased yields over the past 40 years, but these increases have slowed down or even been reversed in recent years due to decreasing soil fertility, degradation of water resources, and the buildup of pest populations and resistance to pesticides (Rundgren 2006). Furthermore, recorded damages to human health and the environment from conventional agriculture are also causing concern. All this has given rise to an interest in organic agriculture in developing countries; an interest that parallels that in developed countries, but is driven by somewhat different factors—more notably as a way of obtaining sustainable increases in production.

According to a survey by the International Federation of Organic Agriculture Movements (IFOAM), Stiftung Ökologie und Landbau, and Forschungsinstitut für biologischen Landbau (Research Institute for Organic Agriculture) in 2012, approximately 37.2 million hectares (ha) of farmland are under organic management worldwide (Willer, Lernoud, and Kilcher 2013),² which is a small portion of roughly 5 billion ha of agricultural land on earth. But growth of organic agricultural land had been substantial in recent decades; it grew at 11% per annum from 1998 to 2005, and increased to 17% in 2005–2006 (EC 2005). Only in recent years did the growth rate slow down, owing to the global economic crisis which started in 2008, increasingly only by 3% compared to the 2010 figure (Willer, Lernoud, and Kilcher 2013).

² The classification of land as organic is strict by IFOAM criteria and includes only land under certified organic production. Such certification requires third-party inspection, and although specific standards vary across countries, the requirement is always for a complete absence of inorganic external inputs, chemical pesticides, etc. It excludes, for example, land with good agricultural practices and low external inputs, which are also regulated in some countries—see the case of the People's Republic of China (PRC), where there are three categories: organic food, green food and nonpolluting food (Qiao, Halberg, and Setboonsarng 2007). If one takes a wider definition of “organic” to include land farmed with low external inputs, the amount would be much larger. In 2002, a Greenpeace report indicated that land that was managed according to ecological principles was about 3% of agricultural land in developing countries, while that classified as organic was only about 0.7% (Parrott and Marsden 2002). Thus the former could be as much as 4 times the latter.



Asia, Europe, North America, and Oceania³ saw increases in organic agricultural land. Oceania has overtaken Europe in terms of having the largest areas of organic agricultural land (12.2 million ha or 33% vs. 10.6 million ha or 29%). This is mainly due to Australia, the country that has the most organic agricultural land (12.0 million ha), followed by Argentina (3.8 million ha) and the United States (1.9 million ha). Asia has recovered from a major drop in organic land area in 2010 and has gained 0.9 million more hectares in recent years. Europe also increased its area by 0.6 million ha (6%), while Latin America experienced a decrease as Argentina reduced its organic grazing areas. Roughly one-third of the world's agricultural land (12.0 million ha) are in developing countries and emerging markets, and of the 1.8 million organic producers in the world, developing countries have about 1.5 million, with Asia topping the list (34%), followed by Africa (30%) and Europe (16%). India alone has almost 0.6 million organic producers (Willer, Lernoud, and Kilcher 2013).

For the case studies in this chapter, according to the IFOAM database, Cambodia and the Lao PDR devoted only 0.15% of their agricultural land to organic agriculture in 2011, which appeared to be a very low estimate. Interest in organic agriculture in both countries, however, is growing and a number of active programs have taken hold. In the Lao PDR, for instance, agricultural planning in support of the National Socio-Economic Development Plan in 2006 explicitly aimed to develop organic agriculture in all upland areas. In Cambodia, organic agriculture export is highlighted in the National Export Strategy. These are discussed in sections 6.3 and 6.4, respectively.

Case studies in India, the People's Republic of China (PRC), and Latin America indicate that the introduction of organic methods is often beneficial to small, resource-poor farmers, and that the conversion to market-oriented and certified organic agriculture can contribute to poverty alleviation and is well warranted (IFAD 2002; Giovannuci 2005). This also goes for other developing countries (Parrott, Olesen, and Høgh-Jensen 2006; Pretty et al. 2006). Yields of organic agriculture are often higher, especially in marginal areas, and certified organic products generally receive a price premium. Evidence on whether a higher price actually benefits smallholders is limited.

³ According to IFOAM figures, this region includes Australia, New Zealand, and Pacific Island states including Fiji, Papua New Guinea, Tonga, and Vanuatu, among others.



Besides the price premium and the improved market links, other advantages such as improvement of soil fertility, enhancement or preservation of biodiversity, and improved health from the absence of chemical pesticides are widely reported from organic farming projects (Scialabba and Hattam 2002; Halberg et al. 2006; Setboonsarng 2006). The wider environmental benefits of organic agriculture, however, were subject to some controversy in the late 1990s (Trewavas 2001). Since then, several studies have been carried out in Europe, comparing environmental effects, particularly greenhouse gas (GHG) emissions across a range of products produced under organic and conventional agriculture. Based on a “cradle to grave” approach, which looks at all impacts, including those in the production of inputs that go into the different forms of agriculture (also referred to as life cycle assessment [LCA]), these studies reveal that, in developed countries at least, organic agriculture outperforms conventional agriculture with respect to its impacts on floral and faunal diversity, soil conservation, water leaching rates, and pesticide pollution to water (Stolze et al. 2000; DEFRA 2003).

The picture is less clear with respect to overall energy use per unit of output. In most cases, organic agriculture uses less energy, but higher figures are found for potatoes and poultry meat (Williams, Audsley, and Sandars 2006; BML 2000). In terms of GHG emissions, the Federal Ministry for Food Agriculture and Forestry (Bundesministerium für Ernährung, Landwirtschaft und Forsten, BML) study also found lower emissions per unit of output for organic agriculture.

All these studies look only at the farm gate impacts. Other studies have also looked at energy use and GHG emissions, including transport to the consumer, where the use of airfreight is of particular concern (Chapter 11 of this volume). Another issue raised by critics of organic agriculture is that a significant shift from conventional to organic agriculture would result in food shortages as yields from organic agriculture are sometimes lower than those from conventional agriculture. This is, however, a misplaced concern, primarily because yields from organic agriculture are *not* lower in developing countries (although they can be in developed ones). A careful study by Badgley et al. (2007) shows that organic agriculture methods could produce enough food on a global *per capita* basis to sustain the current human population and potentially even a larger one without an increase in the agricultural land base.

The other global concern is whether there is enough organic fertilizer available that meets phytosanitary standards for such a massive shift in



production. Again, the same study shows that leguminous cover crops could fix enough nitrogen to replace the amount of synthetic fertilizer in use. Moreover, as it is unlikely we will ever have full conversion to organic agriculture, organic agriculture should be sustainable for a long time to come.

In developing countries there are other, secondary, benefits from organic agriculture. The diversification of smallholder farms into growing a variety of crops and multipurpose trees combined with livestock enterprises and/or fish culture is shown to enhance the overall yield stability (so-called resilience) and therefore the food security of organic farmers. Moreover, organic agriculture (in principle) will enhance and preserve biodiversity and soil fertility, while reducing negative impacts on the environment and health, compared to chemically based farming methods. For Giovannucci (2005), organic agriculture on a macro scale can provide several public benefits that should make it a strategic tool for many Asian policy makers who prioritize enhanced health, food security, and incomes.

Therefore, organic farming may contribute positively to the Millennium Development Goals (MDG), such as eradication of poverty and hunger, improved health, and ensured environmental sustainability (UN 2005). Moreover, for this purpose, it may not be necessary to have full certification of the organic products to the achievement contribute to MDGs. One cannot, however, expect a simple “yes/no” relationship between organic agriculture and the MDGs; it will depend on the context. More knowledge is needed regarding the actual benefits for smallholder farmers and the environment of certified organic agriculture, including the necessary socioeconomic conditions, organizational context, and market access.

6.3 BIOFUELS IN DEVELOPING COUNTRIES

In the last 2 decades, usage of biofuels has been significant; that is, bioethanol and biodiesel which account for 90% of biofuel usage as sources of energy to replace fossil fuels. Bioethanol is mainly derived from grains or seeds (e.g., maize, cassava, wheat, potato), sugar crops (sugar beets and sugarcane), and lignocellulose biomass (which include a range of forestry products such as short rotation coppices and energy grasses); while sources for biodiesel are oilseeds such as rapeseed, soybean, sunflower, jatropha, and palm oil.



The United States Energy Information Administration estimated that global biofuel production was 1,897,200 barrels per day (bpd) in 2011, nearly tripling the quantity in 2005 (Table 6.1). The amounts of biofuel, however, still make only a small impression on global petroleum demand of 87.5 million bpd in 2010, which has largely remained stable over the last decade.

The United States and Brazil are the two leading countries in the world in ethanol production (Table 6.2) but the United States has since significantly increased its production, which nearly quadrupled in 2011, while Brazil showed relatively modest increases. In terms of biodiesel production, European countries—Germany, France, and Italy—are the top producers, as is the United States (Table 6.3).

Production of biofuels in Asia (outside of the PRC) is still relatively small, and the region is, therefore, a minor player when it comes to determining trends in world markets. In the Mekong subregion, the Lao PDR and Cambodia are beginning to look at biofuels, and there is

Table 6.1 Global Biofuel Production ('000 barrels per day)

	2005	2011
Bioethanol	585.0	1,493.5
Biodiesel	71.2	403.7
Total biofuels	656.2	1,897.2

Source: United States Energy Information Administration database.

Table 6.2 Major Biofuel Producing Countries, 2006

Country	Ethanol		Country	Biodiesel	
	Billion gallons	Share (%)		Billion gallons	Share (%)
United States	4.86	37.3	Germany	0.79	41.40
Brazil	4.76	36.5	United States	0.39	20.00
PRC	1.08	3.7	France	0.22	11.60
India	0.49	1.9	Italy	0.13	7.00

PRC = People's Republic of China.

Source: Birur, Hertel, and Tyner (2008).



Table 6.3 Major Biofuel Producing Countries, 2005 and 2011
(’000 barrels per day)

Ethanol			Biodiesel		
Country	2005	2011	Country	2005	2011
United States	254.7	908.62	Germany	33.0	52.0
Brazil	276.4	392.00	United States	5.9	63.0
PRC	20.7	29.00	France	8.4	34.0
Canada	4.4	30.00	Italy	7.7	11.2

PRC = People's Republic of China.

Source: United States Energy Information Administration database.

believed to be considerable potential relative to the size of the countries' energy sectors. While governments in many countries are actively promoting biofuels, there are several concerns about them. The cases for and against biofuels relate to their economic, social, and environmental implications.

6.3.1 Economic and Social Arguments Favoring Biofuels

The economic rationale for more biofuel use includes that biofuels (i) are a competitive source relative to gasoline and diesel, (ii) generate employment and economic growth by replacing imports with domestic production, and (iii) provide energy security by reducing dependence on imported fuels from politically unstable parts of the world. The competitiveness of biofuel, however, depends on the world price of oil and on the taxation regimes for oil products relative to biofuels.

Disregarding the tax dimension and looking at costs of production alone, a European Union (EU 2006b) study indicated that costs of biodiesel are around \$900 per ton of oil equivalent (toe), and ethanol at around \$816–\$1,080/toe.⁴ At the same time, costs of conventional diesel are \$395 at an oil price of \$28 per barrel, and \$939 at \$90 per barrel. For gasoline, the corresponding figures are \$373 (low oil price) and \$917 (high oil price). This clearly showed that even at the “high” oil price of \$90, some subsidy

⁴ The actual calculations were done in euros. An exchange rate of \$1.20 = €1.00 has been used, reflecting the exchange rate prevailing at the time of the study.

**Table 6.4 Fuel Cost, Excluding Taxes, Subsidies, External Costs, and Benefits (\$ per ton of oil equivalent)**

	Conventional Fuels			Subsidy Needed for Biofuels (%)	
	Low OP	High OP	Biofuels	Low OP	High OP
Diesel/Biodiesel	395	939	900	128	-4
Gasoline/Ethanol	373	917	816-1,080	118-189	-11-18%

OP= oil price.

Note: "Low OP" is \$28 per barrel; "high OP" is \$90 per barrel.

Source: Adapted from EC (2005).

may be needed to allow the market to adopt biofuel. Table 6.4 indicates the size of the subsidy required for the European market, which could be provided by the EU or the exporter—although such a policy may run into difficulties with the World Trade Organization (WTO).⁵

The other economic objectives of job creation, growth, and energy security are difficult to quantify, but nevertheless can be very real. Employment and growth effects are more likely in those developing countries where there is an agriculture sector inefficiency that can be exploited to increase production of biofuels, and where the environmental and economic consequences of shifting production to biofuels from other crops (discussed in subsequent sections) are not serious (Lanzini 2007; UN 2007). The case most cited is Brazil, where there has been significant job creation in the sugarcane sector, creating 700,000 direct jobs and 3.5 million indirect jobs in 2004. The sector is one of the most efficient in creating jobs per unit of investment.

Subsidies on biofuels in developed countries are already present and take many forms, including indirect ones such as mandating a minimum use of biofuels in mixture with gasoline or diesel.⁶ The actual cost of

⁵ In fact, the current price of oil (2013) is over \$100, making the required subsidy even more unnecessary.

⁶ Subsidies are defined in Eurostat as *current unrequited payments from government to producers* with the objective of influencing their levels of production, their prices, or the remuneration of the factors of production. They can take the form of income transfers to producers or consumers of a commodity, or price supports to producers. They can also be indirect, as in the case of biofuels, where demand for the product is artificially raised by mandating their use for transport; or they can be provided by placing tariffs on the imports of competitive products (as is the case with ethanol in the United States).



support per liter of ethanol ranges from \$0.29–\$0.36 in the United States, to around \$1.00 in the EU. Actual support for biodiesel varies from between \$0.20 per liter in Canada, to \$1.00 in Switzerland (Wolf 2007). This support is likely to continue and will create an opportunity for exporters from developing countries *as long as the subsidies are not only on domestic production.*

6.3.2 Economic and Social Arguments against Biofuels

The major economic concerns about the expansion of biofuels are at the global level. Some argue that switching land to this use will reduce the amount available for food production. Either that or it will cause loss of protected land or forest land. Indeed, a number of reports point to the clearance of rainforests in Indonesia to plant palm oil for biodiesel production. The data in support of a “land problem” are fragmented and sometimes anecdotal. An EU study (2006b) estimated that based on current yields, it is impossible to meet some of the biofuel targets.

While these views are commonly asserted, they do not go unchallenged. Hausmann (2007), for example, claims that there are 95 countries that have between them 700 million ha of good quality land not being cultivated. This could yield some 500 million–1 billion barrels of biofuels—in the same range as oil production today. Hausmann does not, however, explore the reasons why these quality lands are not already being used.

Studies to date suggest the need to be more careful about how future energy demands are to be met from this energy source, and at what pace and extent such fuels can meet energy demands. For example, meeting biofuel targets from one crop inside a major fuel-consuming area is not the way to go. Imported fuel and other efficient sources must be exploited.

Other arguments against biofuels are based on their social consequences. One of these arises from the shift in power amongst producers of energy and food crops. The production of biofuels is more cost-efficient on a large scale, which has resulted in a concentration of ownership of ethanol plants in Brazil and the United States. This, in turn, can put pressures on small farmers, dealing with large companies who have market power.



A second set of social consequences is rising prices of feedstocks fueling food price hikes. The International Food Policy Research Institute (IFPRI) estimated that biofuel production will increase global maize prices by 41% by 2020. The prices of oilseeds, including soybeans, rapeseeds, and sunflower seeds, are projected to rise by 76% by 2020. In the case of cassava, a staple in sub-Saharan Africa, Asia, and Latin America, growing crops for biofuel without technology improvements such as cellulosic conversion is expected to increase its price by 135% by 2020 (IFPRI 2006).⁷

While a price hike of feedstocks benefits the farmers who grow the crops, these are often well-off farmers or big producers. The burden is ultimately borne by consumers as prices of grains and meat rise. A policy instrument is needed to ensure that smaller farmers also benefit. A World Bank study estimates that the caloric consumption among the world's poor decreases by about 0.5% whenever the average price of all major staples increases by 1%. If staples such as maize, wheat, potato, cassava, and sugarcane increase in price because of the demand for biofuel production, other staples such as rice will also be affected (Runge 2007).

6.3.3 Environmental Issues for Biofuels

On the environmental side, biofuels are promoted as a way of reducing GHGs when they replace fossil fuels. A review of different studies shows the following reductions in GHGs when there is biofuel substitution (EC 2006):

- Bioethanol from sugar crops: -11% to +75%
- Bioethanol from grain: -6% to +75%
- Biodiesel from rapeseed: +16% to +74%

⁷ These sharp increases in prices will be mitigated if crop yields increase substantially, or if biofuel production becomes based on other raw materials, such as trees and grass. The average yield of maize in the United States has increased about 2% a year over the last 15 years, and the United States Department of Agriculture projects a further improvement of 10% over the next 10 years for maize and 5% for soy. In Brazil's Sao Paulo region, sugarcane yields increased 33% between 1975 and 2000. Efficiency of conversion from feedstock to biofuel have also been increasing at about 1% a year for ethanol, and about 0.3% for biodiesel.



Life cycle assessments (LCAs) have also been carried out for some feedstocks commonly grown in developing countries (other than sugarcane). In agreement with previous LCA reviewers, Larson (2006) found a wide range of values for GHG emissions, depending on whether (i) land had to be cleared for the crop; (ii) indirect emissions had been accounted for (e.g., nitrogen oxide, carbon monoxide); (iii) GHG emissions of nitrous oxide, from fertilizer application, have been accounted for; and (iv) the extent of soil carbon buildup associated with growing biomass had been taken account of (e.g., if previously heavily tilled land is converted to an energy crop with lower tillage requirements, the soil carbon impacts are increased).

Apart from sugarcane, palm oil is the other crop predominantly grown in developing countries. Using the LCA methodology, McCormack (2007) found biodiesel from palm to generate 0.018 kilogram of carbon dioxide equivalent per megajoule ($\text{kg CO}_2\text{eq/MJ}$) if there was no land conversion involved, and 0.143 $\text{kg CO}_2\text{eq/MJ}$ if there was. By contrast, conventional low sulfur fuel generates 0.091 $\text{kg CO}_2\text{eq/MJ}$ —more than palm oil without land clearance, but less than palm oil with land clearance.

As studies have shown, the carbon savings benefit of biofuels will be greater if (i) the conversion process uses the biofuel itself, or another renewable energy source; (ii) by-products are produced, such as glycerin (from biodiesel production), lignin (from bioethanol production), and animal feed (from both processes); and (iii) biofuel is used close to where it is produced as its transport causes significant GHG emissions (biofuels cannot be piped).

Given that biofuel production costs are high and its processing generates GHGs, the resulting costs per ton of CO_2 equivalent reduced by switching to biofuels is also high (€40–€100 or \$48–\$120) per ton of CO_2 avoided.⁸ Since there are many options for reducing GHGs at a lower

⁸ Some studies find even higher costs per ton of CO_2 avoided. Wolf (2007) cites a range from \$150 to \$1,000.



cost,⁹ a switch to biofuels as a GHG-reducing measure is unlikely to be economic, at least in the short run. There are, however, other benefits such as energy security, savings on foreign exchange by reducing imports, and employment generation, among others, to justify adopting biofuels as part of an economically efficient solution. The other environmental impacts of the switch arise from the effects of (i) feedstock cultivation and (ii) reduced emissions of pollutants harmful to health.

6.3.4 Biofuel Feedstock Cultivation and Its Environmental Impacts

As growing crops for biofuels becomes financially attractive, more land is taken into production, resulting in serious problems of deforestation, erosion, and unsustainable use of marginal land. In Brazil, for example, agricultural expansion is proceeding rapidly and causing deforestation in the Amazon Basin. In Southeast Asia, large tracts of forestland are being cleared to plant oil palms destined for conversion to biodiesel (Runge 2007). This could negate many of the possible benefits from the switch away from fossil fuels. To avoid such shifts, “biofuel certification” (as for sustainable forest certification) should be implemented so that fuels are sourced only from locations where sustainable agricultural practices are followed. A green label specifically tailored to biofuels and assessment of their whole value chain should be created, as the only type of certificate that exists is a guarantee of a certain percentage of biofuel content in gasoline or diesel (EU 2006a and 2006b).

In Europe, studies of the environmental effects of biofuels note the following negative effects of feedstock cultivation: (i) loss of biodiversity as more set-aside land is brought into production, (ii) increased demand for water as fast-growing species are brought into production,

⁹ The 2007 Intergovernmental Panel on Climate Change (IPCC) estimates, based on bottom-up studies, that between 16 and 31 gigatons of carbon could be removed at an economically acceptable cost in 2030. Of this, 5–7 gigatons can be removed at a cost of less than \$5 per ton, 9–17 gigatons at a cost of less than \$20 per ton, 13–26 gigatons at a cost of less than \$50 per ton. The rest (3–5 gigatons) have a cost of between \$50 per ton and \$100 per ton (IPCC 2007). Options at below \$50 per ton include demand side management; improved efficiency in fossil fuel generation; efficient lighting, electric appliances, and heating and cooling devices in buildings; more fuel-efficient vehicles; heat and power recovery; and more efficient end-use equipment in industry; reforestation and afforestation; and landfill methane recovery.



(iii) increased use of pesticides as farmers do not expect residue testing for biofuel crops unlike in food crops, and (iv) increased application of fertilizer causing runoff and associated problems of nonpoint pollution. On the positive side, they note the following effects: (i) energy crops can allow a greater choice of crops to be grown with, for example, a possible shift of land under sugar beet production to land for cereals, which carry less risk of erosion and less input of chemicals; and (ii) in certain regions, energy crops may contribute to maintaining agricultural land in production, which may help prevent floods and landslides.

6.3.5 Local Air and Water Pollution Impacts of a Switch to Biofuels

In terms of local air pollution and related effects, the picture is a mixed one, though generally favoring biofuels. Table 6.5 summarizes the findings of studies carried out by the United States Environmental Protection Agency (USEPA). It reports changes in emissions for a 85% ethanol blend, a 20% and 50% biodiesel blend, and a second-generation biodiesel technology (the Fischer-Tropsch process) that comprises gasification of biomass feedstocks, cleaning and conditioning of the produced synthesis gas, and subsequent synthesis to liquid (or gaseous) biofuels. They show reductions in carbon monoxide and particulate matter in all cases, reductions in sulfates, volatile organic compounds and nitrogen oxides with bioethanol and biodiesel, and lower nitrogen oxide emissions with bioethanol but higher emissions with biodiesel. It should be noted that studies exist showing biodiesel and ethanol blends to have a significant impact on acidification and eutrophication of water (Lanzini 2007).

Brazil, which leads the world in ethanol production, has recently increased the blend of biofuel in gasoline from 20% to 25%, increasing sugar millers' production of ethanol to 25 billion liters in 2013, from 22 billion liters in 2012 (Nielsen 2013). The shift will further reduce ambient lead concentrations, like in the Sao Paulo Metropolitan Region where it has dropped from 1.4 gram per cubic meter (g/M^3) in 1978 to less than 0.1 g/M^3 in 1991. In addition, carbon monoxide emissions fell from over 50 grams per kilometer (g/km) to less than 5.8 g/km in 1995 (EU 2006a). Based on evidence, biofuels are beneficial in terms of reducing carbon monoxide and particulate matter and ambient lead (where still in use).



Table 6.5 Typical Biofuel Emissions Compared to Standard Fuels

Bioethanol (E85)	Biodiesel (B20 and B100)	Biodiesel 2nd Generation
<ul style="list-style-type: none"> • 15% reduction in VOCs • 40% reduction in CO • 20% reductions in PM • 10% reduction in NOx • 80% reduction in sulfates • Lower reactivity of hydrocarbon emissions • Higher ethanol and acetaldehyde emissions 	<ul style="list-style-type: none"> • 10% (B20) and 50% (B100) reduction in CO • 15% (B20) and 70% (B100) reduction in PM • 10% (B20) and 40% (B100) reduction in hydrocarbons • 20% (B20) and 100% (B100) reduction in sulfates • 2% (B20) and 9% (B100) increase in NOx • No change in methane emissions with other blend 	<ul style="list-style-type: none"> • NOx reductions • Little or no particulate emissions • Expected reductions in hydrocarbon and CO emissions

CO = carbon monoxide, NOx = nitrogen oxide, PM = particulate matter, VOC = volatile organic compound.

Source: Dufey (2006).

6.4 ORGANIC AGRICULTURE AND BIOFUELS IN CAMBODIA

6.4.1 Organic Agriculture in Cambodia

Little data are available on the nascent organic agriculture in Cambodia, except that the focus is on rice, for which a national export strategy has been drawn up to generate employment opportunities for the landless and to reduce poverty among the rural population and improve the well-being of farmers (Ministry of Commerce 2006). The Cambodian Center for Study and Development in Agriculture (CEDAC¹⁰) estimated that 5,400 ha of paddies are organic (only 0.02% of the total paddy land) and only around 5,000 of the 1.8 million rice farmers practice

¹⁰ Originally French for Centre d'Etude et de Developpment Agricole Cambodgien (<http://www.cedac.org.kh/>).



organic farming.¹¹ In light of the negative effects of improper use of agrochemicals, especially on poor Cambodian farmers, advertising of chemical fertilizers and pesticides by the media has been banned in Cambodia.

CEDAC handles a large organic rice production program in Cambodia and promotes the System of Rice Intensification (SRI).¹² SRI is a method of practicing organic agriculture where some flexibility in the adoption of organic methods is allowed. This implies less use of water—an important factor in Cambodia and the Lao PDR, where most agriculture is rainfed.¹³ The system is based on trust and has no certification. There were about 60,000 farmers in 15 of Cambodia's 20 provinces engaged in the SRI program in 2006 and growing; rice output under the program went up from 20 tons in 2005 to 420 tons in 2006. About 30% of these farmers could be described as fully organic.

An evaluation of the SRI program in 2004 by the German Technical Cooperation (GTZ), which supported SRI in Cambodia, compared SRI farmers with control groups in five provinces (Kandal, Kampong Thom, Kampot, Takeo, and Prey Veng). The study (Anthofer 2004) revealed the following: (i) incomplete SRI practices among SRI farmers, but with substantial results: age of seedlings dropped 67% and rates of planting 67%; (ii) higher yields than control groups: from 1,629 kg/ha to 2,289 kg/ha (41% increase) at the time of study in all five provinces; (iii) overall labor demand showed SRI to be more or less labor-neutral with respect to family labor but is more labor-intensive in the earlier years; and (iv) gross profits are higher than conventional farmers (\$120 per hectare vs. \$209 per hectare, or a 74% increase). Following this analysis, if 10% of Cambodian rice farmers converted 42% of the rice area to SRI, the economic benefit to the nation would be \$36 million. This result echoes other evaluation studies of SRI.¹⁴ Another CEDAC

¹¹ Presentation by Keam Makarady, Program Officer, CEDAC to the Regional Conference on Organic Agriculture in Asia, 12–15 December, Bangkok, Thailand.

¹² There is also a contract farming program for rice under which a company (AKR) provides seeds in credit and agrees to buy the output at a minimum price. It covers about 1,000 households, but it is not an organic program.

¹³ See <http://www.sciencedaily.com/releases/2007/10/071014202450.htm>

¹⁴ See, for example, Namara, Weligamage, and Barker (2003).



study was even more optimistic of SRI's benefits: increasing yields by 105% and gross household incomes by 89%.¹⁵

Based on these results, it is possible to estimate the potential benefits of a wider shift to “more organic” rice production in Cambodia. For this purpose, the following assumptions were made:

- (i) An extended program would provide SRI extension services to 20% of the wet season rice farmers in the country.
- (ii) The program would affect both poor and nonpoor farmers in proportion to their numbers in the communities in which it is carried out—i.e., there is no special targeting of farmers better-off or worse-off.
- (iii) In the case of poor farmers, around 19% are landless (World Bank 2006a). Since they do not own or rent land, the SRI program would not affect their income.
- (iv) Incomes from rice cultivation would increase by 75% as a result of the program.
- (v) Shares of income from wet season rice cultivation are as given in Table 6.6.

Table 6.6 provides estimates of the increase in incomes in each of the five regions: Tonle Sap, coastal, mountain and/or plateau, plains, and Phnom Penh, as well as estimates of the number of households that will move out of poverty as a result of the program.¹⁶

With around 1.5 million rural households engaged in wet season rice production in Cambodia, a 20% targeting of this group would involve 300,000 households. Such a program would increase incomes of rural households by around 68% in Tonle Sap, 74% in the coastal regions and Phnom Penh (there are a few rural households in the capital city region), and 39% in the plains. The benefits, however, are negligible in the mountain and/or plateau region, because very little household income derives from rice cultivation there. Based on the analysis done by the

¹⁵ Mimeo. Provided by Yang Saing Koma, President, CEDAC, Phnom Penh.

¹⁶ Tonle Sap consists of the provinces of Banteay Meanchey, Battambang, Kampong Thom, Siem Reap, and Kompong Chhnang. The coastal zone is made up of Kampot, Preah Sihanouk, Kep, and Koh Kong provinces. The mountain and/or plateau region consists of Kampong Speu, Kratie, Mondulhiri, Preah Vihear, Ratanakiri, Stung Treng, Oddar Meanchey, and Pailin provinces. Finally, the plains region is made up of Kampong Cham, Kandal, Prey Veng, Svay Rieng, and Takeo provinces.



Table 6.6 Impacts of an Expansion of the System of Rice Intensification Program by 20%

Region	% of Income of Rural Households from Wet Season Rice	% Increase in Total Income	Number of Households Taken out of Poverty by the Program
Tonle Sap	91.7	68.8	12,346
Coastal	98.3	73.7	1,538
Mountain/plateau	0.9	0.7	196
Plains	51.8	38.8	7,201
Phnom Penh	99.7	74.8	35
Total	–	–	21,317

Source: Authors' calculations. The method for the poverty reduction calculation is explained in Annex 6.2.

World Bank (2006), SRI program targeting 20% of the poor households would take about 21,300 individuals out of poverty—i.e., reduce the rural poverty rate by about 3.3%.¹⁷

Based on similar programs in the Lao PDR, we estimate the costs at around \$150 million or about \$7.50 per family taken out of poverty.¹⁸ In addition, some support may be needed in the first 2 years of the program, when yields can decline and the benefits not fully realized. In Cambodia, where most land is under rainfed conditions using low levels of chemicals, the introduction of organic agriculture should not cause declining yields.

The program would provide considerable benefits in addition to those already identified:

- (i) **Food security.** As noted, with SRI methods, the farmers' risk of getting a lower yield after changing from conventional practices are much smaller than the probability of getting a higher yield.

¹⁷ The number is relatively small partly because a number of poor households are landless and partly because of the depth of poverty.

¹⁸ This is based on the Lao PDR's data indicating a cost of around \$580 per household for a small program. Allowing for economies of scale we have taken a cost of \$500 per household. Unfortunately, no data were available on the costs of the CEDAC program.



Another indicator calculated by the GTZ study found the probability of *not achieving* a gross margin of \$100 per hectare was 42% with conventional practice, but only 17% with SRI.

- (ii) **Access to organic markets.** According to CEDAC, the small amount sold in Phnom Penh attracts a price premium of about 15% over the conventional rice. Profits may be lowered with certification, but Cambodian farmers can export to foreign markets, generating foreign exchange for the country. In 2010/11, Cambodia had 2.5 million tons of surplus rice, up from 1.4 million in 2006/07. Rice exports are a major government strategy; if only smuggling could be curtailed, the sector could generate millions in earnings. For example, if 20% of 6 million tons produced in 2004 were exported as Good Agricultural Practice (GAP) rice at a price of \$150 per ton, versus \$135 per ton as smuggled rice, the government could have earned \$180 million.
- (iii) **Other benefits.** Although these have not been documented in the case of the SRI program, other studies in the region have found benefits to farmers of a shift to organic agriculture in the form of better health effects (fewer cases of pesticide poisoning, and a better diet as a result of higher output and incomes), more involvement of women on organic agriculture farms, and higher incomes for the households (Setboonsarng and Markandya 2007). They also found environmental benefits from the lower application of pesticides and other external inputs.

6.4.2 Biofuels in Cambodia

Biofuel production in Cambodia is in its infancy. Possible feedstocks are cassava, soy, maize, sugarcane, and jatropha. The production volume of biofuel crops is small but has risen significantly in the last decade (Table 6.7). Volume is much lower compared to that of rice, which is the country's major crop. The rice produced in 2010/11 was 8.2 million tons, up from 6.2 million tons in 2006/07.

Cambodia is interested in jatropha and cassava as biofuel crops. As of 2010, one of Cambodia's biofuel companies, NTC Jacam Energy, had suspended production due to shortage of raw materials (jatropha). NTC Jacam purchased 500 ha in Kampong Seu and Koh Kong provinces. In other areas where jatropha is grown, such as Aural and Samraong



Table 6.7 Crop Production Statistics, 2005/06 and 2010/11 (ton)

Crops	Production in 2005/06	Production in 2010/11
Maize	248,000 mainly grown in Battambang in Tonle Sap and Pailin in the mountain region	773,269
Cassava	536,000 mainly grown in Kampong Cham province	4,248,924
Sugarcane	118,000 mainly grown in Kampong Cham and Kampong Thom provinces	365,555
Soybean	179,000 mainly grown in Battambang in the Tonle Sap region and in Kampong Cham in the plains region	156,589

Sources: Som (2012); Ministry of Planning (2005).

provinces, farmers switched to other crops due to low crop yields of *jatropha* (*Biofuels Digest* 2010a).

In terms of ethanol production, Cambodia has engaged the private sector, by contracting a Korean company (MH Bio-Energy Group) that started operations in 2008 and has a production capacity of 40,000 kiloliters a year. In early 2010, the plant shut down due to rising cassava prices and low oil prices. The price of ethanol and oil go hand in hand. As the company could not increase the price of ethanol it would receive in the EU market, it had to stop production. To avoid a similar event in the future, the company has contracted local farmers to fulfill its target of 10,000 tons of cassava. This is jeopardized, however, by low cassava prices as occurred in 2008 when 1 ton fetched only \$24 and farmers switched to growing corn (*Biofuels Digest* 2010b).

6.4.3 Cassava for Bioethanol in Cambodia

In 2005, cassava was a feed crop, with small quantities being exported. Based on the experience of Thailand, the cost was estimated at \$341.7 per hectare for the average farmer. If the yield was 17.8 tons, and the root price was \$21.6 per hectare,¹⁹ a gross income of \$384.4 per hectare and a net return of \$42.7 per hectare would be gained, which was slightly

¹⁹ Data are from Watananonta and Howeler (2005). In fact, the price of cassava has risen since then, making the crop more attractive.



below the average for all crops in Cambodia (\$46.3 per hectare) and well below that of rice (around \$100 per hectare).²⁰

The analysis below investigated a program in which production of cassava would be increased from 535,000 tons in 2005, to nearly 1 million tons by 2011, which was below actual production in 2010/11 at 4.2 million tons. Production of the increased cassava is undertaken partly by smallholders and partly by concessions given to the companies producing the ethanol. The resulting calculations are shown in Table 6.8.

The following are the assumptions of the analysis:

- (i) Yields can be increased by about 5% to 22.8 t/ha by 2012 from 17.8 t/ha in 2005.
- (ii) Based on an IFPRI study (Rosegrant et al. 2005), the price of fresh roots would be expected to increase by 33% in 2010, and by another 20% in 2020. We assume that in the intermediate years the price increases at a constant rate.
- (iii) Based on calculations by Watananonta and Howeler (2005), production costs would increase 8% adjusted to inflation from labor costs and 3% for other components.
- (iv) The opportunity cost for land that is shifted to cassava production was \$46 per hectare and increased at 8% in real terms, to reflect general growth in the economy.
- (v) The impacts of the program on the poor are estimated based on the previous calculation of the number of poor rural households and assumed to affect about 37% of the households. This percentage is expected to decline 5%, reflecting national poverty reduction programs.
- (vi) Average holdings are taken as 1.5 ha, which is equal to the national average.

²⁰ An issue that has been raised with cassava is its contribution to soil erosion, especially in upland areas. Some of this soil moves to lower spots as well as lowlands and delta areas, benefiting them. There are also negative effects, however, including loss of fertility in the upland areas where cassava is grown, as well as deposition of eroded sediments in irrigation systems, reservoirs, and harbors. The Food and Agriculture Organization of the United Nations reports that while it is known that cassava has such effects, the magnitude cannot be estimated from the sediment loads of the main drainage basins (see <http://www.fao.org/docrep/007/y2413e/y2413e0a.htm>). Yield data for cassava in South East Asia, however, do not show any declining trend over the period 1983–2005 (Watananonta and Howeler 2005).



Table 6.8 Effects of Cassava Ethanol Program on Incomes, Poverty, Etc.

	Units	2006	2008	2009	2010	2011
Cassava grown by smallholders						
Output	t ('000)	536	647	758	869	980
Yield	t/ha	17.9	18.8	19.7	20.7	21.7
Price of fresh root	\$/t	26.0	30.3	32.4	34.6	35.1
Cost of production	\$/ha	340.8	359.4	379.0	399.6	421.4
Opportunity cost for new farmers	\$/ha	46.0	49.7	53.7	58.0	62.6
Increase in income of smallholders*	%	–	68.8	24.5	21.4	8.2
Net income of farmers	\$ million	3.7	7.0	9.5	12.6	14.5
Number of HH that are poor	%	37	35	33	32	30
Number of HH engaged in production	no.	19,983	22,980	25,645	28,005	30,082
Number of new HH taking up cassava production	no.		2,996	2,666	2,360	2,077
Number taken out of poverty by program	no.		3,292	1,467	1,339	594
Cassava grown under concession						
Output	t ('000)	188	197	207	217	228
Yield	t/ha	17.9	18.8	19.7	20.7	21.7
Area	ha	10,000	10,000	10,000	10,000	10,000
Employment	no.	2,080	2,080	2,080	2,080	2,080
Earnings	\$ million	–	2.9	3.1	3.3	3.6
Production of biofuels and by-products						
Ethanol	million l	–	53.5	66.8	80.3	93.9
Value of ethanol	\$ million		32.1	42.9	55.0	65.3
CO ₂	million t		35.3	44.1	53.0	62.0
Value	\$ million		7.1	8.8	10.6	12.4

– = data not available, CO₂ = carbon dioxide, ha = hectare, HH = households, l = liter, t = ton.

* The increase in 2008 is with respect to 2006. For other years, it is with respect to the previous year.

Source: Authors' calculations. The method for the poverty reduction calculation is explained in Appendix 6.1



- (vii) Concessional land is taken as 10,000 ha, which is roughly what the current private sector initiative plans to use.
- (viii) Wages are set at \$3.75 per day, increasing at 8% per annum.

Based on the results, the following are noted:

- (i) The smallholder component of the program would increase net farmer income by nearly \$10 million from 2006 to 2011, increasing incomes of participating farmers by 69% in the first year, rising to 114% by 2011, reducing poverty in about 7,300 of the participating 30,000 households.
- (ii) The concessionaire program is smaller, involving 10,000 ha instead of 15,000 ha under the stakeholder program, with an even small social impact. This is expected to employ 2,100 individuals, increasing incomes from \$7 million to \$12 million.
- (iii) The production of ethanol from the cassava would realize exports of \$32 million in 2008, rising to \$65 million by 2011. In addition, local sales of about \$7 million–\$10 million are generated from the CO₂ produced.
- (iv) Other minor benefits include some employment created in the processing of the cassava chips to ethanol.

Issues that need to be addressed in such a program are the following:

- (i) **Carbon credits.** Some benefits can be derived from the replacement of gasoline by ethanol and will depend on the processing of ethanol, as well as the efficiency of the processes used. An analysis of these possible benefits should be carried out.
- (ii) **Risks.** These are mainly failure to increase yields and fall in the price of gasoline. At \$90 per barrel of oil, subsidy to ethanol for it to be competitive. Given the extensive program of subsidies in developed countries, cassava is likely to remain competitive as long as it has access to the Organisation for Economic Co-operation and Development (OECD) country markets.
- (iii) **Capacity building.** This is an essential component of such a program, as farmers and workers need to be instructed on how to increase yields for cassava. A major program would be needed for this purpose and its costs should be estimated carefully.



6.5 ORGANIC AGRICULTURE AND BIOFUELS IN THE LAO PEOPLE'S DEMOCRATIC REPUBLIC

6.5.1 Organic Agriculture in the Lao People's Democratic Republic

The level of certified organic production in the Lao PDR is very small, although in practice much of the agriculture is free of pesticide use and has low levels of external inputs in the form of inorganic fertilizers. There is also a strong policy commitment to “Clean Agriculture” through a differentiated regional approach. In support of these goals, a large number of nongovernment organizations (NGOs) and donors are providing some assistance, much of which is small-scale and not particularly well coordinated (Helvetas 2005). A review of the main stakeholders reveals significant differences in opinion on what is feasible and desirable in promoting organic agriculture, or GAP more generally.

The main commodity for which organic agriculture can be developed is rice, although there is also some potential being realized for coffee and mulberry. For rice, the potential is for both white rice and sticky rice. Since the Lao PDR has the highest number of varieties of sticky rice in the world, it has the potential to be marketed as unique products from the Lao PDR, a so-called geographical indication product under the WTO.

The issues to be resolved in developing organic agriculture in the Lao PDR are basically to respond to the question: Can farmers improve net incomes if they go organic? This, in turn, will depend on what happens to yields, prices, and the efficiency with which the products are marketed. Each is considered in turn using the case of rice production, which has the most potential.

6.5.2 Impacts of Organic Agriculture on Rice Yields

One of the main areas of difference is over views about the impacts of low external input agriculture on yields. Some agents argue that training and supporting extension service can increase yields. The Mennonite Central Committee, for example, which runs two programs in support of sustainable agriculture in Bolikhamxay, Pakngum, and Xaythany, have helped the farmers find new sources of organic compost and, with better seeds, have increased yields of rice from 2 to 4 tons per hectare middle



of the last decade in the four villages where they are active. One farmer using SRI reported a yield of 6 t/ha, which may be exceptional, but is indicative of what can be achieved.

On the other hand, a number of stakeholders have expressed doubts about the scope for increasing yields. In one of the interviews conducted by Helvetas (2005), a farmer from Nakey village, who farms 2 ha of wet season rice with yields of 4.2–5 t/ha, stated that turning organic would reduce yields to 3 t/ha. Insufficiency of cow dung limited yields to less than 3 t/ha. The alternative of making compost from weeds would require much more work. Other options include cowpea and mung bean, which was recommended by a director at Thasano Rice Research and Seed Multiplication Center as material for green manure, as well as guano and rock phosphate for enhancing soil fertility.

Several experts recommend lower external inputs instead of a complete ban on inorganic fertilizer to maintain yields. This was the position taken by the National Rice Research Program of the International Rice Research Institute, who argued that some fertilizer is needed to maintain yields. In this context, it is useful also to look at rice yields in northeast Thailand, where background conditions are similar, and where some farmers have adopted certified organic practices for rice. Setboonsarng, Leung, and Cai (2006) cite data showing yields at around 2.4 t/ha for conventional farms and 2.6 t/ha for farms that have been certified as organic, so at least some evidence indicates that a move to organic agriculture can sustain yields.

Others see a small role for organic agriculture but not for conservation agriculture, which constrains the practice of tillage. The scope for such agriculture has been investigated in some detail by the Lao National Agro-Ecology Programme (PRONAE), in collaboration with Centre de Coopération Internationale en Recherche Agronomique pour le Développement (CIRAD) of France. This holistic approach emphasizes the process of adaptation and validation by farmer groups, in light of the constraints of their farming systems and the overall environmental conditions. Pilot schemes in the high plains have been successful with mixed farming dominated by livestock, producing income equivalent to a rice yield of 1.8 t/ha, which is considered good for that region (Lienhard et al. 2007).

Expanding conservation agriculture of this kind is seen by the Government of the Lao PDR as complementary to attempts to foster organic agriculture and GAP systems such as SRI. A demonstration



project has been expanded to cover 1,000 ha in the upland and midstream regions. The method uses some fertilizer and pesticides, but in limited quantities and under controlled conditions. There is presently a market for the output of such farms in France, where buyers will accept products with slightly higher residues than organic agriculture certification would allow. Similar deals may be possible within the Association of Southeast Asian Nations.²¹

6.5.3 Impacts on Prices

The common view is that organic rice can be sold at a premium in the markets of the developed countries and also perhaps in Thailand. A study by Helvetas (Roder 2004) concluded that organic rice attracts a premium in the range of 10%–150% in the Swiss market. In Cambodia, interviews with experts from CEDAC indicate that rice, without full organic certification, can be sold at a premium of 10% in domestic and even international markets (small quantities exported to France of rice under the SRI program). Hence, going for organic agriculture makes sense at premiums of 40%, which is offered in Thailand even if yields are a little lower. For lower premiums, however, GAP practices may be more beneficial as long as yields are maintained. This could be true in lowland, irrigated rice ecosystems. On the other hand, for marginal upland farmers, it may be appropriate to go for certified organic agriculture, in conjunction with continuing inputs to support and help in obtaining certification.

6.5.4 Efficiency in Marketing

It is essential for an organic agriculture strategy that a market be identified for the products, and that the farmers be an integral part of the product chain. Often, this is achieved by contract farming, in which the ultimate buyer contracts the farmer to produce according to certain conditions, sometimes supplying the farmer with key inputs, and guarantees to purchase the output on agreed terms. In other cases, a farmer may not be contracted, but nevertheless needs support to market the products and to ensure products are delivered to the next stage in the chain in a timely and efficient manner. As the rice market is still

²¹ Personal communication with Phouangparisack Pravongviengkham, Director General, Directorate of Planning, Ministry of Agriculture in the Lao PDR.



developing, with weak transportation and communication links, prices and supplies greatly vary from one region to another. Often, farmers will travel long distances by tractor to sell their rice, thereby adding to their costs. This results in higher margins for the intermediaries and lower prices for the farmers (Lao Consulting Group 2004).

6.5.5 Promoting Organic Rice in the Lao People's Democratic Republic

In the Lao PDR, organic rice²² is being developed under the “ProRice Program,” referred to as PROFIL. The program is being carried out by Helvetas and the Department of Agriculture. The goal is to produce and market good-quality organic rice produced in the marginal rainfed rice-growing environments of the Lao PDR. It aims to do this by

- providing farmers with the rice varieties that are demanded in the market, and giving them the production technologies necessary for this purpose;
- assisting farmers with the management of soil fertility under organic conditions;
- organizing producers so they can have a voice in the marketing of the rice and in the terms of the certification; and
- establishing appropriate and responsible structures, so that the rice can be sold under credible labels in the national and international markets.

The project was implemented from 2006 to 2009, involved 600 producers to produce 850 tons of rice, of which 800 tons were to be exported. The project was designed to engage poor farmers in marginal areas; hence, the logistics of collecting the surplus production and transferring the rice to the relevant distribution points were developed. Another project, involving 958 families, which was similar to the ProRice Program, was implemented by the government in 10 villages in Santhong district, close to the Thai border. The project was designed to build better relationships between millers and farmers, and to promote the output under a local certification label.

²² In this chapter, we focus only on organic agriculture and GAP rice production. We have not looked at the economic potential for conservation agriculture in detail, due to lack of data. This does not mean, of course, that such a system cannot complement SRI or other rice growing systems.



Given these initiatives, the subsequent discussion explores the potential for organic rice and gains for farmers. Given limited data, a rough estimate is used based on the two missions to the Lao PDR.

First, the Lao PDR now exports rice to the PRC, Thailand, and Viet Nam, but the volume is unclear as exports are largely unofficial. One estimate says 100,000 tons per year go to Viet Nam and 50,000 tons to Thailand. In terms of self-sufficiency, the Lao PDR needs about 160 kg per person (Helvetas 2005); making the minimum domestic requirement about 0.9 million tons. In 2005, paddy production was almost double that, and although some areas were ones of deficit and some of surplus, transfers were not always carried out effectively from one to the other.

The following assumptions on the impacts of the proposed program were made:

- (i) The average holding of farmers is 1.6 ha (Lao PDR Committee for Planning and Investment 2006).
- (ii) Of the households in the program, 50% are in the lowlands and 50% in the uplands.
- (iii) The average yield is 3.0 t/ha in the lowlands and 1.8 t/ha in the uplands (Helvetas 2005).
- (iv) Gross income per hectare in the lowlands is \$450 and in the uplands \$270 (Helvetas 2005).²³
- (v) The poverty rate among lowland farmers is the same as the national average (39%, World Bank 2006b). The poverty rate among upland farmers is taken as 100%.

Of the official export target of 250,000 tons in 2010, 25% could be organic and the rest GAP rice. With improved efficiency in marketing and distribution, farmers can expect a 10% premium on the current rice price in both cases. In addition, one can expect some gains from the improved marketing and communication. A conservative estimate of gains is at 5% of the price, making the total premium 15%. If yields do not decline, increase in incomes and the numbers taken out of poverty are shown in Table 6.8.

²³ The yields in the uplands are 60% of those in the lowlands, and labor inputs are almost double per hectare.



The program would benefit about 105,000 households and generate an additional \$5.6 million in income. The estimated impacts on poverty are speculative, but the figures indicate that about 7,300 rural lowland households could be taken out of poverty, while as many as 26,000 upland households would benefit (Table 6.8).

The costs of such a program can be estimated roughly, based on a scaling up of the Helvetas project, which includes 600 households and costs \$350,000. The scaled-up cost would be about \$52 million. However, with annual benefits of at least \$5.6 million, the “rate of return” would be about 7.5%.²⁴ This is a substantial benefit for low-income households, in addition to an improved environment, better health of the households, and the demonstration effect on other households (who would copy some of the practices introduced to the selected farmers).

6.5.6 Biofuels in the Lao People’s Democratic Republic

According to the Ministry of Energy and Mines of the Lao PDR, biofuel production is estimated to reach 4 million liters by 2015 and biofuels will make up about 10% of total fuel use by 2025 based on the government’s renewable energy development strategy. The ministry is allocating modest resources to research in renewable energy and is expected to release its policy for bioenergy. So far, the government has a program in Sanyaburi province, where a 10-kilowatt (kW) biodiesel generator has been installed (Vongsay 2012).

6.5.6.1 *Jatropha*

The Lao PDR government chose *jatropha* for the production of biodiesel. About 40,000 ha were targeted for production in 2008, up from 8,000 ha in 2006, and estimated to produce 10 million–26 million liters of biodiesel, or 3%–8% of fuel oil imports. The cultivation was planned for areas in the wastelands not suitable for agriculture and some intercropping on selected agricultural land.

Interest in *jatropha* from the private sector is strong in the Lao PDR. A Korean company, Kolao, had initiated a program on *jatropha* production

²⁴ The estimate assumes that the \$52 million is spread over 4 years, and the increases in income build up to the maximum of \$5.6 million over those 4 years. The benefits are taken over 30 years.



in early 2000. The oil from jatropha seeds is converted and used to make biodiesel, with an estimated production capacity of 2 million liters of biodiesel or BD5 in 2012 (Vongsay 2012).²⁵ However, expectations for expanding jatropha production may be exaggerated. Discussions with Sunlabob, a company that is undertaking research into jatropha in the Lao PDR, revealed that a great deal of research and development is needed before successful large-scale production of biofuel from jatropha can be implemented. It has prepared detailed plans for its own program, carried out through its research branch Lao Institute for Renewable Energy (LIRE), to cost about \$2 million. Sunlabob estimates that jatropha, along with other energy crops, could supply up to 40% of the country's rural off-grid electricity needs. According to Rietzler and Pudel (2010), the agricultural challenges are greater than the technical challenges to jatropha, as there appear to be insufficient jatropha feedstocks for production.

As in Cambodia, an important issue for the government's bioenergy policy is to decide how to structure the involvement by the private sector. Concession fee rates, usage charges for natural resources, and royalties do not reflect supply and demand and are not determined according to any clear set of guidelines (Schumann et al. 2006). There were also problems on clarity in awarding contracts, conflicts with local communities, and increased environmental damage (WWF 2007).

In terms of benefits, smallholder programs can generate benefits of \$30–\$98 for an average farm of 1.5 ha, if 15% of their land is allocated to jatropha—the exact amount depending on the yield achieved. Farmers' net incomes from land would go up 25% in the lowlands and 75% in the uplands. With programs involving large concessions, employment generated could be around 0.9 persons per hectare devoted to jatropha. At a price of \$0.40 per liter, some subsidy or support may be needed for smallholders if the program is to be viable.

6.5.6.2 *Cassava*

Although the government has not targeted cassava as a biofuel crop, there can be significant benefits from providing advice and support to increase yields and to assist in the transport and marketing of the chips for export. In 2005, production of cassava was 51,300 tons on

²⁵ BD5 refers to fuel that is 95% diesel and 5% biofuel.



6,765 ha; it increased to 743,190 tons on 31,135 ha in 2011 (FAO 2011). In 2005, the yield was only 8.35 t/ha and it increased to 26.31 t/ha in 2011; agricultural productivity quadrupled in 6 years, making cassava an attractive biofuel crop.

6.6 CONCLUSION

This chapter looked at the options for organic agriculture and biofuels in Cambodia and the Lao PDR, in the context of the wider developments in these two markets worldwide. The broader context points to strong and growing demand in both organic agriculture and biofuels, especially in developed countries. The benefits of organic agriculture and biofuels to developing countries such as Cambodia and the Lao PDR are likely to be significant, although the full extent is subject to market access and—particularly for organic foods—the costs of certification. Indeed, one of the main recommendations from the study is to assist Cambodia and the Lao PDR in building capacity for certification in both areas—organic agriculture and biofuels. In addition to a formal certification system using a third-party inspection body, an alternative certification system based on existing social capital should be used, particularly for the domestic market.

In the case of organic foods, one possible concern for the future that could be relevant to Cambodia and the Lao PDR relates to energy costs of transportation, especially by air. This will be relevant to the extent that the market for the products is in the developed countries of Europe and the United States, but it could be reduced to the extent that the potential market is in the region (i.e., the PRC, Malaysia, Singapore, and Thailand), where organic products are currently being imported from Australia and Europe. In fact, if “regional” organic products replace those being imported from Australia and Europe, there are environmental benefits generated for the international community as well.

Issues of available organic fertilizer for a major expansion of organic agriculture in the developed world appear to be misplaced, as do those of a decline in aggregate food production if all farmers go organic.

In the case of biofuels, the main concern for Cambodia and the Lao PDR is the problem of obtaining carbon credits for the shift, when the biofuels are processed with considerable fossil energy. One should also note that



the local environmental impacts of the shift need careful analysis. The other concern with biofuels—that of an increase in the price of cereals—remains a global issue, but it is unlikely to be affected by the amounts produced in the Lao PDR and Cambodia. It is recommended that international institutions such as the Asian Development Bank support the countries in (i) identifying the likely carbon benefits of biofuels produced in these two countries, (ii) promoting the technologies and processes that generate measurable and acceptable benefits, and (iii) preparing the case for them to the Clean Development Mechanism Executive Board of the United National Framework Convention on Climate Change.

6.6.1 Cambodia

The detailed consideration of options in Cambodia indicates that a move to a more organic agriculture is desirable through SRI. The program promotes GAP when used along with a program supporting full organic agriculture in more exclusive or isolated areas. The analysis indicates that the combination is already yielding considerable benefits. Therefore, an expansion of the present program, to convert 20% of wet season rice farmers to SRI (i.e., about 300,000 units), would increase their incomes by 40%–70% depending on the region. About 21,000 households could be taken out of poverty even if the program was not particularly targeted at the poor. There is a potential for export sales of up to \$180 million, although all this is unlikely to be realized. The program would also increase food security and provide environmental benefits. These have not been quantified but are very real.

Thus, while an expanded SRI program is recommended, one should also recognize its market limitations. The amount of chemical-free rice that can be sold at a premium in the local market is limited and demand outside the country may be small. For this reason, promotion of certified organic agriculture in Cambodia can proceed alongside the GAP program, with the government supporting initiatives where contract farming is introduced to produce certified organic products for niche markets. The potential for certified organic agriculture has not been fully evaluated, but there are good reasons to believe that Cambodia may have a comparative advantage in these markets, given that most land areas presently contain a limited amount of inorganic residues.



On the biofuels side, of the two options, jatropha and cassava, the latter is attractive for Cambodia. Cassava has already attracted private sector interest. The recommendation is to develop a program to increase yields from the current 17.8 t/ha to 22.8 t/ha by 2012. This will need an extension and advice program of a fair size. The program would have two components: a smallholder part and a concession part. The smallholder part would target 20,000 households initially, going up to 30,000 by 2011. It would take about 7,000 households out of poverty and increase the net incomes of farmers by \$3.7 million in 2006, going up to \$14.5 million in 2011. The concessionaire component is more effective in terms of yield, but has less of a social impact; it would create about 2,000 jobs. The roots would partly go for ethanol production, for export, generating earnings of \$32 million in 2008, going up to \$65 million in 2011. The rest will continue to be used as animal feed and as an input for starch production. The project needs to be costed in terms of the support program, and analyzed with respect to the possible carbon credits.

There is a trade-off in the biodiesel projects between efficiency, which supports concessions, and equity, which may support smallholders. At present, the system of concessions is unsatisfactory and reforms are urgently needed. These should address the concerns of transparency and proper procedures—with respect to consultations, and environmental and social assessment. With reforms, it may also be possible to envisage institutional arrangements where farmers can participate on a more equitable basis.

All three of these initiatives can be pursued simultaneously, but if funds are limited, the highest priority should go to the rice project, because it generates the greatest increases in poverty reduction for the least outlay.

6.6.2 The Lao People's Democratic Republic

Data for the Lao PDR were not as comprehensive as those for Cambodia, so the analysis is less rigorous and the recommendations more generic.

It is clear from what is known, however, that the Lao PDR has much to be recommended as a center for organic agriculture. Indeed, present agriculture involves very low external inputs and the agricultural environment is generally regarded as clean. Thus, production for a high-value market may be the preferred strategy, rather than to intensify through conventional methods and compete with other more developed countries.



This study has looked at the organic agriculture potential for rice alone, although there is a small market for coffee and some other products as well. There is also a major initiative on conservation agriculture (which looks at livestock and mixed farming systems), and which should contribute to a more sustainable agriculture.

For rice, unlike Cambodia, there is not the same evidence in favor of an SRI approach raising yields, and indeed the reviews show a wide divergence of opinions. Having looked at this, we conclude that a shift to organic agriculture should not cause a fall in yields as long as it is supported by suitable advice from well-qualified experts. This is even more likely to be the case if the aim is not organic agriculture in a formal sense, but GAP, with some permitted external inputs. In fact, both GAP and organic agriculture can run together in a program, following the regional demarcations laid out by the government.

If yields can be maintained, and if marketing and communication improved as indicated in the surveys, a 15% increase in farmer incomes was estimated as feasible. With a program covering around 100,000 households, half of which are upland and half lowland, an increase in incomes of about \$5.6 million is feasible. This should take about 33,000 households out of poverty. The likely cost of the program would be about \$52 million, possibly less, based on data from small-scale ongoing efforts.

On the biofuels side, two options are attractive for the Lao PDR, but both need further investigation and development before they can be realized. The present targets are unrealistic, and the government and the international community need to devote more resources to supporting research on jatropha and cassava. The government also needs to improve the framework for concessions of land to private investors, if these are not to cause conflict and even hardship to local communities.

In terms of benefits, the program's economics should be similar to those in Cambodia. Smallholder programs would guarantee that most participating farmers who were poor would be taken out of poverty. With programs involving large concessions, all employees should earn enough to take them out of poverty. Exact estimates of the numbers who would benefit and be taken out of poverty, however, are not possible given the data available. The problems facing any program will be the economics of obtaining a reasonable return on the capital invested. This in turn will depend on the price of biodiesel, with a price of \$0.40 per



liter not being enough to make the smallholder program viable, but likely to be enough to make the concessionaire program viable. As in the case of Cambodia, some subsidy or support may be needed for smallholders if the program is to be viable.

For cassava, if the program could achieve a 50% increase, the surplus production could be exported as root or processed chips. The potential to the growers could be around \$70.7 per hectare, which would make a major change in their livelihoods. In terms of priority, as with Cambodia, the GAP rice development should take first place, with certified organic agriculture programs being developed where market niches can be identified. On biofuels, further investigation is needed before a judgment can be made on which is the more attractive.

REFERENCES

- Anthofer, J. 2004. *The Potential of the System of Rice Intensification (SRI) for Poverty Reduction in Cambodia*. <http://www.tropentag.de/2004/abstracts/full/399.pdf> (accessed 15 June 2013).
- Badgley, C., J. Moghtader, E. Quintero, E. Zakem, M.J. Chappell, K. Avilés-Vázquez, A. Samulon, and I. Perfecto. 2007. Organic Agriculture and the Global Food Supply. *Renewable Agriculture and Food Systems*. 22 (2). pp. 86–108.
- Biofuels Digest*. 2010a. Cambodia's NTC Halts Production as Low Jatropha Yields Bite. 19 November. <http://www.biofuelsdigest.com/bdigest/2010/11/19/cambodias-ntc-halts-production-as-low-jatropha-yields-bite/>
- . 2010b. MH Bio-Energy in Cambodia Expects to Reopen Cassava Ethanol Plant. 14 July. <http://www.biofuelsdigest.com/bdigest/2010/07/14/mh-bio-energy-in-cambodia-expects-to-reopen-cassava-ethanol-plant/>
- Birur, D., T. Hertel, and W. Tyner. 2008. Impact of Biofuel Production on World Agricultural Markets: A Computable General Equilibrium Analysis. Department of Agricultural Economics, Purdue University. GTAP Working Paper No. 53. <https://www.gtap.agecon.purdue.edu/resources/download/4034.pdf>



- BML (Bundesministerium für Ernährung, Landwirtschaft und Forsten). 2000. *Evaluation of Conventional and Organic Agricultural Production in Relation to Primary Energy Inputs and Certain Pollution Gas Emissions*. Commissioned by the Federal Ministry for Food, Agriculture and Forestry (BML). Bonn: Federal Research Centre of Agriculture.
- DEFRA (Department for Environment, Food and Rural Affairs). 2003. *An Assessment of the Environmental Impacts of Organic Farming*. Elm Farm Research Centre and Institute for Grassland and Environmental Research. May. <http://www.defra.gov.uk/farm/organic/policy/research/pdf/env-impacts2.pdf>
- Dufey, A. 2006. *Biofuels, Production, Trade and Sustainable Development: Emerging Issues*. London: Environmental Economics Programme/Sustainable Markets Group, International Institute for Environment and Development.
- EC (European Commission). 2005. *Organic Farming in the European Union: Facts and Figures*. Brussels: Directorate General 2 (DG2).
- EU (European Union). 2006a. *Communication from the Commission: An EU Strategy for Biofuels COM (2006) 34 Final*. White Paper. Brussels.
- . 2006b. *An EU Strategy for Biofuels: Impact Assessment*. Commission Staff Working Document. Communication (COM) (2006) 34 Final. Brussels.
- FAO (Food and Agriculture Organization of the United Nations). 2011. FAOSTAT. 2011. <http://faostat.fao.org/site/339/default.aspx>
- Giovannucci, D. 2005. *Organic Agriculture for Poverty Reduction in Asia: [the People's Republic of] China and India Focus. Thematic Evaluation*. International Fund for Agricultural Development (IFAD), Report 1664. Rome: IFAD.
- Halberg, N., M.T. Knudsen, H.F. Alrøe, and E.S. Kristensen, eds. 2006. *Global Development of Organic Agriculture: Challenges and Prospects*. Wallingford: Centre for Agriculture and Biosciences International.



- Hausmann, R. 2007. Biofuels Can Match Oil Production. *Financial Times*. 7 November.
- Helvetas. 2005. *Promotion of Organic Rice from Lao “ProRice.”* Vientiane.
- IFAD (International Fund for Agricultural Development). 2002. *Thematic Evaluation of Organic Agriculture in Latin America and the Caribbean*. Evaluation Committee Document. Rome.
- IFPRI (International Food Policy Research Institute). 2006. *Bioenergy and Agriculture: Promises and Challenges*. Focus 14, Brief 3. December. Washington, DC.
- IPCC (Intergovernmental Panel on Climate Change). 2007. *Climate Change 2007. Mitigation of Climate Change: Working Group III Contribution to the Fourth Assessment Report of the IPCC*. Cambridge, UK: Cambridge University Press.
- Lanzini, P. 2007. *Food Crops vs. Fuel Crops: Perspectives and Policy Options*. New York, NY: United Nations Commission on Sustainable Development.
- Lao Consulting Group. 2004. *Lao People’s Democratic Republic Small and Medium Enterprises (Small and Medium Enterprises (SME)) Agribusiness Study for the Vientiane Plan*. Mekong Private Sector Development Facility.
- Lao PDR Committee for Planning and Investment. 2006. *Statistical Yearbook 2005*. Vientiane: National Statistical Center. Center for Statistics and Communication, Department of Planning, Ministry of Agriculture and Forestry.
- Larson, E.D. 2006. A Review of Life-Cycle Analysis Studies on Liquid Biofuel Systems for the Transport Sector. *Energy for Sustainable Development*. 10 (2). pp. 109–126.
- Lienhard, P., H. Tran Quoc, C. Khamxaykhay, T. Sosomphou, F. Tivet, G. Lestrelin, K. Panyasiri, and L. Séguy. 2007. *Improving Smallholder Livelihood, Watershed and Soil Management through Conservation Agriculture in the Lao People’s Democratic Republic*. <http://dev.thegnscs.org/sitefiles/file/>



- Laos_Agriculture_Conservation_Lienhard%20et%20al_.pdf (accessed 20 June 2013).
- McCormack, J. 2007. *A Life Cycle Assessment of Biodiesel from Malaysian Palm Oil*. Department of Mechanical Engineering, University of Bath.
- Ministry of Commerce, Government of Cambodia. 2006. *Cambodia National Export Strategy 2006–2008*. Phnom Penh.
- Ministry of Planning, Cambodia. 2005. *Crop Production in Cambodia 2004*. Phnom Penh: National Institute of Statistics.
- Namara, R.E., P. Weligamage, and R. Barker. 2003. *Prospects of System of Rice Intensification Adoption in Sri Lanka: A Socioeconomic Assessment*. Research Report No. 75. Colombo, Sri Lanka: The International Water Management Institute.
- Nielsen, S. 2013. Brazil Ethanol Output Seen Jumping 14% on Fuel Blend. *Bloomberg*. 17 January. <http://www.bloomberg.com/news/2013-01-16/brazil-ethanol-output-seen-jumping-14-on-fuel-blend.html>
- Parrott, N., and T. Marsden. 2002. *The Real Green Revolution. Organic and Agroecological Farming in the South*. London: Greenpeace Environmental Trust.
- Parrott, N., J.E. Olesen, and H. Høgh-Jensen. 2006. Certified and Non-Certified Organic Farming in the Developing World. In N. Halberg, M.T. Knudsen, H.F. Alrøe, and E.S. Kristensen, eds. *Global Development of Organic Agriculture: Challenges and Prospects*. Wallingford: Centre for Agriculture and Biosciences International. pp. 153–176. <http://ecowiki.org/GlobalPerspective/ReportOutline>
- Pretty, J.N., A.D. Noble, D. Bossio, J. Dixon, R.E. Hine, F.T. Penning De Vries, and J.L. Morison. 2006. Resource-Conserving Agriculture Increases Yields in Developing Countries. *Environmental Science & Technology*. 40 (4). pp. 1114–1119.
- Qiao, Yu, N. Halberg, and S. Setboonsarng. 2007. Development of Organic Agriculture in Case Areas: [the People's Republic of] China. In



- S. Setboonsarng and A. Markandya, eds. *Meeting the Multiple Bottomline and Achieving the Millennium Development Goals through Organic Agriculture*. ADBI Mimeo.
- Rietzler, J., and F. Pudel. 2010. Using *Jatropha Curcas* for Generating Energy – A Study of the Properties during Processing. Presentation at Biofuels & *Jatropha*, Markets Asia – International Conference for Renewable Resources. Jakarta. 29 June–1 July. http://www.lao-ire.org/data/documents/data_research/general/LIRE-Using_Jatropha_Curcas_for_Generating_Energy.pdf
- Roder, W. 2004. *Organic Rice Market Study. Potential for Organic Rice from the Lao People's Democratic Republic – With Special Focus on Switzerland*. Zurich, Switzerland: Helvetas.
- Rosegrant, M.W., C. Ringler, T. Benson, X. Diao, D. Resnick, J. Thurlow, M. Torero, and D. Orden. 2005. *Agriculture and Achieving the Millennium Development Goals*. Agriculture and Rural Development Department. Washington, DC: World Bank.
- Rundgren, G. 2006. *Organic Agriculture and Food Security*. Bonn: International Federation of Organic Agriculture Movements.
- Runge, C.F. 2007. *How Biofuels Could Starve the Poor*. New York, NY: Foreign Affairs.
- Scialabba, N.E., and C. Hattam, eds. 2002. *Organic Agriculture, Environment and Food Security*. Rome: Environment and Natural Resources Service Sustainable Development Department, Food and Agriculture Organization of the United Nations.
- Schumann, G., P. Ngaosrivathana, B. Soulianh, S. Kenpraseuth, K. Onmanivong, K. Vongphansipraseuth, and C. Bounkhong. 2006. *Study on State Land Leases and Concessions in Lao PDR*. Land Policy Study No. 4. Lao-German Land Policy Development Project.
- Setboonsarng, S. 2006. Organic Agriculture and the MDGs: Impacts Reported in Existing Literature. ADBI Discussion Paper No. 54. Tokyo: Asian Development Bank Institute.



- Setboonsarng, S., and A. Markandya, eds. 2007. *Organic Agriculture, Poverty Reduction, and the Millennium Development Goals*. ADBI Mimeo.
- Setboonsarng, S., P. Leung, and J. Cai. 2006. Contract Farming and Poverty Reduction: the Case of Organic Rice Contract Farming in Thailand. ADBI Discussion Paper No. 49. Tokyo: ADBI.
- Som, L. 2012. Crop Production Situation in Cambodia. Presented at the Asian Seed Congress. Pattaya, Thailand. 17 February–2 March. <http://apsaseed.org/ASC2011/Presentation/TechnicalSession/Cambodia.pdf>
- Stolze, M., A. Piorr, A. Häring, and S. Dabbert. 2000. The Environmental Impacts of Organic Farming in Europe. *Organic Farming in Europe: Economics and Policy*. Vol. 6.
- Trewavas, A. 2001. Urban Myths of Organic Farming. Organic Agriculture as an Ideology, But Can It Meet Today's Needs? *Nature*. 410 (March), pp. 409–410.
- UN (United Nations). 2005. Millennium Development Goal Indicators Database. United Nations Statistics Division. http://unstats.un.org/unsd/mi/mi_goals.asp
- . 2007. *Sustainable Bioenergy: A Framework for Decision Makers*. New York, NY.
- Vongsay, P. 2012. Biofuels a Growing Industry in the Lao People's Democratic Republic. *Vientiane Times*, Asia News Network. 1 March. <http://my.news.yahoo.com/biofuels-growing-industry-laos-054005997.html>
- Watananonta, W., and R.H. Howeler. 2005. *Present Situation and Future Potential of Cassava Production and Utilization in Thailand*. Bangkok: International Centre for Tropical Agriculture.
- Williams, A.G., E. Audsley, and D.L. Sandars. 2006. *Determining the Environmental Burdens and Resource Use in the Production of Agricultural and Horticultural Commodities. Main Report*. Department for the Environment, Food and Rural Affairs



(DEFRA) Research Project IS0205. Bedford: Cranfield University and DEFRA.

Willer, H., J. Lernoud, and L. Kilcher, eds. 2013. *The World of Organic Agriculture: Statistics and Emerging Trends 2013*. 14th edition. Bonn: International Federation of Organic Agriculture Movements and Frick: Forschungsinstitut für biologischen Landbau.

Wolf, M. 2007. Biofuels: An Everyday Story of Special Interests and Subsidies. *Financial Times*. 31 October.

World Bank. 2006a. *Cambodia. Halving Poverty by 2015? Poverty Assessment 2006*. Washington, DC: East Asia and Pacific Region, World Bank.

_____. 2006b. World Development Indicators. Washington, DC.

WWF (World Wide Fund for Nature). 2007. *Addressing the Environmental and Social Challenges Resulting from Large-Scale Agricultural Land Concessions in Cambodia and Lao PDR*. WWF Cambodia and Lao offices Mimeo.



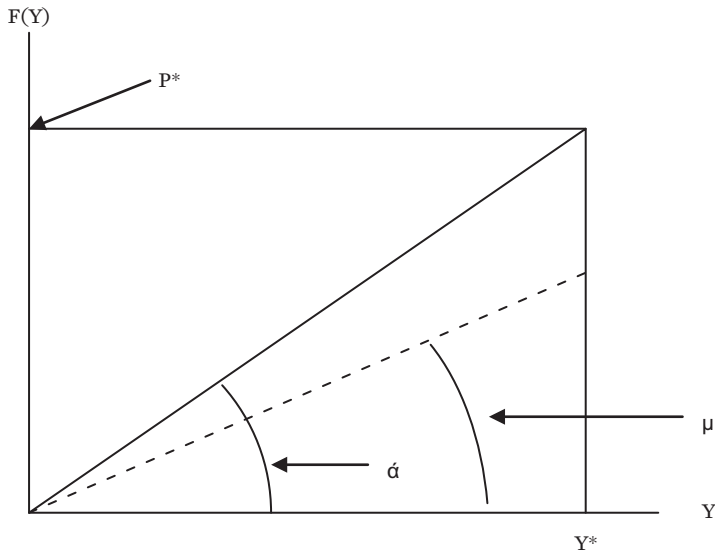
Appendix 6.1 ESTIMATING THE NUMBER OF HOUSEHOLDS TAKEN OUT OF POVERTY

The number of households that are poor (P) with income below Y are $F(Y)$.

The cut-off limit for households to be poor is Y^* .

In the absence of knowledge of the function $F(Y)$, we assume a linear cumulative density function as shown in the figure.

An increase in incomes of $\gamma\%$ would shift the line to the dashed line on the right as shown in the same figure.



On the original line, given by $P = \alpha Y$, the number of poor with income below Y^* is P^* where

$$P^* = \alpha Y^*.$$



On the new line with increased incomes that are $\gamma\%$ higher for all households, the value of Y below which P^* households have an income of less than Y is given by

$$P^* = \mu(1 + \gamma)Y^*.$$

Hence,

$$\mu = P^*/(1 + \gamma)Y^*.$$

So μ is given by

$$\mu = P^*/((1 + \gamma)Y^*).$$

Hence, the value of P corresponding to Y^* on the dashed line is given by P^{**} where

$$P^{**} = \mu Y^* = P^*/(1 + \gamma). \quad Y^* = P^*/(1 + \gamma).$$

In other words, the number still in poverty is reduced by a factor of $1/(1 + \gamma)$.

This approximation has been used as we do not have the distribution function for the poor households. It is likely to underestimate the number taken out of poverty, as a lognormal distribution would have more households closer to the poverty line than this linear approximation suggests.



Chapter 7 | **Macroeconomic Impacts of Organic Agriculture in Thailand: Results Summary**

Somchai Jitsuchon and Nuntaporn Methakunavut

7.1 INTRODUCTION

Thailand has practiced traditional organic agriculture for hundreds of years. Most of its traditional organic farms remain as they have been in the past despite the Green Revolution that swept the country and the world in the 1960s. Much of the local indigenous knowledge of environmentally sustainable farming is still a source for the development and enrichment of organic farming practices in Thailand (TOTA website).

Furthermore, “modern” organic agriculture has experienced steady growth in the last two decades. In terms of land area, such organic production grew from 320 hectares (ha) in 1992 to about 37,000 ha in 2011. This is still a small proportion, however, of the 21.074 million ha of agricultural land in the country. Demand for organic products also grew, with their value steadily increasing from \$0.8 million in 1992 to about \$65.0 million in 2011. This is still dwarfed by the value of total agricultural production in Thailand in 2010 at \$47.0 billion (FAOSTAT 2011).

In terms of volume organic production, the figures more than quintupled from 9,756 tons in 2003 to 47,547 tons in 2010 (Chinsathit 2012). Despite organic agriculture’s steady growth, it is still a very small portion of the agriculture sector. However, its future looks rosy as more consumers worldwide demand such produce. Locally, more Thais are also shifting to organic products and those who are able to afford the premium price difference between conventional and organic produce are growing in number. All these developments have fueled the growth of organic fresh vegetables, fruit, and rice for domestic production and export. Organic processed products have also been developed, such as sugar, tapioca



starch, and palm oil, albeit few due to limited raw organic materials¹ (IFOAM website).

For the organic sector to grow, government support remains a crucial factor. While the Thai government has promoted organic agriculture through its implementation of the National Agenda on Organic Agriculture for 2005–2009, it is widely seen as inadequate. One of the reasons is the lack of a full understanding of the impact of organic agriculture on the overall economy. This chapter attempts to address this knowledge gap by taking into account the complete mechanism at the macroeconomic level, supported by parameters from microlevel studies to build a comprehensive sectoral model that separates some important organic farming sectors in Thailand from their traditional counterparts.

The findings in this chapter are the summarized results of a computable general equilibrium (CGE) model to produce simulated comprehensive impacts of organic agriculture promotion on the Thai economy. The CGE model incorporated both the positive and negative consequences to other production sectors, as well as the overall impacts on the entire economy. Selected parameters will be discussed and categorized based on their impacts on some of the target variables of the model, allowing for interactions between all economic sectors in the model.²

7.2 DATA CLASSIFICATION ON ORGANIC AGRICULTURE IN THAILAND

Thailand's main certified organic crops are rice, fruit and vegetable, and shrimp. As the sector is still small, data on organic agriculture in Thailand are scarce, complicated by data classification based on various certification standards for organic produce (certified) and other safe produce (noncertified), making it impossible to categorically differentiate between the two markets (TOTA 2011). Table 7.1 summarizes the major groups of agri-produce and the organic products and/or crops under each group.

¹ Importers prefer to process raw organic materials from Thailand in their respective countries to ensure the high quality of the final product and low import taxes.

² The full report is available from the editors.

**Table 7.1 Main Organic Agriculture Headings in Thailand**

Headings	Organic Products
Rice	White rice and brown rice (i.e., Hom mali rice)
Bean	Soy bean, peanuts
Maize	Baby corn (fresh, frozen, and bottled)
Vegetables	Asparagus, okra, salads
Fruit	Banana, papaya, pineapple, mango
Herbs	Herbal tea, dried lemongrass, etc.
Shrimp	Giant tiger shrimp

Sources: Summarized from interview information; Green Net/Sai Yai Pan-Din Foundation 2004 data.

The practice of certified organic agriculture is grouped into three business models: (i) small-scale monocrop farming by small-scale family farming or small private firms; (ii) integrated farming, where groups of farmers combine their efforts with nongovernment organization (NGO) support; and (iii) large contract farming by big firms, particularly targeting export markets.

7.3 THAILAND ORGANIC AGRICULTURE– COMPUTABLE GENERAL EQUILIBRIUM MODEL STRUCTURE AND SPECIFICATION

A computable general equilibrium (CGE) model was built to analyze the macroeconomic impacts of organic agriculture in Thailand. The model is based on a social accounting matrix (SAM) that represents the complete set of all economic transactions of Thailand in one particular year. As the classification of economic transactions in SAM determines their potential use for CGE modeling, the SAM constructed for this project is specially designed to incorporate information on selected organic agriculture-related economic transactions taking place in the study year.

A customized SAM was created to serve as a database, using the 2005 dataset to build the CGE model, hence dubbed “OA SAM 2005.” The data used include production structure and costs, sales, prices, and margins.



7.3.1 Organic Agriculture Social Accounting Matrix Structure

OA SAM 2005 has 488 accounts, with 53 production sectors, commodities, or activities, 12 of which are agricultural products selected for this study. It has four organic agri-products: (i) rice, (ii) maize, (iii) vegetables, and (iv) fruit. About half of the remaining sectors are either agriculture or agri-business and the other half is nonagriculture (manufacturing and service sectors). The four selected agriculture sectors are subdivided into (i) conventional, (ii) chemical-free, and (iii) organic agriculture, for a total of 12 sectors. The organic sectors are those with certified produce. The chemical-free sectors did not have certification, hence compliance of their farming practices with organic standards is not guaranteed.

OA SAM 2005 has four institutions as follows: (i) 20 groups of households, which consist of 10 agricultural households (HH agr) and another 10 nonagricultural households (HH nonagr) classified into income classes; (ii) 1 business sector, which includes state enterprises; (iii) 1 government sector (GOV), which represents both the central government and local governments as a whole; and (iv) rest of the world (ROW) accounts, covering all external transactions including exports, imports (ROW noninvestment income), factor income payment (ROW investment income), current transfers (ROW transfer), and capital flows (ROW cap).

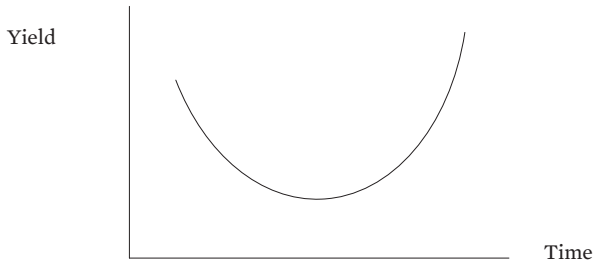
7.3.2 Data Sources and Model Structure

To build OA SAM 2005, four main sources of data are used: (i) input-output (I-O) tables, (ii) macroeconomic data, (iii) agricultural I-O and census data, and (iv) organic agriculture survey data. The analysis uses a static CGE model based on the prepared OA SAM 2005 with standard CGE specifications commonly used in the literature. To analyze the macroeconomic impacts of organic agriculture, the following are some explicit treatments of the organic sectors:

- (i) Organic and nonorganic farming sectors are allowed to substitute each other, as factors of production, making the “switching” between organic agriculture and nonorganic agriculture possible.
- (ii) Organic products have a “price premium” in international markets, useful for tracking the impacts of its change to growth of organic production vis-à-vis nonorganic production.



Figure 7.1 Time-Varying Yield Rates of Organic Agriculture



Source: Authors' depiction.

- (iii) Exports of organic products are treated separately from nonorganic exports, as organic exports may have a lower price demand elasticity than nonorganic exports (manufacturing and service sectors).
- (iv) While this is a static model, time-varying yield rates of organic production may be experienced as revealed in some research, suggesting that the expected yield curve of organic agriculture is a long-tailed U-curve (Figure 7.1). The “efficiency gain and/or loss” is captured in the model through “technology parameters” inherited in the production functions of the selected organic products.³

7.3.2.1 Functional specifications in organic agriculture-computable general equilibrium model

The functional specifications in the model include production functions, consumption functions, export functions, import functions, and tax functions. The specification of organic agriculture and nonorganic agriculture substitution and price premiums are also included.

³ The model is purely a theoretical or experimental exercise. In a dynamic model, the organic benefits would increase over time, albeit after a possible small decline, for this reason.



(i) Nested production functions

The first layer models uses of all production inputs (intermediate and primary inputs) following the Leontief production function:

$$t_{ij} = \frac{t_{ij}^0}{Y_j^0} \cdot Y_j \cdot \left(\frac{P_i}{P_j} \right) \quad (1)$$

t_{ij} is a payment value for input i needed to produce output j , which has market value at Y_j . The superscript 0 indicates the value for the base year, which is 2005 in this study. P_i and P_j are equilibrium prices of input i and output j , respectively. The second, inner layer of the production function involves the primary input requirements, which are disaggregated into labor input and capital input. For this layer, the constant elasticity substitution (CES) production function with technical changes is used:

$$t_{ij} = \frac{t_{ij}^0}{Y_j^0} \cdot Y_j \cdot \left(\frac{P_i/P_j}{E_{ij}} \right)^{1-\sigma_j} \quad (2)$$

The CES production function covers various possibilities, depending on the value of fixed substitution elasticity σ_j . When elasticity equals unity ($\sigma_j = 1$), the CES boils down to the Cobb-Douglas production function. The value Y_j can be regarded as a composite indicator of sector j value-added at factor cost. The parameter E_{ij} represents the productivity level of input i in producing output j , and is normalized to unity in the base year. An $E_{ij} > 1$ in the subsequent period indicates more productive use than in the base year. It is through this parameter that the model allows for the U-curve yield path of the organic farming activities.

(ii) Consumption function

The model uses a nonlinear expenditure system:

$$t_{ij} = \left[\frac{t_{ij}^0}{Y_j^0} + \rho_{ij} \cdot \exp\left(\frac{-\beta_j}{Y_j/P_j}\right) - \exp\left(\frac{-\beta_j^0}{Y_j^0}\right) \right] \cdot Y_j \quad (3)$$

The value share (ratio of consuming goods i to total consumption [Y_j]) is derived from the base year share, corrected over time for changes in real income (Y_j/P_j) and changes in pattern of consumption or expenditure. The pattern of expenditure changes includes direction of changing income (captured by ρ_{ij}) and the speed with which the changes take place (captured by β_j).



(iii) Export function

$$t_{ij} = t_{ij}^0 \cdot R_{ij} \cdot (PIX_i \cdot e_j)^{\eta_i} \cdot P_i^{(1-\eta_i)} \quad (4)$$

The export demand function depends on the export price in the local currency P_i , world price in foreign currency PIX_i , and the price of foreign currency (exchange rate) e_j . η_i denotes the elasticity of substitution between goods supplied to domestic markets and those supplied to export markets. In addition, exports also depend on a nonprice factor, which is denoted by growth parameter R_{ij} . Since every commodity has its own export function, this means the export of organic products is also a function of their own export prices and elasticity of substitution.

(iv) Import payment function

$$t_{ij} = \frac{t_{ij}^0}{Y_j^0} \cdot Y_j \cdot PIM_j \cdot \frac{e_i}{P_j} \quad (5)$$

Payments for imports depend on world import price in foreign currency PIM_j , multiplied by the exchange rate e_i and have an inverse relationship with the domestic price in the local currency P_j .

(v) Tax function

$$t_{ij} = \left(\frac{\theta_{ij}}{1 + \theta_i} \right) \cdot Y_j \quad (6)$$

This specifies a fixed proportion of the income before tax to account j , which is paid as tax to account i . θ_{ij} represents the tax rate as a fraction of the transfer excluding tax, and $\theta_j = \alpha \theta_{ij}$.

(vi) Price premium specification

As mentioned, this captures consumers willingness to pay extra for organic products. There are some technical issues of modeling price premiums in CGE models, where all prices are normally initialized to 1 in the base period, including the organic and nonorganic agriculture exports. To overcome this, a pseudo-account was created for “nonorganic agriculture equivalent export.” The pseudo-account has the role of intermediating export receipts from export sectors of both organic agriculture and nonorganic agriculture to the respective production sectors. However, when intermediating export receipts from organic agriculture exports, the intermediated amount is only equal to



the receipts calculated at the price of nonorganic agriculture exports, hence the name. The remaining extra receipts of the organic agriculture exports is paid to another account called “organic agriculture price premium.” The specification of this payment (from organic agriculture export to price premium) is similar to a tax payment.

Specifically, the payment from organic agriculture export to nonorganic agriculture equivalent export account follows the Leontief relation

$$t_{ij} = \frac{t_{ij}^0}{Y_j^0} \cdot Y_j \cdot \left(\frac{P_i}{P_j} \right) \quad (7)$$

The Leontief relation is used here because when there is only one “input” (nonorganic agriculture equivalent) quantity, that quantity will be equal to the “output” (organic agriculture-export) quantity. The payment to price premium is specified as:

$$t_{ij} = \frac{THET_j}{(1 + THET_j)} \cdot Y_j \cdot (8)$$

$THET_j$ is the tax (premium) rate as a fraction of the export receipts from organic agriculture exports. Note that the price premium account has no quantity. In summary, the model has 11 parameters and the following are the values of all exogenous variables that needed to be specified for the model simulation:

ETA	= Export elasticity	$THET$	= Tax rate
$SIGM$	= Elasticity of substitution	PIM	= Import prices in foreign currency
C	= Exogenous value share	PIX	= Export prices in foreign currency
E	= Productivity or technical change	$PRICE$	= Exogenous prices
F	= Exogenous value transferred	$QUAN$	= Exogenous quantities
R	= Export trend		

7.3.2.2 Productivity growth on organic agriculture

Productivity growth is modeled as “technical shocks” to the production of organic agriculture, which will ultimately affect both production and prices. In the model, productivity growth is experimented through changes in parameter E , when E gradually increases to above 1. Productivity growth in the organic farming sectors may come from technical advancement or from the lower cost after the initial stage



of implementing organic practices, as depicted along the U-curve yield (Figure 7.1). With lowered cost, organic farming outputs tend to rise and the price tends to fall. Or, if prices do not fall, profits rise, further fueling the production of organic agriculture. Under general equilibrium mechanisms, many other sectors stand to benefit from technological improvement in organic agriculture as well through increased demand from organic farmers and exporters. Some nonorganic sectors will experience negative impacts, including the chemical fertilizer and pesticide sectors. These negative impacts are also enlarged through the general equilibrium mechanism.

7.3.2.3 Exports of organic products

R and PIX are the main “exogenous” parameters for exports. The R parameter represents the shift parameters (nonprice factors) of each exported commodity. For organic agriculture, this could mean that organic agriculture is experiencing increased popularity among foreign consumers, or that Thai organic agriculture exporters are able to find more export markets, either because of increased competitiveness or because some international organic exporters relocated their operations to Thailand. The export price PIX represents the price that Thai exporters receive in foreign currencies.

7.4 CONSTRUCTION OF THE SOCIAL ACCOUNTING MATRIX: ORGANIC AGRICULTURE PARTS

For the four selected agricultural products (rice, maize, fruit, and vegetables), the basic information relating to production structure and cost, sales, prices, and profit margins were used. There are three main sources for the production structure: (i) agricultural census of 2003 useful for controlling for the total amount of production in each crop as SAM represents the overall transactions for the country; (ii) organic farm survey with detailed questions on organic and nonorganic farming activities, including cost, sale, prices and profit margins;⁴ and (iii) researchers’ field surveys of organic producers and marketing

⁴ Since the surveys were only conducted in some provinces in the north and northeast regions, some adjustments were necessary when applying the survey results to the whole country.



companies to complement the incomplete picture provided by the above two secondary data.⁵

To build OA SAM, microlevel data on the production cost structure, profit margins, and certification cost were compiled and then scaled up and applied, with appropriate adjustments, to the national level.⁶

7.4.1 Scaling Up to National Level

The four selected agricultural products in the OA SAM are rice, maize, vegetables, and fruit, based on three production systems: (i) organic agriculture, (ii) chemical-free agriculture, and (iii) conventional agriculture.⁷ To scale up the production structure to the national level for input into OA SAM, all information obtained from the microlevel must be used to estimate their macrolevel counterparts.

The production structure used at the macrolevel:

$$\text{Output Value} = (WP + IIP + IR + P + \text{Depreciation})$$

The components of the output value can be calculated as:

- (i) Output Value = Planted area (rai) × Average yield (kilogram per rai)
- (ii) Wage Payment (WP) = Average employment (persons) × Average working day (days/year) × Average daily wage rate
- (iii) Intermediate Inputs Payment (IIP) = Fertilizer per kilogram × Output + Pesticide per kilogram × Output + Other intermediates
- (iv) Interest and Rent (IR) = Interest and rent per kilogram × Output
- (v) Profit (P) = Profit per kilogram × Output

The estimation of the production structure for the three rice categories used information from organic farming surveys together with those from the agricultural census, I-O tables, case studies, and relevant

⁵ Appendix I has the names of the persons and organizations consulted.

⁶ A detailed description of the sequence in the procedure is available upon request from the editors.

⁷ Details of the calculation and assumptions for the construction of the production structure are available upon request from the editors.

**Table 7.2 Data on Organic and Nonorganic Crops, 2005–2006**

Organic Agriculture	Planted Area	Production		Sale Amount	Income		Unit Price
	(rai)	(kg)	(kg/rai)	(kg)	(baht)	(baht/rai)	(baht/kg)
Rice	4,899	1,663,523	340	1,094,426	10,813,023	2,207	9.88
Maize	27	18,434	683	18,420	59,050	2,187	3.21
Vegetables	22	30,458	1,384	28,470	192,270	8,738	6.75
Fruit	78	17,117	220	16,177	131,908	1,697	8.15
Total	5,204	1,821,848	350	1,239,239	11,442,567	2,199	9.23
Nonorganic Agriculture							
Rice	4,596	1,635,305	356	1,037,631	9,304,842	2,024	8.97
Maize	66	48,268	737	48,268	149,100	2,276	3.09
Vegetables	5	3,670	816	3,097	51,461	11,436	16.62
Fruit	179	47,937	268	46,297	393,200	2,200	8.49
Total	4,955	1,767,828	357	1,154,006	10,100,686	2,039	8.75

kg = kilogram.

Source: Processed from Organic Agriculture Survey 2005/06, Office of Agricultural Economics, Ministry of Agriculture.

macro variables, as summarized in Tables 7.2 and 7.3. A similar treatment is applied to maize, vegetables, and fruit.

It should be noted, however, that the data from the organic agriculture surveys cover only north and northeast of Thailand, so it is subject to sampling biases, as the distribution of both organic activities and nonorganic activities will not reflect the national distribution. For this reason, adjustments must be made, either by comparisons with other secondary data or with macro figures.

7.5 CONSTRUCTION OF THE SOCIAL ACCOUNTING MATRIX: NONORGANIC AGRICULTURE PARTS

The nonorganic agriculture parts are the other macro elements of OA SAM, except those relating to the 12 agriculture sectors (relating to conventional or chemical, chemical-free, and organic agriculture sectors). The nonorganic agriculture parts represent more than 90% of OA SAM. The construction procedure basically follows the standard practice in constructing classical SAMs. The steps taken in OA SAM

**Table 7.3 Average Wage Rate Paid in Organic and Nonorganic Production**

	Organic Agriculture		Nonorganic Agriculture	
	Mean (baht)	No. of observations	Mean (baht)	Number of Observations
Rice	121.0	51,109	148.5	32,426
Maize	129.0	129	118.1	307
Vegetables	137.2	533	126.8	62
Fruit	137.8	242	160.7	245
Total	117.8	83,208	124.1	103,857

Source: Processed from Organic Agriculture Survey 2005/06, Office of Agricultural Economics, Ministry of Agriculture.

construction include (i) mapping I-O and the National Income Account to OA SAM; (ii) applying 2005 data to the I-O 2000 structure; and (iii) expanding to 20 household accounts.

The organic agriculture part is inserted by adding the 12 accounts of the chemical, chemical-free, and organic sectors from the previous section. Following this, composite accounts (combinations of domestic and import intermediate and final demand) and saving and/or investment accounts will be created to complete OA SAM 2005.

7.6 COMBINING ORGANIC AND NONORGANIC AGRICULTURE PARTS: COMPLETE SOCIAL ACCOUNTING MATRIX 2005

Once the final version of the production structure is done, the remaining task for OA SAM is to complete the “output distribution” parts of the 12 agriculture sectors (conventional, chemical-free, and organic sectors) selected for the study. There are two main parts to disaggregate the four selected agricultural commodity groups (paddy rice, maize, vegetables, and fruit) to the 12 sectors as mentioned. The first part is the production structure containing the value-added and intermediated input structure. The second part is the final demand, including domestic private consumption expenditure (PCE) and export with extracted price premiums. Expanding PCE to 20 household accounts is also included in this part.



7.7 MACROECONOMIC IMPACTS OF ORGANIC AGRICULTURE PROMOTION

The completed OA SAM was then used as a database for building a CGE model to study the macroeconomic impacts of various kinds of promotion of organic agriculture in Thailand. The way that the final CGE model is modeled enables evaluations of a number of possible ways to promote organic agriculture.

First, the model is used to study the impacts on the Thai economy if Thai organic produce were to become more popular or if global consumers demand more organic produce, which would increase Thai organic exports.

Second, increased awareness about health among global consumers, to the extent that they are willing to pay more for organic over conventional farming produce, translates into higher price premiums for exported organic products from everywhere, including Thailand.

Third, organic produce may gain popularity in domestic markets as well. If that is the case, production and sales of organic produce would rise there as well.

Fourth, similar to export premiums, the increased popularity in domestic markets could result in higher price premiums for domestically sold organic produce.

Note that in CGE modeling, as well as in reality, any increased production must be met by an equivalent increase in demand, external or internal. It is important to point out that there is certainly plenty of room to promote organic agriculture. Organic agriculture still accounted for very low shares of total output values for all the four agricultural products in this study. The shares ranged from a mere 0.2% for organic fruit to 1.4% for organic vegetables.

For each experiment, a number of important macroeconomic variables will be evaluated and reported. These variables are (i) gross domestic product (GDP); (ii) employment; (iii) trade in goods and services, both exports and imports; (iv) general price level; (v) final demand and its components; and (vi) private consumption disaggregated into consumption by agricultural and nonagricultural households.



The following sections present model results of macroeconomic impacts of the four experiments.

7.7.1 Experiment 1: Increased Global Awareness of Organic Agriculture or Its Export Promotion

In this experiment, we assume that the exports of all four organic farming sectors in the model (rice, maize, vegetables, and fruit) enjoy an increase of 10 times their values in the base year (2005), as shown in Table 7.4.

Once exports increase, the whole economy will adjust itself, in a general equilibrium fashion. First, there will be more employment as the production for exported organic produce must increase as well. As organic production systems are labor-intensive, the employment impacts from organic exports are larger than the employment impacts of nonorganic exports of the same amount.

The percentage increase in employment is generally not the same as the percentage increase in export, because each sector has a different proportion of output being exported. For example, organic maize's base value was B0.24 million, so a tenfold across-the-board organic agriculture export increase will raise the value to only B2.41 million. This is still quite small compared to the other three exported crops. Organic agriculture as a whole gains about 2.4 times in terms of value-added (GDP). Other sectors, such as nonorganic agriculture, industry, and services, also benefit through general equilibrium mechanisms. The entire economy gains B7.6 billion (in real terms), which is a 1.06% increase in agriculture output compared to the base year. The simulation shows, furthermore, that if the government is somehow able to promote exports of organic agriculture to increase by 10 times, GDP would increase by 0.14%. Given the current small areas of organic production relative to the size of growing demand, a tenfold expansion may be achieved.

The increase in organic agriculture exports, equivalent to B14.5 billion in this experiment, helps improve the balance of trade, but this export value also increases imports, bringing net trade improvement to B3.4 billion. The current account balance improves as well, although not as much as the improvement in the trade balance, at B1.2 billion. This is because import of services also rises with higher economic growth as more specialist services are imported. Price level increases in general



Table 7.4 Impacts of Organic Agriculture Export Promotion
(B million)

	Base Value	Experiment Value	Difference	% Difference
Rice	300.97	3,009.73	2,708.8	900.00
Maize	0.24	2.41	2.2	900.00
Vegetables	1,307.86	13,078.60	11,770.7	900.00
Fruit	9.64	96.39	86.8	900.00
Total	1,618.71	16,187.14	14,568.4	900.00
Employment Impacts (measured by constant price wage bill, B million)				
Total organic agriculture	10,740.00	40,558.50	29,818.5	277.64
Key Macroeconomic Impacts (real term, B million)				
GDP				
Agriculture	721,682.60	729,321.00	7,638.4	1.06
<i>Organic agriculture</i>	2,737.60	9,353.00	6,615.5	241.65
<i>Nonorganic agriculture</i>	718,945.00	719,967.90	1,022.9	0.14
Industry	3,125,218.30	3,125,543.70	325.4	0.01
Services	3,240,760.10	3,242,895.40	2,135.3	0.07
Total GDP	7,087,661.00	7,097,760.10	10,099.1	0.14
Export	4,399,824.00	4,414,392.40	14,568.4	0.33
<i>Organic agriculture</i>	1,618.70	16,187.10	14,568.4	900.00
<i>Nonorganic agriculture</i>	4,398,205.30	4,398,205.30	0.0	0.00
Import	4,737,800.80	4,748,996.10	11,195.2	0.24
XM balance	-337,976.90	-334,603.70	3,373.1	1.00
CA balance	-302,492.80	-301,260.20	1,232.6	0.41
CPI	100.00	100.10	0.1	0.09

B = baht, CA balance = current account balance, CPI = consumer price index (inflation rate), GDP = gross domestic product, XM balance = trade balance.

Source: Results of CGE modeling.

are measured by the consumer price index (CPI). The inflation rate in this experiment is 0.09%, a small increase in general price.

Household incomes increase across-the-board, but more so for agricultural households (Table 7.5). In real terms, agricultural households gain 0.56% over the base value. Nonagricultural households gain 0.02%.

**Table 7.5 Household Income (B million)**

	Base Value	Experiment Value	Difference	% Difference
Nominal Income				
All households	4,048,655	4,057,013	8,357.7	0.21
<i>Agricultural households</i>	764,899	769,815	4,916.3	0.64
<i>Nonagricultural households</i>	3,283,756	3,287,198	3,441.4	0.10
Real Income				
All households	4,048,655	4,053,443	4,788.1	0.12
<i>Agricultural households</i>	764,899	769,157	4,258.8	0.56
<i>Nonagricultural households</i>	3,283,756	3,284,285	529.3	0.02

B = baht.

Source: Results of CGE modeling.

Household income in nominal terms is slightly higher than in real terms. One important consequence of this finding is that the income distribution in Thailand has improved because agricultural households are generally much poorer than nonagricultural households.

Although organic agriculture sectors are still relatively small in Thai economy, if and when they penetrate more in the world market, or the government promotes them, they have the potential to expand economic growth, improving external balance and income distribution.

7.7.2 Experiment 2: Increased Organic Agriculture Export Price Premium

One possible development in the global organic markets is that more consumers are sensitive to health-related consumption of food, which would result in more demand for organic produce. If production of organic produce cannot keep pace with increased demand, the price premium for organic agriculture would be greater. This experiment doubles the premium for all organic exports from Thailand with an supply elasticity response of 1.5 to increase in price premium. This means that an export price premium increase of 100% will increase the export value by 150%.

The impacts on the Thai economy are similar to those of experiment 1, because of the increase in the export value, but with additional impacts



from the increase in the export price premium. Total employment in organic agriculture increases by 46%, much lower than 277% in experiment 1, due mainly to the smaller increase in the export value. The overall GDP gain is also small, 0.18% or B13 billion. All major economic sectors still gain from nonorganic agriculture, industry, and service. Similarly, the trade and current account balances improve. The inflation rate is positive but very small. Both agricultural and nonagricultural households enjoy higher income in both nominal and real terms, with agricultural households gaining more.

In summary, the two experiments yield results that are extremely comparable in terms of impact directions, but they differ in terms of impact magnitude.

7.7.3 Experiment 3: Domestic Market Promotion

The third experiment is a situation where domestic consumers, rather than global consumers, are the ones who want to buy more organic produce. The assumption is that sales in domestic markets of all four kinds of organic produce increase tenfold, the same proportion as in the export sales in the first experiment. Table 7.6 shows the base and experiment values of domestic consumption of the four organic farming sectors. Note that the experiment value of domestic consumption is slightly lower than the experiment value of export in the first experiment (B14.7 billion compared with B16.2 billion).

As in the export promotion case, the increased demand for organic produce leads to more production and hence employment. The total employment increase is similar to the export promotion case, but the employment gains by sector are quite different. Employment in paddy, rice milling, and fruit is higher in this experiment, because the proportion of domestic sales in these sectors is higher than the proportion of exports. The opposite is true for maize and vegetables.

On key macroeconomic variables, the agriculture sector GDP gain is slightly smaller in experiment 2 than in experiment 1 (0.92% vs. 1.06%) due to the smaller size of the demand shock. While most other production sectors gain through general equilibrium mechanisms from expanding organic farming sectors, the service sectors as a whole contract rather than expand. This is common in any general equilibrium model. When some sectors expand, resources (land, labor, and capital) are drawn

**Table 7.6 Base Value and Experiment Value for Domestic Organic Consumption – Experiment 3 (B million)**

	Base Value	Experiment Value	Difference	% Difference
Rice	596.72	5,967.19	5,370.5	900.00
Maize	–	–	0.0	
Vegetables	633.96	6,339.60	5,705.6	900.00
Fruit	243.08	2,430.85	2,187.8	900.00
Total	1,473.76	14,737.64	13,263.9	900.00
Employment Impacts (measured by constant price wage bill)				
Total organic agriculture	10,740.00	15,614.2	4,874.2	45.38

B = baht, – = data not available.

Source: Authors' calculations.

into those sectors at the expense of other sectors. Other sectors end up expanding or contracting depending on whether they benefit more from forward and backward linkages from the initial sectors or lose more from the battle over limited resources.

Unlike experiment 1, the trade balance worsens in experiment 3. This is simply because the source of the demand shocks is now internal, not external. When imports are higher than the base value due to economic expansion, but exports are assumed to remain unchanged, the trade account inevitably worsens. The current account, however, improves, because of the shrinking service sectors which lower imports of services.

The inflation rate is negative, which is also explained by the shrinking service sectors. As service sectors are generally at the upper end of the production linkage, price depression among service sectors usually carry downward pressure on price down the production linkage. Meanwhile, the impact on household income is similar to the first two experiments in that incomes of agricultural households rise more than those of nonagricultural households, and hence income distribution improves.

7.7.4 Experiment 4: Increased Domestic Organic Market Premium

The last experiment is an across-the-board increase in price premium for organic produce sold in domestic markets. As in experiment 2 (export price premium), an additional assumption of supply response



Table 7.7 Base Value and Experiment Value for Domestic Organic Consumption – Experiment 4 (B million)

	Base Value	Experiment Value	Difference	% Difference
Rice	596.72	1,491.80	895.1	150.00
Maize	–	–	0.0	
Vegetables	633.96	1,584.90	950.9	150.00
Fruit	243.08	607.71	364.6	150.00
Total	1,473.76	3,684.41	2,210.6	150.00
Employment Impacts (measured by constant price wage bill)				
Total organic agriculture	10,740.00	15,614.2	4,874.2	45.38

B = baht.

Source: Results of CGE modeling.

elasticity of 1.5 is assumed. Domestic consumption of organic produce, which entails employment in the organic farming sectors is shown in Table 7.7.

The macroeconomic impacts (Table 7.8) in this case are qualitatively similar to the previous case, but smaller in magnitude. One exception is the impact on the general price level and the inflation rate, which is positive here, and not negative as in the previous case. This is because the increased price premium from the organic farming sectors helps compensate the downward price pressure from the shrinking service sectors. The other notable finding from this experiment is that real income of nonagricultural households falls slightly by 0.01%. This is also a direct effect of the increased price premium. As rich nonagricultural households are the major consumers of organic produce (almost 90%), their real income (deflated nominal income by consumer price) is thus negatively affected.

7.7.5 Summary of Macroeconomic Impacts of Organic Agriculture Interventions

Table 7.9 is a reproduction of the macroeconomic impacts of the four experiments. The following is a summary of the key findings:

1. Given its small size in the whole economy, the organic sectors need to expand several times to have any measurable impacts on


Table 7.8 Key Macroeconomic Impacts (in real terms, B million)

	Base Value	Experiment Value	Difference	% Difference
GDP				
Agriculture	721,682.6	722,529.3	846.7	0.12
<i>Organic agriculture</i>	2,737.6	3,415.3	677.7	24.76
<i>Nonorganic agriculture</i>	718,945.0	719,114.0	169.0	0.02
Industry	3,125,218.3	3,125,623.3	405.0	0.01
Services	3,240,760.1	3,240,739.5	-20.6	0.00
Total	7,087,661.0	7,088,892.1	1,231.1	0.02
Export	4,399,824.0	4,399,824.0	0.0	0.00
<i>Organic agriculture export</i>	1,618.7	1,618.7	0.0	0.00
<i>Nonorganic agriculture export</i>	4,398,205.3	4,398,205.3	0.0	0.00
Import	4,737,800.8	4,737,968.0	167.1	0.00
Trade balance	-337,976.9	-338,144.0	-167.1	-0.05
Current account balance	-302,492.8	-302,447.4	45.4	0.02
CPI (inflation rate)	100.0	100.0	0.0	0.02

B = baht, CPI = consumer price index, GDP = gross domestic product.

Source: Authors' calculations.

the Thai economy. At the same time, their small size also means that there is plenty of room for the sectors to expand as well.

2. The promotion of the organic sectors resulting in higher demand—external or internal—has positive impacts in expanding the Thai economy. The impact size generally depends on the size of the increased demand.
3. Whether the increased demand is from external (export) or internal (domestic consumption) sources does not affect the total impact size, but the sectoral distribution is different. A surge in exports from organic agriculture benefits the service sectors more than the industry sectors, while a domestic consumption surge benefits the industry sectors more (to the point where the service sectors might contract if the demand surge is not large enough).
4. Employment impacts are universally positive and are roughly proportional to the size of increased demand. Organic



vegetables enjoy the largest employment gains when demand is external, while paddy and rice, and fruit benefit more from domestic demand.

5. Since organic agricultural production is generally more labor-intensive than conventional agriculture, the employment generated from the promotion of organic produce is greater than the employment gain from nonorganic agriculture from the same size of demand shocks.
6. The current account balance improves in all four cases, but the trade account only improves with external demand shocks.
7. The inflation rate is mostly positive, due to increased demand and an expanding economy, except in experiment 4 when pressure on the service sectors causes general prices to fall.
8. Real income distribution improves in all four cases, as agricultural households' real incomes increase more than nonagricultural households' incomes.

The results presented so far in this section are examples of applications of the CGE model. There are many other possible applications. For example, one may want to explore what happens if productivity of organic produce is somehow improved or if the government spends money to promote organic agriculture and at the same time tax the nonorganic farming sectors.

The results from the CGE model show that organic agriculture promotion yields favorable macroeconomic consequences in general. However, those favorable consequences are by no means exclusively specific to increased demand in organic agriculture. An equal increase in demand in nonorganic agriculture would yield similar macroeconomic results, except with fewer employment impacts. The rationale for promoting organic production is more on the microeconomic level and on their noneconomic benefits.

7.8 HEALTH IMPACTS OF ORGANIC AGRICULTURE PROMOTION

Literature on the health benefits of organic agriculture is growing although there are detractors with respect to the consumption benefits. The benefits on the production side, however are clearer. At the individual level, organic farmers are more protected from the



Table 7.9 Comparison of Macroeconomic Impacts in Four Experiments (change from base value, B million)

	Experiment			
	1	2	3	4
GDP (real)				
Agriculture	7,638	1,283	6,618	847
<i>Organic agriculture</i>	6,615	1,112	5,954	678
<i>Nonorganic agriculture</i>	1,023	171	665	169
Industry	325	52	1,541	405
Services	2,135	356	-20	-21
Total	10,099	1,691	8,140	1,231
Employment				
<i>Paddy</i>	4,648.0	774.7	6,867.1	1,144.5
<i>Rice mill (organic agriculture only)</i>	834.1	139.0	1,335.0	222.5
<i>Maize</i>	8.3	1.4	4.3	0.7
<i>Vegetables</i>	24,062.2	4,010.4	13,357.2	2,226.2
<i>Fruit</i>	266.0	44.3	7,681.6	1,280.3
Total employment (organic agriculture)	29,818.5	4,969.8	29,245.2	4,874.2
Export (nominal)				
<i>Organic agriculture export</i>	14,568	2,428	-	-
<i>Nonorganic agriculture export</i>	-	-	-	-
Import (nominal)				
	11,195	1,865	867	167
Trade balance (nominal)				
	3,373	563	-867	-167
Service balance (nominal)				
	2,141	357	1,182	213
Current account balance				
	1,233	206	315	45
Inflation rate (%)				
	0.09	0.01	-0.03	0.02
Real household income (%)				
<i>Agriculture HHs</i>	0.56	0.09	0.59	0.07
<i>Nonagricultural HHs</i>	0.02	0.00	0.11	-0.01

B = baht, - = data not available, GDP = gross domestic product, HH = household.

Source: Authors' calculations.

detrimental health effects of heavy pesticide use in conventional agriculture. At the community level, a cleaner farming environment prevents various kinds of community illnesses. The crop intensity of



conventional agricultural practices is threatening environmental health and also depletes soil quality. It then becomes interesting to evaluate the actual health impacts of the organic agriculture promotion experiments in the previous section to complete the analysis.

7.8.1 Pesticide-Related Health Problems

The literature points to several health problems for humans that are related to the use of or exposure to pesticides:⁸ (i) eye irritation; (ii) skin diseases; (iii) respiratory tract illnesses; (iv) cardiovascular effects; (v) gastrointestinal tract effects; and (vi) neurological effects, such as motor weakness, distal muscles, and sensory deficit.

7.8.2 Health Benefits of Organic Agriculture Promotions

A study in the Philippines by Pingali (1995) revealed harmful effects of agrochemicals used in conventional agricultural. Eye and respiratory impairments are significantly associated with the application of extremely hazardous pesticides. Table 7.10 reveals that increased exposure to pesticides raises the probability of health impairments. As conventional agriculture employs millions of workers, increasing organic agriculture and chemical-free agriculture can significantly improve the health of farmers by avoiding exposure to agrochemicals (Table 7.11).

Table 7.10 Probability of Health Impairment by Dose of Pesticide Applications in the Philippines

	At Sample Mean	0 Dose	1 Dose	2 Doses	3 Doses
Eye effects	0.36	0.28	0.36	0.44	0.53
Pulmonary		0.30	0.47	0.68	
Polyneuropathy	0.02				
Skin effects		0.12	0.30	0.50	
Gastrointestinal	0.27			0.50	0.72
Multiple impairments	0.19				

Source: Pingali et al. (1995), Table 12.5.

⁸ Summarized from Pingali et al. (1995).



The chosen probability vectors are applied to these conventional farm workers, as they would be exposed to the pesticides. Table 7.12 is the result of health benefits from organic agriculture promotion, measured in terms of numbers of farm workers who would have otherwise suffered from a health impairment. The promotion of organic exports or domestic consumption (experiments 1 and 3) can prevent the detrimental health effects on farmers.

Table 7.11 Labor Employment Implied in Organic Agriculture–Social Accounting Matrix (persons)

	Conventional	Chemical-Free	Organic Agriculture
Rice	4,209,773	460,006	20,085
Maize	499,557	46,078	237
Vegetables	517,211	44,847	7,185
Fruit	764,868	294,378	14,344

Source: Authors' compiled calculations.

The promotion of organic vegetables would help the most farmers (131 to 32,640), followed by organic rice (33 to 2,214), fruit (2 to 19,675), and maize (0 to 89). The incidence of gastrointestinal impairments (4,734 to 36,877 total) are prevented most, followed by pulmonary (2,994 to 29,013 total), multiple impairments (2,178 to 28,332 total), eye effects (2,642 to 23,979), and skin effects (1,853 to 20,217). Needless to say, several assumptions had to be made due to lack of direct evidence; nonetheless, the results show that the health benefits from organic agriculture promotion can be very significant.

7.9 CONCLUSION

This chapter seeks to build a comprehensive sectoral macroeconomic model showing the impacts of organic agriculture on other production sectors and on the entire economy in Thailand. The results from the CGE model show that the promotion of organic agriculture yields favorable macroeconomic consequences in general. However, those favorable consequences are by no means exclusively specific to an increase demand in organic agriculture. An equal increase in demand in nonorganic agriculture would yield similar macroeconomic results, except with fewer employment impacts. The rationale for promoting organic production is more on the microeconomic level and on their noneconomic benefits.



Table 7.12 Numbers of Farm Workers Saved from Health Impairment (persons)

	Number of Farm Workers Who Would Have Health Impairments						
	Additional Pesticide Users	Eye Effects	Pulmonary	Poly-neuropathy	Skin Effects	Gastro-intestinal	Multiple Impairment
Rice							
Experiment 1	17,802	6,409	6,854	356	3,738	12,833	3,382
Experiment 2	27,214	9,797	10,477	544	5,715	19,618	5,171
Experiment 3	4,582	1,650	1,764	92	962	3,303	871
Experiment 4	1,672	602	644	33	351	1,206	318
Maize							
Experiment 1	89	32	34	2	19	64	17
Experiment 2	18	6	7	0	4	13	3
Experiment 3	1	0	0	0	0	1	0
Experiment 4	1	0	0	0	0	0	0
Vegetables							
Experiment 1	32,640	17,299	21,869	2,611	16,320	23,501	24,806
Experiment 2	5,492	2,911	3,680	439	2,746	3,954	4,174
Experiment 3	19,174	10,162	12,846	1,534	9,587	13,805	14,572
Experiment 4	1,632	865	1,093	131	816	1,175	1,240

continued on next page



Table 7.12 continued

Fruit	Additional Pesticide Users	Number of Farm Workers Who Would Have Health Impairments					
		Eye Effects	Pulmonary	Poly-neuropathy	Skin Effects	Gastro-intestinal	Multiple Impairment
Experiment 1	665	239	256	13	140	480	126
Experiment 2	110	40	42	2	23	80	21
Experiment 3	19,675	7,083	7,575	393	4,132	14,184	3,738
Experiment 4	3,264	1,175	1,257	65	685	2,353	620
Total							
Experiment 1	51,195	23,979	29,013	2,982	20,217	36,877	28,332
Experiment 2	32,834	12,754	14,206	986	8,488	23,665	9,369
Experiment 3	43,432	18,895	22,186	2,019	14,681	31,293	19,181
Experiment 4	6,569	2,642	2,994	229	1,853	4,734	2,178

Source: Authors' calculations.



This chapter also explores one of the most important benefits of organic agriculture—the health impacts. The literature on the health benefits of organic agriculture is large and growing. At the individual level, organic farmers are safer from the harmful health effects of pesticides used intensively in conventional agriculture. At the community level, a cleaner farming environment prevents various kinds of community illnesses. The crop intensity of conventional agricultural practices is threatening environmental health and depleting soil quality. It is interesting to evaluate the health impacts of the organic agriculture promotion experiments in this chapter to complete the analysis.

In summary, although the organic farming sectors are still relatively small within the Thai economy, if and when they penetrate more into the world market, or the government promotes them, they have the potential to expand economic growth and improve the external balance and income distribution, coupled with health benefits for the farmers and the environment.

BIBLIOGRAPHY

- Baldwin, K.R. 2004. *Soil Quality Considerations for Organic Farmers*. The Center for Environmental Farming Systems.
- Budget Bureau. 2007. *Budget in Brief in Fiscal Year 2007* (in Thai). Bangkok.
- Chinsathit, S., 2012. Factors relating the success of organic farming in Thailand. Proceeding of the Workshop on Asian Network for Sustainable Organic Farming Technology, In Gwangju, Jeonnam Province, the Republic of Korea. pp. 1-10.
- Coastal Fisheries Research and Development Bureau. *Giant Tiger Prawn Culture by Local Feed* (in Thai). Songkhla, Thailand.
- Darko, Z., J. Pretty, S. K. Todorović, and J. Morrison. 2005. *Impact of Organic Agriculture on the Environmental and Economic Performance of Croatia*. University of Essex.
- Ekasingh, B., P. Gypmantasiri, K.Thong-ngam, and P. Grudloyma. 2004. *Maize in Thailand: Production Systems, Constraints, and*



Research Priorities. Mexico: International Maize and Wheat Improvement Center (CIMMYT).

Ellis, W., V. Panyakul, D. Vildoza, and A. Kasterine. 2006. *Strengthening the Export Capacity of Thailand's Organic Agriculture Final Report*. An Asia Trust Fund Project implemented with technical assistance from the International Trade Centre (UNCTAD/WTO), Geneva, Switzerland, co-funded by the European Commission, in cooperation with the National Innovation Agency, Ministry of Science and Technology, and the Ministry of Agriculture and Cooperatives, Thailand. August.

FAO (Food and Agriculture Organization of the United Nations). 2004. *Production and Exports of Organic Fruit and Vegetables in Asia*. Rome.

—. 2007. *Organic Certification Schemes: Managerial Skills and Associated Costs: Synthesis Report from Case Studies in the Rice and Vegetable Sectors*. Agricultural Management, Marketing and Finance Occasional Paper 16. Rome.

—. 2011. FAOSTAT. <http://faostat.fao.org/site/339/default.aspx>

Gunnar, R. 2006. *Best Practices for Organic Policy: What Developing Country Governments Can Do to Promote the Organic Sector*. *Developing Country Organic Policy* (Draft). <http://www.unep-unctad.org/CBTF/events/arusha/Best%20Practices%20for%20Organic%20Policy.Rundgren.draft.27Feb06.pdf>

—. 2007. *Best Practices for Organic Marketing Regulation, Standards and Certification: Guidance for Developing Countries*. International Task Force Harmonization and Equivalence in Organic Agriculture. http://www.unctad.org/trade_env/ITF-organic/meetings/misc/ITF_Reg_Guide_Final_20070116.pdf

Halweil, B. 2006. Can Organic Farming Feed Us All? *World Watch Magazine*. 19 (3). pp. 135-140.

Hambrey, J., and C. K. Lin. 1996. *Shrimp Culture in Thailand*. Bangkok: Asian Institute of Technology. <http://www.aquafind.com/articles/shmcul.php>



- Hira, J. 2007. *Organic Agriculture: Proven But Needs Political Support* (Third World Network Associate, Indonesia). Third World Network Information Service on Sustainable Agriculture. 30 May (Press).
- Hobbs, P., R. Gupta, and C. Meisner. 2006. *Conservation Agriculture and Its Applications in South Asia*. India and Bangladesh: Rice-Wheat Consortium for The Indo-Gangetic Plains and International Center for Improvement of Wheat and Maize (CIMMYT). http://www.css.cornell.edu/faculty/hobbs/Papers/SBB24%20Conservation%20Agriculture_last.pdf
- IFAD (International Fund for Agricultural Development). 2005. *Organic Agriculture and Poverty Reduction in Asia: [the People's Republic of] China and India Focus*. Report No. 1664. http://www.ifad.org/evaluation/public_html/eksyst/doc/thematic/organic/asia.pdf
- ITC (International Trade Center). 2007. *The European Market for Organic Fruit and Vegetables from Thailand*. Funded under the EU-ITC Project Strengthening the Export Capacity of Thailand's Organic Agriculture (Asia Trust Fund). http://www.intracen.org/uploadedFiles/intracenorg/Content/Exporters/Sectoral_Information/Agricultural_Products/Organic_Products/The_European_Market_for_Organic_Fruit-and_Vegetables_from_Thailand.pdf
- Jha, V. 2002. *Production and Trade in Organic Agricultural Products*. http://www.unctad.org/trade_env/docs/organic%20agriculture.%20cuba.pdf
- Kotschi, J, W. Bayer, T. Becker, and B. Schrimpf, eds. 2003. *AlterOrganic: Local Agendas for Organic Agriculture in Rural Development*. Proceedings of an International Workshop at Bonn-Königswinter, 21-24 October 2002. Agro-ecol, Marburg, Germany.
- Liu, P. 2007. *FAO's Assistance to Developing Countries in Dealing with Private Standards*. WTO-UNCTAD Symposium. 25 June. http://www.wto.org/english/tratop_e/sps_e/private_standards_june07_e/private_standards_june07_e.htm



- National Agricultural Research Institute. Organic Agriculture Programme. <http://www.agrinetguyana.org.gy/nari/research/organic/organicagriculture.htm#>
- The Organic Standard. 2001. What Cost Is Organic Certification? *Certification & Accreditation*. 7. pp. 7-12.
- Panyakul, V. 2002. VIII. National Study: Thailand. Bangkok: Green Net Cooperative and Earth Net Foundation. [http://www.unescap.org/rural/doc/organic agriculture/Thailand.PDF](http://www.unescap.org/rural/doc/organic%20agriculture/Thailand.PDF)
- Pathak, R. K., and R. A. Ram. 2002. *Successful Conversion of Conventional to Organic/Biodynamic: A Case Study*. Presented at Seminar on Production and Export of Organic Fruit and Vegetables in Asia. Proceedings of the Seminar held in Bangkok, Thailand, 3-5 November 2003.
- Pilkauskas, P. 2003. *Strategies and Technology for Improving Production of Organic Fruit and Vegetables in Asia*. Presented at Seminar on Production and Export of Organic Fruit and Vegetables in Asia. Proceedings of the Seminar held in Bangkok, Thailand, 3-5 November 2003.
- Pingali, P. L., C. B. Marquez, F. G. Palis, and A. C. Rola. 1995. The Impacts of Pesticides on Farmer Health: A Medical and Economic Analysis in the Philippines. In P.L. Pingali and P.A. Roger, eds. *Impact of Pesticides on Farmer Health and the Rice Environment*. International Rice Research Institute.
- Ratanawaraha C., W. Ellis, V. Panyakul, and B. Rauschelbach. 2007. *Organic Agri-Business: A Status Quo Report for Thailand 2007*. Bangkok: Thai-German Programme for Enterprise Competitiveness (GTZ), Sustainable Agriculture Foundation (Thailand), Green Net Foundation.
- Santacoloma, P. 2007. *Organic Certification Schemes: Managerial Skills and Associated Costs—Synthesis Report from Case Studies in the Rice and Vegetable Sectors*. Agricultural Management, Marketing and Finance Occasional Paper 16. Rome: Food and Agriculture Organization of the United Nations.



- Siraporn, B. *Chemical Usage in Agricultural and Poverty Reduction*. Thailand Research Fund (in Thai).
- Sligh, M., and C. Christman. 2003. *Who Owns Organic? The Global Status, Prospects, and Challenges of a Changing Organic Market*. Rural Advancement Foundation International. <http://www.rafiusa.org/pubs/OrganicReport.pdf>
- Srivichai, C., S. Eakmaharaj, and N. Visetso. 2005. *Documents on Organic Fishery: Focusing on Organic Shrimp*. Bangkok: National Research Council of Thailand (in Thai).
- Stolze, M., H. Moschitz, M. Schneider, and M. Heeb. 2005. *Needs Assessment for Information and Communication Capacity Building in the National Agriculture Research Systems with Particular Emphasis on Ecological and Organic Agricultural Production in Bulgaria, Serbia and Kosovo*. FiBL.
- Swift Co., Ltd. 2006. *Poverty Reduction through Contract Farming: Lessons from Sa Kaew's Farmer* (in Thai). <http://www.thaifreshproduce.com/ADB/ADBI.pdf>
- Titapiwatanakun, B. 2005. *Organic Rice Production and Marketing in Thailand 2002/3: A Lesson Learned* (Draft). June.
- TOTA (Thai Organic Trade Association). 2011.
- WTO (World Trade Organization). 2012. *International Trade Statistics 2012*.
- Williams, J. 2005. *Understanding the Overuse of Chemical Fertilizer in [the People's Republic of] China: A Synthesis of Historic Trends, Recent Studies, and Field Experiences*. P.R.E.M.I.U.M. 2005 Research Experience for Undergraduates, sponsored by the National Science Foundation and Michigan State University. July.
- Wynen, E. 2004. *Impact of Organic Guarantee Systems on Production and Trade in Organic Products*. Working Paper. UNCTAD/IFOAM/FAO, International Task Force on Harmonization and Equivalence. August. <ftp://ftp.fao.org/paia/organicag/ofs/Darko.pdf>



WEBSITES

Organic Overview

- International Federation of Organic Agriculture Movements (IFOAM) (http://www.ifoam.org/growing_organic/2_policy/case_studies/thailand_ag_conditions.php)
- Kasetsart University, Kamphansan Campus (<http://www.agri.kps.ku.ac.th/oa/index.html>)
- Organic Agriculture Department and Promote Group (<http://plantpro.doae.go.th/organic/general/general.html>)
- Thai Organic Trade Association (TOTA) (<http://www.thaiorganictrade.com/en/article/442>)

Organic Statistics

- Green Net and Earth Net Foundation (<http://www.greennet.or.th>)

Certificated Information

- Organic Agriculture Certification Thailand (<http://www.actorganic-cert.or.th>)
- National Bureau of Agricultural Commodity and Food Standards (<http://www.acfs.go.th>)
- International Federation of Organic Agriculture Movements (<http://www.ifoam.org>)
- International Organic Accreditation Service (<http://www.ioas.org>)
- Accredited Organic Certification Organization by the Ministry of Agriculture, Forestry and Fisheries (MAFF) of Japan (<http://www.pure-foods.co.jp/index2.html>)

Organic Database

- Land Development Department (<http://www.idd.go.th>)
- Surin Organic Agriculture (http://www.surinorganic.com/organic_db)



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Chapter 8 | **Does Organic Agriculture Lead to Better Health among Organic and Conventional Farmers in Thailand? An Investigation of Health Expenditure among Organic and Conventional Farmers in Thailand¹**

Sununtar Setboonsarng and Rouselle F. Lavado

8.1 INTRODUCTION

Health is one of the most important components of an effective poverty reduction strategy. Better health can increase productivity and household income, while poor health is likely to reduce output and reduce income (Croppenstedt and Muller 2000; Antle and Pingali 1995). The conventional approach to addressing health problems among the poor has been to extend medical and health services. However, this can be a large burden on public expenditure and the outreach to poor in rural areas is often limited.

Among the rural poor, the majority of whom earn their living through agriculture, one of the main causes of health problems is exposure to agrochemicals, in particular pesticides (Blair 1991). The World Health Organization (WHO) estimates that at least 3 million–4 million people in the developing world are severely poisoned each year from exposure

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to agrochemicals, a number that would likely be far higher if it included the many rural poor who do not seek treatment in hospitals. Indeed the problem is also prevalent in the developed world. Attempts to quantify the health costs of pesticide use in Europe have estimated annual costs of €125 million in Germany and €190 million in the United Kingdom (IFAD 2005). In developing countries where safety standards are lower, the costs are likely to be considerably higher. This implies that Van Der Hoek and Konradsen's (2005) estimates of 7.5% of agricultural workers poisoned in Sri Lanka every year are likely in the low range. In Nepal, Atreya (2005) estimates that total annual household health expenditures due to exposure to pesticides ranged from \$0.00 to \$59.34, averaging at \$16.81.

Surveys consistently show that one of the main reasons organic producers choose to shift to organic methods of production is their concern about the health problems associated with the use of chemical inputs (IFAD 2003, 2005). When used in excess without proper care, pesticides and other agrochemicals can negatively affect the health of farmers, their families, and their communities. Incidences of serious illnesses such as cancer due to long-term exposure to pesticides are well documented, with evidence linking pesticide use to increased risks of birth malfunction, birth defects, and other reproductive problems (Kerdsuk 2004; Ransom 2002).

Organic agriculture can eliminate the health risks associated with pesticides and minimize the public health costs of conventional chemical farming. Although there has been little quantitative research on the health effects of shifting to organic agriculture, there is abundant anecdotal evidence. Farmers in India reported that symptoms of pesticide poisoning disappeared after they adopted organic farming (IFAD 2005), while an International Fund for Agricultural Development (IFAD 2003) study in six Latin American countries found that organic farmers generally perceived themselves to be in better health after converting to organic agriculture.

Beyond reduced risk of exposure to agrochemicals, organic agriculture has indirect impacts on health through increased income and improved food security and dietary quality (Setboonsarng 2006 and chapter 1 of this volume). Rising incomes allow households to spend more on food and preventative health care, reducing the incidence of illness and lowering the long-term opportunity costs of poor health. Again, however, this conclusion is based on anecdotal evidence, as little quantitative data is available on the effects of organic production on health.



To fill this gap, this study attempts to empirically examine whether the adoption of organic farming practices leads to better health. As a proxy for health status, we compare the health expenditure patterns of organic and conventional rice-farming households in north and northeast Thailand. Using data from a 2006 household survey covering 626 households in eight provinces, we calculate catastrophic health expenditures as out-of-pocket (OOP) medical expenditures exceeding a specified percentage of the household budget.

8.2 CATASTROPHIC OUT-OF-POCKET MEDICAL EXPENDITURES

The out-of-pocket (OOP) payments are the primary means of financing health care in the many low-income Asian countries that lack prepayment mechanisms such as health insurance or tax (Van Doorslaer et al. 2007). The welfare of households without health insurance may be severely reduced by OOP medical expenditures should a household member fall ill. Households lacking savings or access to credit must cover medical expenses from the household budget. If the OOP expenses are large in proportion to the household budget, they may be considered catastrophic. Having a sick household member can thus lead some households into immediate poverty and force financially constrained households to choose between cutting household consumption and going without treatment.

Ideally, longitudinal data are necessary to allow one to track the changes in nonmedical spending following an illness and estimate the reduction in household welfare caused by a catastrophic medical expenditure. In this case, however, only cross-section data are available, and some approximation must be made. Following Van Doorslaer et al. (2007) and Wagstaff et al. (2007), this chapter defines catastrophic health expenditure as OOP payments exceeding a particular budget threshold. Spending a large share of the household budget on medical expenses can reduce welfare in the short term, if financed by sacrificing current consumption; or in the long term, if financed by savings, credit, or the sale of assets. Although the short-term disruption of living standards is typically more severe, large OOP expenditures can also threaten the long-term stability of a household if it becomes indebted and cannot absorb further economic shocks (Van Doorslaer et al. 2007).

The two key variables for calculating catastrophic expenditure are total household OOP medical expenditure and household expenditure, which



is used as a measure of household resources. Unlike other measures of household resources, such as income, the use of household expenditure reflects the assumption that the impact of OOP expenditure is greater on households without savings (Wagstaff et al. 2007).

8.3 HOUSEHOLD EXPENDITURE AMONG FARMING HOUSEHOLDS IN NORTH AND NORTHEAST THAILAND

The farm survey was conducted from April to July 2006 in eight provinces to compare the socioeconomic characteristics of small-scale organic and conventional rice farmers. In northern Thailand, the survey covered four provinces: Chiang Mai, Phayao, Chiang Rai, and Uthai Thani. In northeast Thailand also, it covered four provinces: Ubon Ratchathani, Amnart Charoen, Surin, and Yasothon. A total of 626 farms were surveyed, including 309 organic farms and 317 conventional farms. All the organic farms were certified organic and had not used chemicals for at least 3 years. They were producing mainly for the export market.

Overall, the survey sample is representative of poor rural households in the rice-based, rainfed ecosystem of Southeast Asia. Table 8.1 shows the household and farm characteristics of the sampled farms. On average, organic and conventional farmers are very similar in terms of age, education, and income, although organic households owned significantly more land than conventional households.

Total household expenditure (Table 8.2) includes all net on- and off-farm expenses, including food, clothing, toiletries, utilities, transportation, health, education, and entertainment. The average annual total household expenditure for all surveyed households was B66,985 (\$2,232).² On average, there was no significant difference in total expenditure by organic and conventional farmers, except in the poorest quintile, where organic farmers spent slightly less than conventional farmers. Total household expenditure increased by approximately B15,000 per quintile until the 80th percentile. The largest increase was from the second richest quintile to the richest quintile, in which total expenditure more than doubled. The top quintile represented the larger farms and farms with high nonfarm incomes.

² Using April 2013 exchange rate of B30 = \$1.

**Table 8.1 Farm and Household Profile**

	Organic (mean)		Conventional (mean)		<i>p</i> value
Age of Household Head	51.9		52.0		0.9128
Educational attainment of household head	No.	(%)	No.	(%)	
None	1	0.3	3	1.0	
Able to read and write (self-study)	3	1.0	2	0.6	
Primary	262	84.8	258	81.4	
Secondary	41	13.3	45	14.2	
Vocational	1	0.3	4	1.3	
University or higher			2	0.6	
Total land area (rai ^a)	26.0		22.1		0.0014***
Owned land area (rai)	24.2		19.5		0.0001***
Rented land area (rai)	1.9		2.5		0.2826
Total income (B)	130,657		141,126		0.3289
Income from crops	50,475		58,760		0.0810*
Income from livestock	14,696		14,973		0.9284
Other on-farm income	10,092		12,104		0.5363
On-farm income from nonagricultural activities	7,864		9,253		0.7712
Off-farm income	4,004		8,551		0.0170**
Off-farm income from nonagricultural activities	43,525		37,484		0.2840

Note:

^arai is a unit of area in Thailand, approximately equal to 1,600 square meters or 0.16 hectares

*significant at 10%, **significant at 5%, ***significant at 1%.

Source: Authors' own calculations.

Although their total household expenditures were similar, Figure 8.1 and Appendix Table A8.1 show that the organic and conventional farmers' spending varied by expenditure category. On average, conventional households had a higher medical expenditure than organic households, yet spent significantly less on education and household operations. Overall, the two groups had similar levels of expenditure on food, tobacco and alcohol, personal care, clothing, fuel, transportation, and communications.



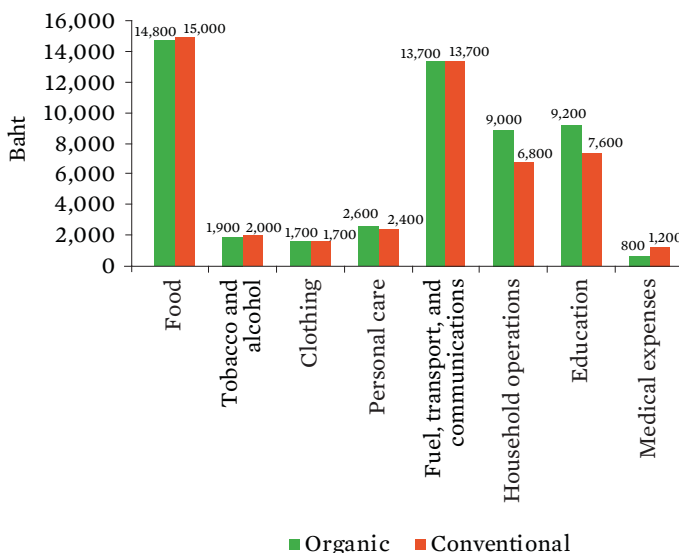
Table 8.2 Total Household Expenditure per Quintile, 2006 (B)

Total Household Expenditure	Total	Organic	Conventional	<i>p</i> value
Poorest 20%	17,966	16,746	19,040	0.0215**
Second poorest	33,014	33,641	32,335	0.9861
Middle	45,746	45,406	46,139	0.1836
Second richest	65,245	65,236	65,255	0.4950
Richest 20%	173,303	175,123	171,455	0.5470

Note: * significant at 10%, **significant at 5%, *** significant at 1%.

Source: Authors' own calculations.

Figure 8.1 Household Expenditure Comparison, Selected Categories



Source: Authors' own calculations.

A potential problem arises, however, if the incidence of catastrophic expenditure is based on OOP payments as a share of *total* household expenditure. As the majority of resources in poor households are devoted to subsistence expenses and few resources are available for health care, the budget share of OOP payments in poor households may appear to be low (Wagstaff et al. 2007). The actual magnitude of



the effect of OOP payments on the welfare of poor households may be better measured as a share of discretionary expenditure—total household expenditure net spending on basic necessities. Following the approach of a number of authors, nonfood expenditure is used as an approximation for discretionary expenditure (Van Doorslaer et al. 2007; Wagstaff et al. 2007).

The average household spent B14,859 (30% of total expenditure), or approximately B1,200 per month, on food (Table 8.3). Although organic households in the poorest, middle, and second richest quintiles spent slightly less on food than conventional households, the overall difference in the food expenditure of the two groups was limited. Annual food expenditure increased by approximately B4,000 per quintile. Consistent with Engel's law, the poor spent a significantly higher proportion of their household expenditure on food. On average, the poorest quintile devoted 36% of household expenditure to food, compared with only 17% by the richest quintile.

Given this severe budget constraint of poor households, discretionary expenditure may better distinguish between rich and poor households and provide a more accurate measure of the impact of health spending on

Table 8.3 Food Expenditure per Quintile, 2006 (B)

Food Expenditure (share of household expenditure)	Total	Organic	Conventional	<i>p</i> value
	14,859 (30%)	14,752 (30%)	14,958 (30%)	0.4126
Poorest 20%	6,274 (36%)	5,914 (38%)	6,592 (35%)	0.0894*
Second poorest	11,033 (33%)	11,489 (34%)	10,540 (33%)	0.8798
Middle	15,088 (33%)	14,980 (33%)	15,158 (33%)	0.4409
Second richest	18,552 (28%)	17,143 (27%)	19,938 (30%)	0.0681*
Richest 20%	23,418 (17%)	23,827 (18%)	23,003 (17%)	0.6009

Note: *significant at 10%, **significant at 5%, ***significant at 1%.

Source: Authors' own calculations.

**Table 8.4 Discretionary Expenditure per Quintile, 2006 (B)**

	Total	Organic	Conventional	<i>p</i> -value
Discretionary Expenditure	52,129	53,133	51,150	0.6067
Poorest 20%	11,691	10,832	12,448	0.0364**
Second poorest	21,980	22,152	21,794	0.6608
Middle	30,658	30,427	30,981	0.3344
Second richest	46,694	48,093	45,317	0.9221
Richest 20%	149,886	151,296	148,452	0.5368

Note: *significant at 10%, **significant at 5%, ***significant at 1%.

Source: Authors' own calculations.

the poor households than household expenditure (Table 8.4). Among all surveyed households, discretionary expenditure averaged B52,129, with no significant difference between the organic and conventional groups. While the trend per quintile is similar to total household expenditure, the difference between the poorest and richest quintiles is significantly more pronounced, as discretionary spending by the rich was nearly 15 times that of the poor.

8.4 BUDGET SHARES OF OUT-OF-POCKET MEDICAL EXPENDITURE

The out-of-pocket (OOP) payment for health care is defined as expenditures for drugs and medicine, medical and dental care, hospital room charges, and contraceptives. In Thailand, since the universal coverage reform in 2001, there has been a flat charge of B30 per visit for most medical services, and no charge for vaccinations, immunizations, and family planning. Under this health program, the medical expenditure reported in the survey is based on number of visits and may underestimate the actual expenditure associated with severity of illness.

Table 8.5 presents the average household medical expenditure. Although survey data on medical expenditure are potentially subject to bias due to the infrequency in which many health care payments are made, the 1-year recall period of this survey should reduce such bias. It appears from Table 8.5 that the OOP medical expenditure is significantly higher for conventional farmers than for organic farmers. On average, conventional



Table 8.5 Out-of-Pocket Medical Expenditure per Quintile, 2006 (B)

	Total	Organic	Conventional	p value
Medical Expenditure	999	712	1,277	0.0676*
Poorest 20%	359	293	406	0.2608
Second poorest	685	564	781	0.2837
Middle	616	483	759	0.8783
Second richest	820	860	767	0.4167
Richest 20%	2,516	1,245	3,892	0.0661*

Note: *significant at 10%, **significant at 5%, ***significant at 1%.

Source: Authors' own calculations.

households spent B1,277 on health care payments, compared with B712 spent by organic households. Except in the second richest quintile, all conventional farming households had a significantly higher OOP medical expenditure, although the difference is statistically significant at a 10% confidence level for the sample as a whole, and in the richest quintile, in which conventional farming households spent B3,892 per year compared to B1,245 per year for organic farming households.

The budget shares of OOP payments are shown in Table 8.6. For all households, OOP payments accounted for 1.62% of the total household expenditure and 2.31% of the discretionary expenditure. The mean budget share of OOP payments was higher for conventional households than for organic households, both as a share of total household expenditure and as a share of discretionary expenditure. In all quintiles except the second richest, organic households spent a smaller proportion of their household budget on health care than their conventional counterparts.

The burden of OOP payments is also disproportionately borne by the poor, as the poorest households spent a larger fraction of their resources on health care than the richest. Of the quintiles, the gradient is steepest for the two poorest, as discretionary spending on health care was approximately 3%, compared with only 1.85% in the two richest quintiles. In addition to the quintile means of budget share, the negative concentration indices confirm that the poor are spending more on health care than the rich, especially in relation to discretionary expenditure.

**Table 8.6 Budget Shares of Out-of-Pocket Payments**

	Total	Organic	Conventional
Payments as a Percentage of Household Expenditure			
Mean	1.62%	1.27%	1.96%
Median	0.20%	0.20%	0.98%
Concentration index	-0.0551	-0.0720	-0.0279
Quintile Means			
Poorest 20%	1.87%	1.48%	2.17%
Second poorest	2.00%	1.63%	2.29%
Middle	1.37%	1.07%	1.71%
Second richest	1.27%	1.33%	1.20%
Richest 20%	1.57%	0.94%	2.25%
Payments as a Percentage of Discretionary Expenditure			
Mean	2.31%	1.81%	2.80%
Median	0.27%	0.27%	0.27%
Concentration index	-0.0966	-0.1048	-0.0746
Quintile Means			
Poorest 20%	2.75%	2.26%	3.12%
Second poorest	3.08%	2.40%	3.62%
Middle	2.03%	1.58%	2.52%
Second richest	1.84%	1.84%	1.83%
Richest 20%	1.85%	1.15%	2.61%

Source: Authors' calculations.

These results are consistent with the findings of Whitehead, Dahgren, and Evans (2001) that poor households in low-income countries spend more on OOP payments than the rich. Yet, they are inconsistent with the findings of Van Doorslaer et al. (2007) that the rich spend more on health care in most countries in Southeast Asia. A possible explanation offered by Van Doorslaer et al. for the disparate results is the finding that poor households spend more on health care is typically based on small samples in rural areas. However, when national datasets are used, the results reflect the health expenditure of the whole country, including OOP payments by the wealthier urban population.



8.5 INCIDENCE OF CATASTROPHIC EXPENDITURE

As defined earlier, medical expenditure can be considered catastrophic if OOP payments account for an excessively high share of household resources. The basic idea is that spending a large proportion of the household budget on health care payments deprives the household of spending on other goods and services and can push some households into poverty. This premise will be examined in the following sections, first by approximating the incidence and depth of catastrophic expenditure and then estimating the decreases in consumption of other goods and services.

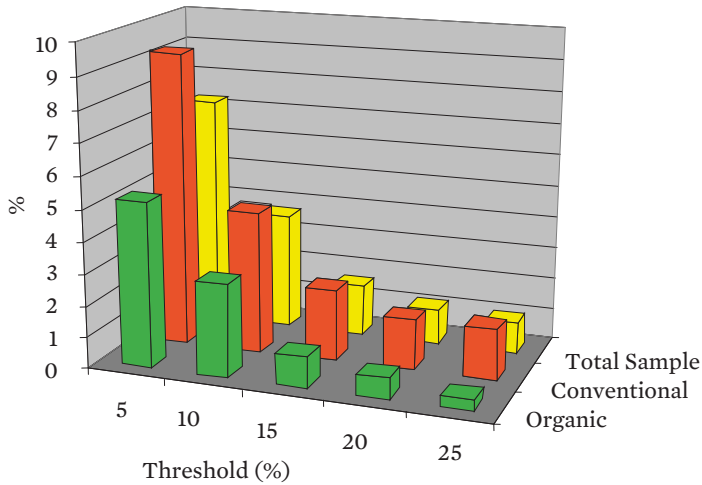
Previous literature highlights the limitations of estimating the catastrophic effect of illness by using the share of high OOP health payments (Xu et al. 2003). First, this method identifies only those households that actually acquire treatment and does not take into account households that have illness but cannot afford treatment. It is likely that these households actually incur a higher opportunity cost from poor health. Second, this method does not distinguish between types of medical expenditure. This is potentially problematic as expenditure by wealthy households on elective medical care would not under normal circumstances be considered catastrophic. However, we can assume that in low-income countries, most medical care is essential (Van Doorslaer et al. 2007).

Finally, there is no a priori standard for choosing the expenditure threshold. A common choice in the literature has been 10% of household expenditure, assumed to be the threshold at which the majority of households are forced to forgo other basic needs. Yet, while 10% of household expenditure on OOP health care payments is catastrophic, 10% of discretionary expenditure is likely not catastrophic (Van Doorslaer et al. 2007; Wagstaff et al. 2007). Therefore, following other authors, we consider various thresholds of both household and discretionary expenditure.

Appendix Table A8.1 shows the catastrophic payment headcounts for organic and conventional households. The catastrophic payment headcount is defined as the percentage of households from the sample exceeding a particular threshold z . Let T_i be the OOP payments of household i , x_i be household expenditure, and E_i an indicator equal to 1 if $T_i/x_i > z$ and zero otherwise. The percentage of households incurring catastrophic expenditure is $H = \frac{1}{N} \sum_{i=1}^N E_i$, where the sample size is denoted by N .



Figure 8.2 Out-of-Pocket Payment as Percentage of Total Household Expenditure



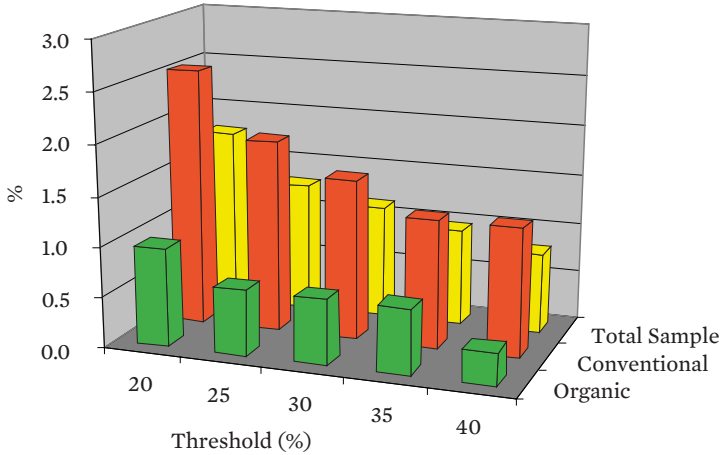
Source: Authors' calculations.

As the threshold rises incrementally from 5% to 25% of total household expenditure, the percentage of households with catastrophic expenditure decreases (Figure 8.2). The largest decline is seen between the 5% and 10% thresholds. At the crucial 10% threshold, nearly 4% of all households had a medical expenditure in excess of 10% of their total household budget. A further 1% of households had OOP payments greater than 25% of total household expenditure. However, organic households had a lower incidence of catastrophic payments than conventional households, regardless of threshold. At 10% of household expenditure, 4.5% of conventional households incurred catastrophic payments, compared with only 2.9% of organic households.

Figure 8.3 presents catastrophic expenditure as a share of discretionary (nonfood) expenses. Nearly 2% of the surveyed households had medical payments in excess of 20% of their discretionary budget. At the staggering 40% threshold, almost 1% of households had catastrophic expenditure. Once again, however, significantly fewer organic households incurred catastrophic payments than did conventional households. Less than 1% of organic households devoted 20% of discretionary spending to health payments, compared with 2.6% of conventional households.



Figure 8.3 Catastrophic Payment Headcount as a Percentage of Discretionary Expenditure

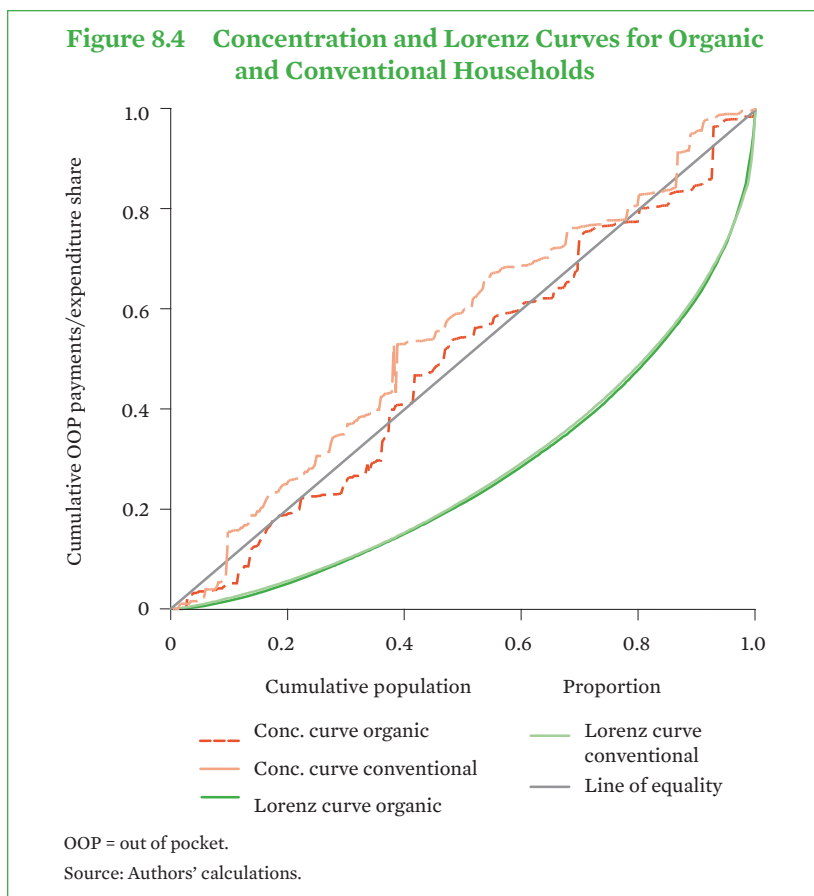


Source: Authors' calculations.

Spending on health care exceeded 40% of discretionary expenditure in 1.3% of conventional households. Such an excessively high expenditure on health care is likely to have a significant impact on the household budget, forcing the household to forgo other consumption and severely reducing its living standard.

These findings show that organic households spend much less on health care than conventional households, both in absolute terms and as a share of household resources. As the household survey does not include data on the health status of household members, it is impossible to conclude with certainty the reason for the lower medical expenditure of organic farmers. However, it is likely that the organic farmers are healthier as they are not exposed to toxic agrochemicals and have better access to homegrown organic products which are known to have higher levels of vitamins and minerals (Brandt 2007).

Among poor farmers in developing countries, illness resulting from the inappropriate use of pesticides is a serious problem. Therefore, it is also important to determine whether poorer organic and conventional households are disproportionately incurring catastrophic health payments. The concentration curves in Figure 8.4 show the concentration indices for catastrophic headcounts at various thresholds



of income. Figure 8.4 also shows Lorenz curves representing household expenditure by organic and conventional households.

The concentration curves suggest that catastrophic payments are higher among the poorest farming households, particularly those practicing conventional chemical agriculture. The curve representing organic households, on the other hand, lies below the conventional curve, indicating that catastrophic medical expenditure is borne more equally among organic households. The Lorenz curves show that organic and conventional households have nearly identical patterns of expenditure. This finding reinforces the earlier findings that despite almost equal household expenditure, under the same expenditure category, conventional farmers are spending significantly more on health care.



Although health expenditure is influenced by many factors, the findings from these different analyses consistently suggest that organic farmers are in better health. However, these findings are also a concern as they imply that the flat charge B30 Scheme of the Government may not be effective at shielding the poor from catastrophic medical expenditure.

8.6 MEDICAL EXPENDITURE AND ITS INFLUENCE ON HOUSEHOLD EXPENDITURE COMPOSITION

Expenditures were separated into eight categories, including expenses that occur frequently (such as food, tobacco and alcohol, personal care, and fuel) and those that occur irregularly (such as education, clothing, and home improvements). The definitions of each expenditure category are listed in Table 8.7. The independent variable (catastrophic expenditure) is defined here as OOP medical expenditure in excess of 10% of total household expenditure.

The descriptive analyses indicate that the average surveyed household spent 2% of total household expenditure on health care (Table 8.7). For households incurring catastrophic payments, however, medical spending was the largest category of expenditure, accounting for 28% of household expenditure, compared to only 1% for households without catastrophic payments. Although expenditure shares of food, tobacco and alcohol, clothing, and personal care were roughly similar for households with and without catastrophic expenditure, spending on education, household operations, and transportation and communications was significantly reduced among households incurring catastrophic payments.

Following Wang, Zhang, and Hsiao (2006), a multiple fractional logit regression model was used to analyze the relationship between catastrophic health expenditure and expenditure patterns after controlling for demographic characteristics. Table 8.8 shows the regression analysis results for each expenditure category. After controlling for age, education of the household head, and organic farming practice, the share of expenditure across all categories is lower for households with catastrophic expenditures. The result is statistically significant for food, clothing, fuel, and education. The relationship between catastrophic payments and decreased expenditure is particularly pronounced for education, pointing to the fact that the



Table 8.7 Expenditure Patterns for Households with and without Catastrophic Expenditure

Expenditure Category	Description	Total		With CE		Without CE	
		Mean	%	Mean	%	Mean	%
Food	Rice, bread, vegetables, fruits, meats, etc.	14,876.14	29	10,552.96	28	15,071.33	29
Tobacco and alcohol	Cigarettes, cigars, beer, wine	1,991.48	4	977.04	3	2,037.28	4
Clothing	Clothes, footwear	1,646.24	3	881.48	2	1,680.77	3
Personal care	Toiletries, beauty products	2,476.00	5	1,888.52	5	2,502.52	5
Fuel, transportation, and communication	Fuel, light, water, transport, communication	13,404.37	26	8,102.89	21	13,644.14	26
Household operations	Rental, repairs, furniture	7,845.19	15	3,046.67	8	8,061.85	15
Education	Tuition, school supplies, books	8,273.04	16	2,040.00	5	8,554.94	16
Medical expenses	Hospital, medical charges, drugs	999.50	2	10,685.19	28	562.19	1

CE = catastrophic expenditure.

Source: Authors' own calculations.

Table 8.8 Results of Regression Analysis of Catastrophic Expenditure and Share of Expenditure Categories

Expenditure Category	Households with Catastrophic Expenditure	Standard Error
Food	-0.000030*	0.0000301
Tobacco and alcohol	-0.00023	0.00015
Clothing	-0.000607**	0.0002498
Personal Care	-0.000135	0.0001356
Fuel, Transportation, and Communication	-0.0000576*	0.0000316
Household Operations	-0.000007	0.0000147
Education	-0.000086**	0.0000494
Medical Expenses	0.0003749*	0.0000694

Notes:

1. **p<0.05, *p<0.10.

2. Regression controlled for age, educational attainment, and farming type.

Source: Authors' own calculations.



welfare of children is most adversely affected when poor households face catastrophic health expenditure.

These findings reveal that catastrophic expenditure on health care has a significant effect on households' consumption and can have a negative impact on both the short- and long-term well-being of a household. Households incurring catastrophic payments were forced to cut back expenditure on essential goods and services, such as clothing; fuel, transportation, and communication; and food, thus investing less in their current production system. Perhaps of greater concern, the incidence of catastrophic expenditure forced households to sharply reduce their investment in education, threatening long-term productivity and well-being. This suggests that often poor households must sacrifice long-term benefits for immediate medical treatment.

8.7 CONCLUSION AND RECOMMENDATIONS

Breaking the vicious cycle of ill health and poverty is essential to economic development. Poor health can reduce productivity by reducing labor capacity, limiting productive investments, and depriving children of educational opportunities. The typical public policy response has been to make health care services available to the poor, an approach that is costly and generally not successful in reaching the most vulnerable groups. Organic agriculture, on the other hand, achieves health outcomes by promoting preventive health by reducing exposure to toxic agrochemicals and possibly by improving the availability and nutritional quality of homegrown produce and improving the environment and sanitation conditions.

Despite abundant anecdotal evidence that organic agriculture leads to better health outcomes among farmers, there has, so far, been limited empirical evidence. Using household catastrophic medical expenditure as a proxy for health status, this chapter attempted to empirically examine whether the adoption of organic agriculture leads to lower medical expenditure, a proxy for improved health. The results of the empirical analysis provide some support for the assertion that organic households are in better health than conventional farming households.

The findings in this chapter revealed that organic households had lower OOP medical expenditure than conventional households, both in



absolute terms and as a share of household expenditure. The results show that organic households had lower incidences of catastrophic medical expenditure, as significantly more conventional farmers incurred health care payments in excess of a large fraction of total household expenditure. In some cases, OOP health care payments absorbed more than one-quarter of total household expenditure and 40% of nonfood expenditure in conventional households.

The findings also revealed that the impacts of catastrophic medical expenditure are greater in low-income households than higher-income households. The concentration curves and indices show that catastrophic health care payments are borne disproportionately by the poor, especially among conventional farmers. The highest medical expenditure is incurred by the poorest quintiles of conventional farming households. This result is not surprising as it is generally accepted that inappropriate pesticide use is most prevalent among the poorest farmers, who are often illiterate and do not receive training on the proper use of pesticides. This finding suggests that promoting organic agriculture among the poor, who are at high risk of pesticide abuse, would result in more significant health gains than promoting organic agriculture among higher-income farmers.

Households incurring catastrophic payments were forced to cut back expenditure on essential goods and services, such as clothing, fuel, transportation, communication, and food, thus investing less in their current production system. Poor households can only cover the high-level medical expenditure by diverting resources from household consumption, accumulating debt, selling assets, or using savings, if they have any. Although we cannot draw a causal relationship between medical expenditure and consumption due to the limitations of cross-sectional data, our findings suggest that household consumption decreased with the incidence of catastrophic medical expenditure. Spending on all major categories of household consumption was lower among households with catastrophic expenditure than those without. Of great concern, education expenditure appears to be among the first to be sacrificed when a household member falls ill and requires medical care. These findings reveal that catastrophic expenditure on health care has a significant effect on household consumption and can have a negative impact on both the short- and long-term well-being of a household.



Our findings indirectly show that organic households experience less illness than conventional households. Although health outcomes are influenced by a variety of factors, it is likely that organic households are healthier due to a combination of reduced exposure to pesticides, improved food security, better nutrition, and better sanitation conditions in general. By reducing spending on health care, the adoption of organic agriculture enables poor households to invest in other areas, such as education, leading to long-term poverty reduction.

Health is so critical to development that three out of the eight United Nations Millennium Development Goals are health related. These findings suggest that promoting organic agriculture is an effective poverty reduction strategy leading to the achievement of the health-related Millennium Development Goals while saving public expenditure on health care for the poor. Organic agriculture also uniquely offers a comprehensive health improvement strategy that goes well beyond spending on health care to improve related areas such as food security, water, sanitation, and the environment.

Future research should further investigate the links between various health factors, such as nutritional intake, exposure (or lack of exposure) to pesticides, sanitation conditions, and health outcomes in organic and conventional households through time-series data or a long-term household study. Beyond the health impacts on producers, the impacts on consumers should be further investigated. Since the trade of organic products is growing rapidly in international markets, future research should also investigate how international trade of organic products can have implications beyond national health programs as a global public good.

REFERENCES

- Antle, J.M., and P.L. Pingali. 1995. Pesticides, Productivity and Farmer Health: A Philippine Case Study. In P.L. Pingali and P. Roger, eds. *Impact of Pesticides on Farmer Health and the Rice Environment*. Los Banos, Philippines: International Rice Research Institute.
- Blair, A. 1991. An Overview of Potential Health Hazards Among Farmers from Use of Pesticides. Presented at Surgeon's General Conference on Agricultural Safety and Health. Convened by



- the National Institute for Occupational Safety and Health. 30 April–3 May 1991. Des Moines, Iowa. <http://www.cdc.gov/niosh/pdfs/92-105i2.pdf>
- Atreya, K. 2005. Health Costs of Pesticide Use in a Vegetable Growing Area, central mid-hills, Nepal. *Himalayan Journal of Sciences*. 3 (5). pp. 81-83.
- Brandt, K. 2007. *Organic Agriculture and Food Utilization*. Issues paper presented at the International Conference on Organic Agriculture and Food Security. 3-5 May. Rome, Italy: FAO. <ftp://ftp.fao.org/paia/organicag/ofs/OFS-2007-4-rev3.pdf>
- Croppenstedt, A., and C. Muller. 2000. The Impact of Farmers' Health and Nutritional Status on their Productivity and Efficiency: Evidence from Ethiopia. *Economic Development and Cultural Change*. 48. pp. 475–502.
- IFAD (International Fund for Agricultural Development). 2003. *The Adoption of Organic Agriculture among Small Farmers in Latin America and the Caribbean: Thematic Evaluation*. Rome.
- _____. 2005. *Organic Agriculture and Poverty Reduction in Asia: [the People's Republic of] China and India Focus*. Rome.
- Kerdsuk, V. 2004. Health Impact of Contract Farming: Case of Tomato and Citrus Production in North and Northeast Thailand. Presentation at the ADBI Regional Research Workshop on Contract Farming and Poverty Reduction: Issues and Research Methodology. 9–12 August. Bangkok.
- Ransom, P. 2002. Women, Pesticides and Sustainable Agriculture. Paper presented at the Women's Caucus for the Earth Summit, CSD NGO Women's Caucus.
- Setboonsarng, S. 2006. Organic Agriculture, Poverty Reduction and the Millennium Development Goals. ADBI. Discussion Paper 54. Tokyo: Asian Development Bank Institute. <http://www.adbi.org/files/2006.09.dp54.organic.agriculture.mdgs.pdf>
- Van Der Hoek, W., and F. Konradsen. 2005. Risk Factors of Acute Pesticide Poisoning in Sri Lanka. *Tropical Medicine and International Health*. 10 (6). pp. 589–596.



- Van Doorslaer, E., O. O'Donnell, R. Rannan-Eliya, A. Somanathan, S. Adhikari, C. Garg, D. Harbianto, A. Herrin, M. Huq, S. Ibragimova, A. Karan, T. Lee, G. Leung, J. Lu, C. Ng, B. Pande, R. Racelis, S. Tao, K. Tin, K. Tisayaticom, L. Trisnantoro, C. Visasvid, and Y. Zhao. 2007. Catastrophic Payments for Health Care in Asia. *Health Economics*. 21. pp. 1159–1184.
- Wagstaff, A., O. O'Donnell, E. Van Doorslaer, and M. Lindelow. 2007. *Analyzing Health Equity Using Household Survey Data: A Guide to Techniques and their Implementation*. Washington, DC: World Bank.
- Wang, H., L. Zhang, and W. Hsiao. 2006. Ill Health and Its Potential Influence on Household Consumptions in Rural [the People's Republic of] China. *Health Policy*. 78. pp. 167–177.
- Whitehead, M., G. Dahgren, and T. Evans. 2001. Equity and Health Sector Reforms: Can Low Income Countries Escape the Medical Poverty Trap? *The Lancet*. 358. pp. 833–836.
- Xu, K., D. Evans, K. Kawabata, R. Zeram dini, J. Klavus, and C. Murray. 2003. Household Catastrophic Health Expenditure: A Multicountry Analysis. *The Lancet*. 362. pp. 111–117.



Appendix

Table A8.1 Household Expenditure, Selected Categories (B)

	Organic	Conventional	p-value
Food	14,752	14,958	0.8250
Tobacco and alcohol	1,930	2,052	0.6292
Clothing	1,662	1,625	0.7913
Personal care	2,561	2,390	0.4202
Fuel, transport, and communications	13,395	13,423	0.9805
Household operations	8,903	6,817	0.5347
Education	9,217	7,349	0.1905
Medical expenses	712	1,277	0.1309

Source: Authors' own calculations.

Table A8.2 Percentage of Households Incurring Catastrophic Out-of-Pocket Medical Expenditure

	Payments as a Percentage of Total Household Expenditure				
	5%	10%	15%	20%	25%
TOTAL SAMPLE					
Headcount	7.23%	3.70%	1.61%	1.13%	0.96%
Standard Error	0.02114	0.010296	0.006105	0.006254	0.004845
Overshoot	0.006507	0.003871	0.002757	0.002081	0.001588
Standard Error	0.002021	0.001517	0.001248	0.000951	0.0007
Mean Positive Overshoot*	8.99%	10.47%	17.15%	18.49%	16.46%
ORGANIC					
Headcount	5.19%	2.92%	0.97%	0.65%	0.32%
Standard Error	0.016397	0.0085	0.006177	0.005915	0.002958
Overshoot	0.003901	0.001687	0.000775	0.000384	0.000199
Standard Error	0.001256	0.000881	0.000635	0.00035	0.000182
Mean Positive Overshoot	7.51%	5.77%	7.95%	5.92%	6.14%

continued on next page

Table A8.2 *continued*

	Payments as a Percentage of Total Household Expenditure				
	5%	10%	15%	20%	25%
CONVENTIONAL					
Headcount	9.27%	4.47%	2.24%	1.60%	1.60%
Standard Error	0.028089	0.013218	0.006609	0.006893	0.006893
Overshoot	0.009093	0.006033	0.004716	0.003757	0.002959
Standard Error	0.002911	0.002195	0.00189	0.001566	0.001225
Mean Positive Overshoot	9.81%	13.49%	21.09%	23.52%	18.52%
TOTAL SAMPLE					
Headcount	1.77%	1.29%	1.13%	0.97%	0.81%
Standard Error	0.006241	0.005612	0.006263	0.004853	0.003476
Overshoot	0.003464	0.002727	0.002109	0.001575	0.001142
Standard Error	0.001646	0.00138	0.001091	0.000804	0.000607
Mean Positive Overshoot	19.56%	21.17%	18.71%	16.30%	14.19%
ORGANIC					
Headcount	0.98%	0.65%	0.65%	0.65%	0.33%
Standard Error	0.008894	0.00593	0.00593	0.00593	0.002965
Overshoot	0.001348	0.000984	0.000659	0.000333	0.000108
Standard Error	0.001227	0.000896	0.000599	0.000303	9.87E-05
Mean Positive Overshoot	13.79%	15.11%	10.11%	5.11%	3.33%
CONVENTIONAL					
Headcount	2.56%	1.92%	1.60%	1.28%	1.28%
Standard Error	0.007014	0.005928	0.006893	0.004358	0.004358
Overshoot	0.005551	0.004445	0.003539	0.002799	0.00216
Standard Error	0.002138	0.001903	0.001601	0.001311	0.001112
Mean Positive Overshoot	21.72%	23.19%	22.15%	21.90%	16.90%

Note: *Mean positive overshoot (MPO) is a measurement of the intensity of catastrophic payments. MPO reflects the payment in excess of the threshold averaged over all households exceeding the threshold (Van Doorslaer et al. 2007). The mean budget share of households exceeding a particular threshold is therefore equal to the threshold plus the MPO. For example, the mean budget share of conventional households exceeding the 25% threshold is 25% + 18.52% = 43.52%.

Source: Authors' own calculations.



Chapter 9 | **Contract Farming of Organic Tea in Kandy: Social, Economic, Health, and Environmental Implications**

L.H.P. Gunaratne

9.1 INTRODUCTION

Sri Lanka is predominantly an agricultural country with roughly 70% of its population of 20 million involved in agriculture. The sector contributed 17.2% to the country's gross domestic product (GDP) in 2006 with a total direct employment of 32.2% (CBSL 2006). Although the share of agriculture in GDP in Sri Lanka declined to 11% in 2011 (CBSL 2012), the sector continues to play a dominant role, as 85% of the population is classified as rural. Moreover, poverty in Sri Lanka is a rural phenomenon as four-fifths of the country's poor live in the rural areas, and almost half of the poor rural population consists of small-scale farmers (IFAD 2011). Therefore, there is an enormous potential and opportunities for the expansion of the economy with new developments in agriculture.

In recent decades, rapid population growth, intensified production, and other economic development activities have led to environmental pollution and degradation of natural resources in developing countries. The agriculture sector in Sri Lanka was not an exception. Improper use of fertilizers and pesticides has contributed immensely to health and environmental problems, such as pollution of soil and water, and loss of biodiversity, leading to poor quality of agricultural products. In this context, organic agriculture emerges as a viable and sustainable option to safeguard the environment while creating interest in ecologically sound alternative farming systems.



Organic agriculture is not new to Sri Lanka as traditional agriculture was practiced using local resources and fewer external inputs for centuries. However, aligning the development of the organic industry with local and global trends requires external support to widen market opportunities. Moreover, organic agriculture gives a particular advantage to small farmers by providing employment opportunities, decreasing production costs, and giving assured access to premium markets. Given organic agriculture's premium prices and contract growing arrangements, it could also increase rural incomes, thus alleviating poverty. That is why organic agriculture has been one of the most rapidly growing sectors in the world during the last decade and is now practiced in 162 countries. It is reported that more than 37.5 million hectares were organically cultivated across the world in 2012 and this continues to grow. Organic agriculture in Asia exhibits a steady expansion which covered 3.2 million hectares in 2012 (Willer, Lernoud, and Kilcher 2013).

This chapter examines whether interventions in the organic sector are capable of improving the socioeconomic, health, and environmental conditions with special reference to the Millennium Development Goals (MDGs). Primary data collected by the Asian Development Bank Institute (ABDI) covering both contract organic tea cultivation and conventional tea cultivation were used for this analysis.

9.2 ORGANIC AGRICULTURE IN SRI LANKA

Sri Lanka is one of the major organic producers in Asia, particularly of organic tea (ESCAP 2006). Sri Lanka trails India, which ranks first in organic black tea production, while the People's Republic of China (PRC) dominates the export market of organic green tea. The organic tea sector is only a very small part of the global tea market, which is still dominated by conventional black tea production (Hajra 2011).

The organic market in Sri Lanka is considered a “niche market,” with a number of organic products—tea, desiccated coconut, cashew nuts, spices (cinnamon, cardamom, nutmeg, pepper, clove, ginger), fruits (mango, papaya, passion fruit), and herbs (citronella, lemongrass)—which are sold in supermarkets. Unlike in the PRC, where there is strong local demand for organic green tea, Sri Lanka's market for organic tea is still embryonic, and mainly for export. A number of leading companies are involved in the export of organic tea, coffee, and spices. The export markets are mainly European countries and the United States. Table 9.1

**Table 9.1 Private Companies that Produce Organic Products**

Company	Area (ac)	
	Organic	Conventional
Stassen Natural Foods	2,247.70	0.00
Renuka Group	2,442.50	0.00
Lanka Organics	2,315.00	1,343.00
Greenfield Bio Plantations	1,089.40	1,343.80
EOAS Organics	3,826.00	500.00
Vita Organics	–	60.00
Bio Foods	4,227.80	155.80
Cecil Food	2,524.00	908.00
HDDDES Extracts	488.00	–
Organic Coconut Growers Association	400.00	–
Maskeliya Plantations	961.80	–

– = data not available, ac = acre.

Source: Sri Lanka Export Development Board.

Box 9.1 National Policy on Agriculture and Livestock (2003–2010)

“The national policy on organic farming is to mobilize resources to produce for the growing demand for organic products and to increase foreign markets for organic products, the comparative advantage exist in Sri Lanka and specially in the rural areas for organic farming, and the high price prevailing for organic products, while planning for the expansion of organic agriculture, providing technology and training for the proper practice for the certification, production, processing and proper implementation of export procedures.”

Source: Sri Lanka National Agriculture Policy, Ministry of Agricultural Development and Agrarian Services.

provides details of different companies along with respective land areas for organic production and land conversion to organic agriculture.

As demand for organic produce continues to increase, the development of local quality standards is a growing necessity. The government has recognized the importance of organic agriculture and the growing



organic movement within the country. In 1999, the Export Development Board initiated a meeting with stakeholders involved in growing, trading, and research about organic agriculture to increase smallholders' organic tea production in terms of quality and quantity.

9.2.1 Policies and Institutional Support for Organic Agriculture in Sri Lanka

Commercial organic agriculture was introduced to Sri Lanka in 1987 by the private sector as certified organic tea production, targeting smallholders. This predominantly export-oriented organic agricultural production currently covers 0.75% of total agricultural land in the country (Willer, Lernoud, and Kilcher 2013). The Government of Sri Lanka has included organic agriculture in the National Agriculture Policy through which the country has the potential to enter into third-country registration (Box 9.1).¹

The promising trend of organic agriculture was facilitated by the numerous government and nongovernment organizations (NGOs). The Sri Lanka Export Development Board, Ministry of Agricultural Development and Agrarian Services, Department of Export Agriculture, Coconut Research institute, Coconut Cultivation Board, Sri Lanka Standard Institute, Department of Agriculture, and Tea Research Institute are some of these service-providing government organizations.

The main activity areas of these organizations are research, market promotion, development of model farms, extension services, and provision of subsidies. Under organic certification, development of the national organic standards is provided by the Sri Lanka Standard Institute. In addition, there are several NGOs and private sector organizations promoting organic farming, particularly among the rural poor, while others are mainly involved in organic exports. They include Gami Seva Sevana, Sewalanka's organic farming group, Environmental Education and Mangrove Nurseries—Alubomulla, Bio Foods, World Vision Sri Lanka, and Lanka Organic Agriculture Movement.

¹ In organic production, the whole process is certified by an accredited third-party organization. Non-European Union countries can be admitted into the Third Country Register under EEC no. 94/92. At present, seven countries (Argentina, Australia, Israel, Czech Republic, Hungary, Switzerland, and India) have entered into this list. Sri Lanka has the potential to enter into the list.



9.3 CONTRACT FARMING AND ORGANIC AGRICULTURE

As market infrastructure is not yet properly established in most of the rural areas in Sri Lanka, the transition from subsistence production to commercial production is most easily achieved by contract farming. Contract farming provides farmers with assured markets for their crops, technical support, credit, and even product accreditation for the export market. Consequently, poor farmers are able to participate in commercial production, resulting in alleviation of poverty. Setboonsarng, Leung, and Cai (2006) provides a discussion on the potential benefits of contract farming.

A number of private firms and NGOs in Sri Lanka have been involved in contract organic tea production. Smallholder farmers, however, dominate the nation's overall tea production, accounting for 76% of tea production. These small growers suffer from high production costs, mainly due to the increasing fertilizer costs. In this context, contract organic farming appears to be an ideal intervention that can improve living standards of the rural poor while protecting the environment and contributing to foreign exchange earnings. The potential is displayed by cumulative bio-tea production of 738.2 metric tons (Mt) in Sri Lanka in July 2007, an increase of over 17% based on 2006 figures.

Against this background, this chapter assesses the contributions of contract organic farming in socioeconomic, health, and environmental improvement of smallholder tea farmers in the mid-country wet zone of Sri Lanka with special reference to the MDGs. In relation to Sri Lanka, the National Campaign for Achieving the MDGs is spearheaded and administered by the Ministry of Finance and Planning, with the support of the United Nations Country Team and with direct implementation assistance by the United Nations Development Programme (UNDP). The National Council for Economic Development (NCED) brings together stakeholders from the private and state sectors to develop economic policies and action plans.²

² The Sri Lankan MDGs were constructed based on the details available at <http://www.undp.lk>



9.4 DATA AND METHODS

The primary data for the analysis were obtained from a comprehensive survey commissioned by ADBI in Tokyo. The survey covered 220 contract and conventional tea growers in the mid-country wet zone of Sri Lanka in 2006. The following framework (Table 9.2) suggested by Jimenez (2007) is used for the analysis:

Table 9.2 Potential Contributions of Organic Agriculture to Achieve the Millennium Development Goals

MDG	Key Contributions of Organic Agriculture (direct and indirect)
1. Eradicate extreme poverty and hunger	Increased yield (productivity increase) in low-input areas, higher income (premium prices), diverse and nutritious diets from organic products, fewer food insecurity problems, reduced hunger pressure, lower costs (for inputs)
2. Achieve universal primary education	Better livelihoods, more self-confidence, extra income used to school children (especially girls), increased attendance and levels of education, organic agricultural practices foster knowledge of local environment, learning-by-doing processes, farmer-to-farmer knowledge exchange
3. Promote gender equality and empower women	Active and diversified role of women, increased responsibilities and decision making for women, more self-confidence among women, community participation and rural development promoted, marginalized groups favored (also less urban migration and slum dwellers in city suburbs)
4. Reduce child mortality	Healthier and safer food (elimination or less exposure to toxic pesticides), improved livelihoods, diversified diets, improved quality of community health
5. Improve maternal health	Healthier and safer food, improved care of children, improved quality of community health, fewer health problems (less exposure to chemicals and pesticides)

continued on next page

Table 9.2 *continued*

MDG	Key Contributions of Organic Agriculture (direct and indirect)
6. Combat HIV/AIDS, malaria, and other diseases	Healthier and safer food, strengthened immune system, increased protection of human health
7. Ensure environmental sustainability	Increased biodiversity and genetic diversity, improved sustainability and resilience of the system, build-up of soil fertility, decreased soil degradation (erosion), improved natural resource management, optimized water-use demand, reduced water runoff and soil erosion, positive externalities and ecosystem services enhanced (payment for ecosystem services, PES), reduced water contamination, farmers as guardians of unique breeds, preserved traditional and indigenous knowledge
8. Develop a global partnership for development	Fostering of collaboration between government and organic agriculture agencies and institutions, effective stakeholder involvement, participatory guarantee systems (IFOAM 2005), capacity-building at the farmer level, reliable institutional support systems, development of business and marketing skills, responsible and fair trade, increased awareness about organic produce in farmers and consumers (participatory guarantee system, PGS)

IFOAM = International Federation of Organic Agriculture Movements, MDG = Millennium Development Goal.

Source: Jimenez (2007).

9.5 RESULTS AND DISCUSSION

9.5.1 Socioeconomic Profile of the Sample Households

The socioeconomic characteristics of the sample population by type of farming are depicted in Table 9.3. As shown, there are no statistical differences between contract and conventional tea growers with respect to their education, and extent of the farm and family size, except for the age of the head of the household (at $p = 0.10$). Overall, the tea growers in the mid-country wet zone of Sri Lanka have an average family size of 4.5 and possess fairly small lands (i.e., less than 0.5 hectares).

**Table 9.3 Household Characteristics of Organic and Conventional Farmers in Sri Lanka**

	Total Farmers Mean (N = 198)	Conventional Farmers Mean (N = 100)	Organic Farmers Mean (N = 98)	t-ratio	p-value
Age of household head (years)	52.22	50.78	53.65	-1.78	0.07
Highest education level*	2.76	2.81	2.7	-0.58	0.56
Total farmed area (hectare)	0.45	0.46	0.45	-0.39	0.69
Family size	4.5	4.5	4.6	0.17	0.87
On-farm employment	68.5%	66%	71%	-	-

-- = data not available.

* 1 = primary, 2 = secondary, 3 = tertiary

Source: Asian Development Bank Institute survey results.

Most nonorganic (66%) and organic farmers (86%) in the surveyed organic and conventional villages completed their education up to the secondary level.

9.5.2 Role of Contract Organic Tea Production in Achieving the Millennium Development Goals

MDG 1: Eradicate Extreme Poverty and Hunger

Target 1A: To halve the number of people who live on less than \$1 a day



The salient feature in income growth in Sri Lanka is the widening disparity between rich and poor. From 1990 to 2002, inequality has expanded as evidenced by the 36% income increase of the poorest quintile and 49% in the richest quintile. Over the same period, a 2.2% increase in consumption expenditure of the poorest quintile had an equivalent increase of 50% in the richest quintile.



Table 9.4 provides the details on household income, although most of the variables such as farm income, crop profits, and nonfarm income (by total farmed area and per hectare) were not statistically significant between the groups. Conventional farmers received a significantly higher total value of crop sold mainly due to high yields, but this was not true on a per hectare basis. By contrast, the cost of production in organic agriculture was found to be significantly lower ($p < 0.01$) by total farmed area as well as by per hectare. Given the high dependence on external inputs in conventional cultivation, this suggests that organic farming has a potential of increasing future farm income. This fact is corroborated by the information provided in Table 9.5.

In this analysis, following Setboonsarng, Leung, and Cai (2006), the organic growers are categorized based on length of experience as initial (0–2 years), transitional (2–4 years), and permanent (over 4 years). This shows that as the years of experience with organic agriculture increase, so do tea yields, thus improving total farm sales. As indicated, this can be attributed to further cutting down the costs of cultivation and improvement of production capacity of the soil base over time. The yields of conventional tea cultivation continue to be high, but organic yields can also pick up over time.

Table 9.4 Household Income and Crop Profit (SLRe)

Means	Total Sample (N = 198)	Conventional (N = 100)	Organic (N = 98)	t-ratio	p-value
Household Income					
Total value of crops sold	55,073	60,703	49,500	1.95	0.05
Total variable cash cost	8,087	13,657	2,771	6.91	0.00
Farm income	53,927	58,268	49,585	1.53	0.13
Profit from crops	45,713	44,612	46,814	-0.42	0.68
Total nonfarm income	104,496	112,188	96,804	1.59	0.11
Profit per Hectare of Crops					
Total value crops sold	120,322	130,643	110,000	1.64	0.16
Total variable cash costs	17,825	29,391	6,024	6.87	0.00
Farm income	117,563	124,789	110,189	1.18	0.24
Profit from crops	99,671	96,982	104,031	-0.75	0.45

N = sample size.

Source: Asian Development Bank Institute survey results.



Table 9.5 Total Sales by Years of Experience in Organic Agriculture

Years of Experience	Quantity harvested (kg)	Total sales (SLRe)
< 2 years organic experience (N = 16)	764	38,725
2–4 years organic experience (N = 30)	1,110	50,346
> 4 years organic experience (N = 52)	1,329	52,243

kg = kilogram, SLRe = Sri Lankan Rupee.

Source: Asian Development Bank Institute survey results.

As shown on Table 9.6, no major differences exist with respect to the wealth of the two categories of farmers. The expenditure acquisition of farm assets, however, and house improvements and expansion was higher for organic than for conventional farmers, although the values of nonfarm assets were significantly high with conventional farming. A significant difference was found with respect to the expenditure on household repairs and/or improvements, which implies that the living standards of organic farmers have improved.

The production risk of farming categories is also interesting to note. In the study area, contract tea growers received a premium price of SLRe40.00 per kilogram of fresh green leaves while the average price received by conventional farmers was SLRe22.60 with a standard

Table 9.6 Other Measures of Wealth

	Total Sample (N = 198)	Conventional Farmers (N = 100)	Organic Farmers (N = 98)	t- ratio	p-value
Own area (hectare)	0.45	0.46	0.45	0.358	0.72
Own land (%)	94	93	96	0.860	0.39
Housing class	1.93	1.92	1.95	0.260	0.79
Acquisition of farm and household assets, per year	7,574	7,035	8,191	0.740	0.46
House repairs, improvements	9,772	4,601	14,996	2.080	0.04
House expansion	8,887	7,260	10,050	0.310	0.75
Nonfarm assets (SLRe)	11,561	15,025	7,327	3.650	0.00
Farm assets (SLRe)	3,274	4,390	2,451	-0.660	0.51

N = sample size.

Source: Asian Development Bank Institute survey results.

**Table 9.7 Production Characteristics Affecting Household Income**

	Total Sample (N = 198)	Conventional Farmers (N = 100)	Organic Farmers (N = 98)	t- ratio	p-value
Production Risk					
Costs of crop damages	6702	131	0.31	-1.27 ^a	0.21
Market Prices (excluding SLRe per kilogram)					
Tea	31.20	22.60	40	68.54	0.00
Pepper	167	149	183	5.05	0.00
Price Variation (standard deviation)					
Tea	–	2.42	0	68.54	0.00
Pepper	–	15.90	33.90	5.05	0.00

– = data not available, N = sample size.

^a Despite the huge difference in costs between the two groups, the low t-ratio resulted from a huge variability in the data on cost of crop damages.

Source: Asian Development Bank Institute survey results.

deviation of SLRe2.42. The production risk, which was measured based on cost of crop damages, was also substantial with conventional farming (Table 9.7).

The net advantage of organic farming was well accepted by the organic tea growers. With the involvement of contract organic farming, they felt that though their yields were comparably low, they were better compensated by a higher price (Table 9.8). Of these, it is worthwhile to mention three main merits as perceived by the organic tea growers: higher price, low input cost, and secured market.

MDG 1: Eradicate Extreme Poverty and Hunger

Target 1B: To halve the proportion of people suffering from hunger



Although there is no difference between conventional and contract organic tea farming with respect to food self-sufficiency, several differences are observed with respect to other variables. Annual total household and per capita expenditure on purchased food are significantly lower (at $p < 0.10$) with the organic tea growers implying that their exposure to environment-friendly farming practices leads to



Table 9.8 Different Impacts on Crop Production Reported by Organic Farmers (N = 98)

Changes	% of Time Mentioned
Perceived Impacts	
Yield improved due to better seed	18
Yield improved due to better management	20
No major changes in yield	13
Yield declined	4
Yield declined but compensated by higher price	33
Other	12
Advantages indicated	
Higher price for output	34
Higher yield	1
Secure market of contract	33
Avoid chemicals	0
Reduction of input costs	20
Soil fertility improvements	10
Good for environment	2

N = sample size.

Source: Asian Development Bank Institute survey results.

decreased dependence on externally produced items (Table 9.9). On the other hand, it may also indicate that organic farming households cannot afford to purchase food with cash. However, there are no substantial improvements of organic farmers with respect to other parameters of food security.

MDG 2: Achieve Universal Primary Education



Since independence, primary, secondary, and tertiary education in Sri Lanka been free through an island-wide network of 10,475 primary and secondary schools and state universities and technical colleges. With a net enrollment ratio of 98.35 (2003), Sri Lanka is the best performer in

**Table 9.9 Food and Nutrition**

	Total Sample (N = 198)	Conventional Farmers (N = 100)	Organic Farmers (N = 98)	t- ratio	p-value
Food self-sufficiency					
Staple food purchased (%)	72	74	70	-0.075	0.28
Annual Food Expenditure (SLRe)					
Household, total purchased food	69,927	72,197	67,680	-1.93	0.19
Purchased food for person	15,859	16,652	15,075	-2.11	0.03
Purchased meat	9,083	8,587	9,565	1.58	0.11
Annual staple food expenditure	52,925	55,774	50,104	1.73	0.09

N = sample size.

Source: Asian Development Bank Institute survey results.

South Asia in achieving universal primary education. However, Sri Lanka needs to ensure that policies promote the participation of poor, rural, street, and other disadvantaged children. In 2002, 97.6% of the children enrolled in primary education reached grade 5 and youth literacy rates reached 95.6%. In the study area, the contribution of organic farming toward achieving this goal was not identified.

MDG 3: Promote Gender Equality and Empower Women



The data analysis shows that there are improvements in gender equity and women empowerment in organic farming, although the differences are not statistically significant. As shown in Table 9.10, the percentage of women working outside their village had been reduced through the involvement in organic cultivation. More males have been found to be sharing domestic activities, while more women became more involved in household decision-making in organic farming. This empowerment may be due to a high number of women participating in various training activities. Table shows the averages over all surveyed households and by farm type.



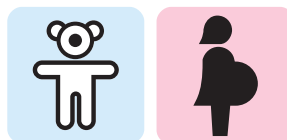
Table 9.10 Indicators for Gender Equality and Empowerment of Women (%)

	Total Sample (N = 198)	Conventional Farmers (N = 100)	Organic Farmers (N = 100)	Comparison of Conventional to Organic Farmers
Women working outside the village	9	11	7	$\chi^2 = 0.85, p = 0.36$
Men sharing domestic duties	95	87	94	$\chi^2 = 1.82, p = 0.18$
Women participated in training	49	44	50	$\chi^2 = 192.63, p = 0.03$
Women making decisions	89	86	87	$\chi^2 = 0.63, p = 0.43$

N = sample size.

Source: Asian Development Bank Institute survey results.

MDGs 4 and 5: Improve Maternal and Child Health



During the last 2 decades, Sri Lanka achieved remarkable progress in improving maternal and child health. The system of trained community health workers and the increased number of rural hospitals has contributed to Sri Lanka’s achievement in reducing maternal mortality. During 1980–2003, Sri Lanka recorded a consistent upward trend in the percentage of babies born in hospitals, which has increased from 75.6% to 91.9%. In this context, having a very high proportion of households (above 95%) with trimester health check-ups and giving birth in clinics or similar situations in the total sample, there appeared to be no significant difference between conventional and organic farmers (Table 9.11).

Table 9.11 Indicators of Maternal Health (%)

	Total Sample Means (N = 195)	Conventional Farmers (N = 98)	Organic Farmers (N = 97)
Place of Last Delivery			
Had trimester health check-up	98	100	96
Gave birth in clinic or equivalent	98	97	95

N = sample size.

Source: Asian Development Bank Institute survey results.



Table 9.12 Maternal Health Questions for Organic and Conventional Farming Households

Question	Total (N = 195)	Organic (N = 97)	Conventional (N = 98)	t-ratio/ χ^2 value	p-value
Number of pregnancies	2.79	2.85	2.74	$t = -0.62$	0.53
Intake of three meals daily while pregnant with last child (%)	97.98	97.98	97.98	$\chi^2 = 0.04$	
Visited health center in first trimester for check-up when pregnant with last child (%)	96.48	95.96	96.97	$\chi^2 = 0.13$	
Time taken to travel from your home to the health center	1.04	0.87	1.22	$t = 4.76$	0.00
Amount spent on delivery (SLRe)	832	729	934	$t = -0.82$	0.41

N = sample size.

Source: Asian Development Bank Institute survey results.

The mothers of respondent families were asked a set of questions related to maternal health and the responses are summarized in Table 9.12. Basically, no important differences were identified, except in the case of distance to travel from home to the health center.

MDG 6: Combat HIV/AIDS, Malaria, and Other Diseases



In Sri Lanka, HIV/AIDS prevalence is relatively low. However, behavioral risk factors such as low contraceptive use, increasing numbers of sex workers, and high number of migratory workers may pose serious challenges in the future. Although the overall awareness of HIV/AIDS is relatively high among women in Sri Lanka (90%), only 45% of women in the estate sector are aware of the disease (NCED and UNDP 2005).

Of the other diseases related to MDG 6, the campaign against malaria is a priority in Sri Lanka. Reports of the Anti-Malaria Campaign by the Ministry of Health indicated an over fourfold reduction in the incidence of malaria between 1994 and 2001 (from 1,520 per 100,000 people to 350 per 100,000 people). Since the mid-1990s, however, no significant reduction in the malaria mortality rate has been reported. By 2002, only the northern and eastern districts reported an increase of malaria cases by 92.3%. The western and southern provinces reported the lowest percentages of malaria cases (0.9%). The success of the campaign is seen in the significant reduction of malaria cases by 99.67% from 210,039 to 684 (Anti-Malaria Campaign Report 2011).

**Table 9.13 Average Health Expenditure and Sick Days in 12 Months per Household**

	Total Sample (N = 198)	Conventional (N = 100)	Organic (N = 98)	t-ratio	p-value
Children's health care (SLRe)	379	702	48	1.29	0.20
Mothers' health care (SLRe)	188	190	187	-0.04	0.97
Total family (SLRe)	1,023	1,428	609	-1.47	0.14
Mother, sick days	0.55	0.54	0.56	0.09	0.92
Children, sick days	0.33	0.5	0.15	-2.39	0.01

N = sample size.

Source: Asian Development Bank Institute survey results.

By 2012, Sri Lanka had recorded the lowest number of malaria cases since 1963, owing to the Anti-Malaria Campaign. Of the other diseases, the incidence of new tuberculosis cases increased between 1991 and 2011 from 6,174 to 9,507 (WHO). No information was found from the survey relevant to the health status related to HIV/AIDS or malaria.

Information on different indicators of average health expenditure is given in Table 9.13. Although no differences were found between the two groups for these indicators, one of the salient findings is that the number of sick days by an average child is significantly lower in organic farming households.

On awareness of pesticide-related risks and pesticides, Table 9.14 shows that 82% of organic farmers perceive pesticide to be associated with high and dangerous risks, as compared with 60% of conventional farmers.

MDG 7: Ensure Environmental Sustainability



A number of parameters were used in the study to test target 1 on reversing loss of environmental resources of MDG 7 on environmental sustainability. Table 9.15 shows that about 61% of organic farmers



Table 9.14 Perception of Different Degrees of Risk for Pesticides (%)

Risks	Conventional (N = 100)	Organic (N = 98)
Risk Perception		
No risk at all	3	0
Small risk	24	5
High risk	52	60
Dangerous risk	8	22
Neutral	13	13
Awareness of Risk		
Heard of local pesticides accidents	47	50
Knew about cases and nature of contaminations	38	50
Believed in harms to own health	81	88
Believed in harms to unborn babies	29	35

N = sample size.

Source: Asian Development Bank Institute survey results.

perceived an improvement in biodiversity on their farmland with the adoption of organic agriculture. Also, more organic farmers felt that the environment is very important for their survival and sustaining production.

Tea growers in the mid-country wet zone of Sri Lanka usually adopt a number of ecological farming practices, whether organic or conventional farmers. There were, however, significant differences between the two groups in terms of ecological methods, soil conservation methods, and the amount of organic manure used. Of the eco-friendly production practices, the most prominent ones adopted by the organic tea growers were the use of compost and green manure. While the use of herbicides and pesticides was almost nil, the use of bio-pesticides or integrated pest management (IPM) was not high either (Table 9.16). This implies the need to promote eco-friendly practices.



Table 9.15 Farmers' Perception of Environmental Effects by Organic Practices

	Total Sample (N = 198)	Conventional (N = 100)	Organic (N = 98)	t-ratio
Farmers' Perception on Biodiversity (%)				
Increase	32	1	61	-
Same	14	27	1	-
Decrease	11	23	0	-
Did not know or no concern	44	49	38	-
Indicated that environment is very important (%)	92	83	98	-
Adopted ecological methods (%)	4.65	3.97	5.32	-3.68
Adopted soil conservation methods (%)	2.96	2.64	3.29	-2.66
Used livestock manure (%)	46	37	55	-
Amount of inorganic fertilizer used (kg)	128	256	0	-
Amount of manure used (kg)	219	2.49	435	-10.01
Amount of manure used (kg/ha)	475	5.4	945.68	-10.04

- = data not available, ha = hectare, kg = kilogram, N = sample size.

Source: Asian Development Bank Institute survey results.

MDG 7: Ensure Environmental Sustainability

Target 9: Integrate the principles of sustainable development into country policies and programs and reverse the loss of environmental resources



Some of the indicators used in measuring the sustainability of systems were farm dependency and household expenditure on nonfood costs. Table 9.17 shows that organic farming was found to be less dependent on outside labor than conventional tea cultivation. Hired labor costs were significantly lower compared to conventional tea growing. Also, expenditure on nonfood items appeared to be lower for organic farming households (Table 9.17), although not statistically significant.

**Table 9.16 Changes of Farm Management Practices**

Management Practices Used (N = 198)	Changes After Joining Organic Contract Farming (%)			
	More	Same	Less	Never Used
Use of chemical fertilizers	1	3	46	50
Use of compost	98	1	1	0
Use of green manure	99	1	0	0
Use of herbicides	0	0	5	95
Use of chemical pesticides	1	0	6	93
Use of biological pesticides	19	28	35	18
Use of other IPM technologies	12	27	4	57

IPM = integrated pest management, N = sample size.

Source: Asian Development Bank Institute survey results.

Table 9.17 Household and Farm Expenditure in Organic and Conventional Farms

	Total Sample (N = 198)	Conventional (N = 100)	Organic (N = 98)	t-ratio	p-value
Total labor used (days/hectare)	268	281	254	1.4	0.16
Expenditure on labor used (% total labor cost)	18	21	11	3.105	0.00
Expenditure on clothing (SLRe)	8,480	8,054	8,933	-1.73	0.086
Expenditure on education (SLRe)	6,458	7,005	5,870	0.84	0.40
Expenditure on total nonfood items (SLRe)	95,493	97,822	92,992	1.08	0.28
Expenditure on total nonfood items per person (SLRe)	21,015	21,594	20,393	1.22	0.22

N = sample size.

Source: Asian Development Bank Institute survey results.

In Sri Lanka, 75% of the urban population receives piped-borne water, but only 14% of the rural population has the same service. However, 65% of the rural population has access to protected well water. During 1994–2001, the proportion of the population with access to piped water rose from 72% to 82%. In the study area, the survey found that almost all the households had access to safe drinking water (Table 9.18).



Table 9.18 Household with Access to Improved Water Supply and Sanitation (%)

	Total Sample (N = 198)	Conventional (N = 100)	Organic (N = 98)
Access to an improved water source	100	100	100
Access to improved sanitation	98	97	100

N = sample size.

Source: Asian Development Bank Institute survey results.

MDG 8: Develop a Global Partnership for Development



In the study area, collaboration between government and organic agriculture agencies and institutions was promoted. Organic farmers also participated actively as reflected in significantly higher membership numbers in farmers’ organizations and number of meetings per year. In effect, organic farming was found to enhance development of social capital (Table 9.19). This may be influenced by the firms involved in contract farming. This is attributed to the effectiveness of stakeholder involvement, participatory guarantee systems (conducted by IFOAM), capacity building at the farmer level, reliable institutional support systems, business and marketing skills developed, responsible and fair trade, and increased awareness about organic produce in farmers and consumers.

Understanding the motivations of farmers is important in promoting organic agriculture. As summarized in Table 9.20, organic farmers listed

Table 9.19 Level of Social Capital of the Organic and Conventional Farmers

	Total Sample (N = 198)	Conventional (N = 100)	Organic (N = 98)	t-ratio	p-value
Membership of organization (%)	72.36	49.49	94.85	–	–
Number of members	46.71	58.19	42.62	3.57	0.00
Number of meeting per year	8.49	3.59	11.01	-13.48	0.00

– = data not available, N = sample size.

Source: Asian Development Bank Institute survey results.



Table 9.20 Reasons of Organic Farmers for Adopting Organic Farming

Reasons for Adoption (N = 98)	Number of Times Mentioned	% of Times Mentioned
Farm leader encouraged me	26	9
Everyone in the village joined	48	16
Firm offered higher price	98	33
Assured market for output	72	24
Access to credit for inputs	51	17
Production system uses nontoxic agrichemicals	4	1
Other	1	0
Total	300	100

N = sample size.

Source: Asian Development Bank Institute survey results.

private benefits, such as higher price and assured market, as motivations for them to adopt organic practices. Better management of the soil was also found to be important.

9.6 SUMMARY AND IMPLICATIONS

The smallholder sector of over 400,000 growers dominates the tea production in Sri Lanka, accounting for about 76% of total tea production. Most of the tea smallholders in the mid-country wet zone of Sri Lanka are in marginal tea lands. Hence, productivity and net return are not substantial. Against this background, several private firms and NGOs promoted contract organic production with the aim of improving rural livelihoods via better market access.

To assess whether these interventions improved the socioeconomic, health, and environmental conditions—with special reference to the MDGs—contract organic tea farmers were compared with conventional tea growers. Initial analysis revealed that the two groups were homogeneous in terms of their family size, education, and farm size. Conventional tea growers had higher yields and so they received a higher gross income compared to organic growers. However, the cost of production of organic growers was significantly lower mainly due to



low external inputs, such as doing away with costly chemical fertilizers, which increased production costs and hence the output price. Moreover, as organic farmers gain more years of organic farming experience, they are able to increase their yields, thus reducing the income gap between the two groups (although this could not be quantified).

Notable contributions of contract organic tea cultivation were found in several areas: reduction of production costs and risk, gender empowerment, improvement of family health (reducing children's sick days), increased adoption of environment-friendly crop production practices, and building of social capital. The survey results also revealed that awareness of contract tea growers on ecological crop cultivation and family nutrition must be raised. The potential benefits can be enhanced by collaboration with government agencies and organizations, such as the Tea Small Holders Development Authority, and the use of fair trade.

The results of this chapter supported institutional intervention of contract organic farming, which has the potential to overcome the obstacles related to market access, transaction costs, and social capital. The potential gains of organic farming could be used to entice conventional growers toward organic tea production. The driving factor behind the improvement is the price premium, but in order to achieve the other MDG targets, these programs should be effectively linked with other related poverty alleviation programs.

REFERENCES

- Anti-Malaria Campaign Report. 2011. <http://www.malariacampaign.gov.lk/presentation/Home.aspx>
- CBSL (Central Bank of Sri Lanka). 2006. *Central Bank of Sri Lanka Annual Report*.
- . 2012. *Central Bank of Sri Lanka Annual Report*.
- ESCAP (United Nations Economic and Social Commission for Asia and the Pacific). 2006. *Country Profile Sri Lanka*. <http://unescap.org/stat/data/statind/pdf/index.asp> (accessed 20 September 2007).



- Hajra, G. 2011. Organic Tea Production and Market: Global Scenario. Paper presented at the 17th IFOAM Organic World Congress in the Republic of Korea, 26–27 September.
- IFAD (International Fund for Agricultural Development). 2011. *Country Factsheets – Enabling the Rural Poor to Overcome Poverty in Sri Lanka*. <http://www.ifad.org/operations/projects/regions/pi/factsheets/srilanka.pdf>
- International Federation of Organic Agriculture Movements (IFOAM). 2005. *The IFOAM Norms for Organic Production and Processing*. Bonn.
- International Trade Center Data. Country Profile Sri Lanka – Organic Products Exporters. <http://www.intracen.org/exporters/organic-products/country-focus/Country-Profile-Sri-Lanka/>
- Jimenez, J. 2007. *Organic Agriculture and the Millennium Development Goals*. Bonn: IFOAM.
- NCED (National Council for Economic Development of Sri Lanka) and UNDP (United Nations Development Programme). 2005. *MDGs Country Report 2005 – Sri Lanka*. <http://planipolis.iiep.unesco.org/upload/Sri%20Lanka/Sri%20Lanka%20MDG%202005.pdf>
- Setboonsarng, S., P. S. Leung, and J. Cai. 2006. Contract Farming and Poverty Reduction: The Case of Organic Rice Contract Farming in Thailand. ADBI Discussion Paper No. 49. Tokyo: Asian Development Bank Institute.
- Willer, H., J. Lernoud, and L. Kilcher, eds. 2013. *The World of Organic Agriculture: Statistics and Emerging Trends 2013*. Frick and Bonn: Research Institute of Organic Agriculture (FiBL) and International Federation of Organic Agriculture Movements (IFOAM).
- WHO (World Health Organization). Tuberculosis Data. <http://www.who.int/tb/data>



Chapter 10 | **Comparative Efficiency of Organic and Conventional Tea and Its Rural Development Implications in Sri Lanka**

L.H.P. Gunaratne

10.1 INTRODUCTION

The plantation sector in Sri Lanka occupies around 40% of total cultivated land and generates 1.5 million employment opportunities. The sector brought in \$2.8 billion of export earnings in 2011 or 2.2% of the country's gross domestic product (GDP), of which about \$2.5 billion were from tea and rubber, the country's traditional plantation crops. Tea is a prominent plantation crop and is one of the most developed industries in terms of cultivation, processing, and grading in the country. A total of 203,885 hectares in 2011 were devoted to tea plantation, of which 59% (120,664 hectares) was owned by smallholder tea farmers, 36% by regional plantation companies, and the remaining 5% by state plantation institutions. In 2011, small tea farmers produced 70% of the national tea production (MPI 2012). Roughly 1.5 million Sri Lankans (around 18% of the labor force) are either directly or indirectly involved in the tea sector.

Meanwhile, recent decades have witnessed a remarkable acceleration of organic agriculture in the developing world as health and environmental concerns of developed countries prompt their consumers to go organic. This has opened up new markets for smallholder organic growers via contract farming. As contracting companies can provide market knowledge and experience, distribution networks, technical skills, timely inputs, and financial clout to contracted farmers, the latter are enabled to export their green agricultural products to lucrative markets abroad (Setboonsarng, Leung and Cai 2006; Marshall et al. 2006).



Increasingly, contract farming is being viewed as a way to share the benefits of expanding markets for nontraditional premium products, such as organic tea, and has a promising role in alleviating rural poverty.

Is contract farming, however, an effective intervention to mitigate rural poverty? An understanding of how resources in organic tea cultivation are utilized is useful in designing efficient policies. One area that needs assessment is production efficiency, which is generally analyzed by examining two components: technical and allocative efficiency. Technical efficiency measures the ratio of actual output to the maximum feasible output, for a given set of inputs. Allocative efficiency refers to the use of inputs in optimal proportions and is measured comparing the marginal product of factors with their normalized prices. In this context, this chapter sets out to analyze the technical efficiency of the organic contract tea farmers with respect to conventional tea growers. The second concern is to identify farm-specific and socioeconomic characteristics that explain the variation of inefficiency of individual tea growers. The differences of technical efficiency between conventional and contract tea growers could be useful in identifying and justifying some institutional interventions toward organic tea production. Finally, an understanding of the constraints faced by organic tea growers would be useful to policy makers in designing new programs and in improving existing ones.

10.2 CONCEPT OF TECHNICAL EFFICIENCY

The concept of efficiency, as described by the pioneering work of Farrell (1957), is the deviation of average practices from the best (maximum output) practices. Given that the production function operated at constant returns to scale, Farrell assumed that observed input-per-unit-of-output values for firms would be above the unit isoquant.¹ If a firm uses only two inputs, x_1 and x_2 to produce output y , the frontier technology can be characterized by a unit isoquant $1 = f(\frac{x_1}{y}, \frac{x_2}{y})$, which defines the most efficient use of inputs to produce that output.

¹ A curve representing the combinations of factor inputs that yield a given level of output in a production function.



Farrell (1957) defined technical efficiency as the ratio of inputs required to produce y_o to the inputs actually used to produce y_o . In other words, any production plan is technically efficient if $y = f(x_1, x_2)$ (for two input case) and technically inefficient if $y < f(x_1, x_2)$. Allocative efficiency deals with the optimum use of input combinations. In other words, the production plan must satisfy the condition that the ratio of marginal physical product² (MPP) is equal to the ratio of factor³ prices.

The combination of these two—technical efficiency and allocative efficiency—is defined as economic (productive, cost, or total) efficiency. The efficient unit isoquant is not observable and cannot be displayed with more than two inputs. Therefore, Farrell suggested two methods to tackle the issue: econometric frontier estimation and programming methods such as estimation of free-disposal-convex-hull⁴ of the observed input–output ratios by linear programming techniques. During the past 2 decades, efficiency measurement techniques have been developed along these two competing approaches: respectively parametric econometric frontiers and nonparametric data envelopment analysis.

Despite the limitation of assumptions on functional form, econometric frontier techniques have been widely used in agriculture-related studies (Coelli 1995). Bauer (1990) pointed out several theoretical and empirical advantages of using econometric frontiers in measuring productive efficiency: (i) the notion of frontiers is consistent with the underlying theory of optimization behavior, (ii) deviations from a frontier have a natural interpretation or inefficiency, and (iii) information about the structure of the frontier and about the relative efficiency of economic units have many policy implications.

Stochastic frontiers were independently proposed by Aigner, Lovell, and Schmidt (1977) and Meeusen and Van Den Broeck (1977). The essential idea here is that the error term comprises two components: symmetric random errors (statistical noise) that are outside the firm's control and the one-sided inefficiency term. A stochastic frontier can be expressed as

$$Y_i = f(X_i P) \exp(v_i - u_i) \quad i = 1, \dots, N \quad (1)$$

² MPP is the extra output that can be produced by using one more unit of the input.

³ Factors refer to inputs used in productions, such as land, labor, and capital.

⁴ Nonparametric estimators of production frontiers.



where v_i is the random error term that is assumed to be distributed independently and identically as $N(0, \sigma_v^2)$ and independent of u_i . Aigner, Lovell, and Schmidt (1977) suggested that maximum likelihood estimates of the parameters can be obtained in terms of parameterization, $\sigma_v^2 + \sigma_u^2 = \sigma_s^2$ and $\lambda = \frac{\sigma_u}{\sigma_v}$, where σ_u and σ_v are standard deviations of u_i and v_i , respectively. Battese and Corra (1977) proposed the parameter $\lambda = \frac{\sigma_v^2}{\sigma_u^2 + \sigma_v^2}$, which lies between 0 and 1, for stochastic frontiers. Greene (1980) proved that if u_i satisfies the condition of independently and identically distributed gamma variables, then maximum likelihood estimates have all desirable statistical properties. The technical inefficiency effects defined by Battese and Coelli (1995) were used as

$$u_i = Z_i \delta + W_i \quad (i=1 \dots N) \quad (2)$$

where Z_i is a vector of explanatory variables associated with technical inefficiency; δ is a vector of unknown parameter to be estimated; and W_i is unobservable random variation that is assumed to be identically distributed, obtained by truncation of the normal distribution with mean 0 and unknown variance σ^2 such that u_i is nonnegative.

10.3 DATA AND THE EMPIRICAL MODEL

The relevant primary data for the analysis pertain to a comprehensive field survey of organic and conventional tea growers conducted by the Asian Development Bank Institute. Samples were drawn from eight villages in the mid-country wet zone of Sri Lanka covering conventional and contract smallholder tea growers. In the preliminary analysis, it was found that the input data are only available for major inputs, labor, and fertilizer as tea smallholders do not usually rely much on external inputs.⁵

The Cobb-Douglas functional form was chosen to represent production technology for several reasons. First, it has been shown to be theoretically sound and attractive due to its computational feasibility and availability of adequate degrees of freedom for statistical testing

⁵ This section looks only at technical efficiency and not at allocative efficiency in the wider sense as discussed earlier.



(Heady and Dillon 1969). It is the most widely used algebraic form in farm efficiency studies for both developing and developed countries (Bravo-Ureta and Pinheiro 1993). Second, the Cobb-Douglas function has a high degree of multicollinearity with more flexible functional forms such as translog. Kawagoe and Hayami (1985) stated that the unitary elasticity of substitution implicit in the Cobb-Douglas function was tested elsewhere (Arrow et al. 1961; Griliches and Ringstad 1971) but no evidence was found against its appropriateness. The Cobb-Douglas stochastic frontier specification used in this study is

$$\ln Y_i = \beta_0 + \beta_1 \ln (X_1) + \beta_2 \ln (X_2) + \beta_3 \ln (X_3) + v_i + u_i \quad (3)$$

where X_1 is the total labor used in number of days per year, X_2 is the total fertilizer used in kilograms, and X_3 is the total manure used in kilograms.

A dummy variable was included to separate the use of two types of fertilizers. The total effect model (Battese and Coelli 1995) was estimated by including the following variables into the model: farming experience (years), experience with organic tea cultivation (years), number of available family members for farming, gender of the household head ($D_1 = 1$ for male), status of farming ($D_2 = 1$ for part-time), and level of education ($D_3 = 1$ for primary education, $D_4 = 1$ for secondary education, and $D_5 = 1$ for tertiary education).

10.4 RESULTS AND DISCUSSION

10.4.1 Summary Statistics

The variables used in the analysis are given in Table 10.1, which highlights a number of points. The farm size in both samples is fairly small with an average land extent of less than 0.5 hectares. The average farming experience of the sampled population is 26.37 years. The mean experience in organic farming (only for contract growers) is 3.5 years with a maximum of 17 years. There were some organic farmers who use a fairly large amount of manure (3,100 kilograms), though the mean is 707 kilograms.

**Table 10.1 Summary Statistics**

Variable	Unit	Mean	Std. Dev	Maximum	Minimum
Tea output	kg	1,422.47	1,067.56	4,820	160
Total labor	days	115.28	50.42	280	15
Land area	ha	0.44	0.26	2.83	0.1
Manure	kg	707.27	569.83	3,100	6
Inorganic fertilizer	kg	201.95	141.61	600	20
Farming experience	years	26.37	11.45	55	3
Organic experience	years	3.5	4.25	17	0
No. of working members		3.67	1.34	9	0

ha = hectare, kg = kilogram.

Source: Author's calculations.

10.4.2 The Structure of the Tea Production

The maximum likelihood estimation (MLE) of the parameters of the Cobb-Douglas stochastic frontier production function given the specification of inefficiency model (Battese and Coelli 1995) was obtained using FRONTIER 4.1⁶ (Coelli 1996). See Table 10.2 for results.

The parameter γ , $\lambda = \frac{\sigma_{\downarrow}u\uparrow}{\sigma_{\downarrow}u\uparrow + \sigma_{\downarrow}v\uparrow}$ which is the ratio of the errors, is statistically different from 0 and comparatively large (0.86). Given that γ should be bounded between 0 and 1, this implies that a substantial inefficiency exists in the overall tea production in the mid-country wet zone. In addition, the significant likelihood ratio test statistic of 239.60 indicates that the inefficiencies are indeed stochastic. The MLE for the individual production systems (i.e., conventional and contract) were also obtained similarly and presented in Table 10.2. In contract organic tea production, though a high inefficiency prevailed, the variance ratio parameter is less than that of the common frontier. In contrast, in the conventional tea production system, this parameter appears to be higher than that of the common frontier.

⁶ FRONTIER is a software program used to obtain maximum likelihood estimates of the parameters of a variety of stochastic production and cost frontiers, and estimates of mean and individual technical or cost efficiencies, written by Tim Coelli, a professor at the Centre for Efficiency and Productivity Analysis (CEPA), University of Queensland, Australia.



Table 10.2 Maximum Likelihood Estimates of the Production Frontier Functions

Variables	Common Frontier	Individual Frontier	
		Organic	Conventional
Constant	2.70 (0.24)*	2.04 (0.20)*	2.21 (2.07)
Total labor (no. of days)	0.23 (0.89)	0.44 (0.09)*	0.11 (0.21)
Land (ha)	0.51 (0.10)*	0.59 (0.09)*	0.29 (0.16)**
Fertilizer (kg)	0.23 (0.03)*	0.15 (0.03)*	0.58 (0.58)
Fertilizer dummy (1 = organic)	-0.40 (0.04)*	-	-
Variance Parameters			
sigma-squared	0.10 (0.04)*	0.04 (0.01)*	0.09 (0.25)
gamma	0.86 (0.09)*	0.77 (0.14)*	0.99 (0.18)*
log likelihood	205.89	53.19	-1.42
LR test	239.60	19.12	14.12
Inefficiency Effects			
Constant	0.26 (0.28)	-0.39 (0.68)	0.62 (1.19)
Gender ($D_1 = 1$ if female)	-0.00002 (0.11)	0.07 (0.09)	-0.12 (0.50)
Farming experience (years)	-0.001 (0.004)	0.004 (0.004)	0.002 (0.02)
Organic experience (years)	-	-0.007 (0.009)	-
No. of available working family members	0.04 (0.04)	0.07 (0.04)**	-0.03 (0.19)
Involvement in tea cultivation ($D_2 = 1$ if part-time)	0.28 (0.13)*	0.14 (0.09)	0.09 (0.11)
Education level ($D_3 = 1$ if primary education)	-0.38 (0.22)**	0.04 (0.62)	-0.07 (0.45)
Education level ($D_4 = 1$ if secondary education)	-0.46 (0.23)*	-0.04 (0.62)	-0.21 (0.13)
Education level ($D_5 = 1$ if tertiary education)	-1.74 (3.68)	-0.39 (1.22)	0.00 (1.00)
Number of observations	178	96	82

- = data not available, ha = hectare, kg = kilogram, LR = likelihood ratio.

Note: Figures in parentheses are standard errors.

* significant at $p = 0.05$, **significant at $p = 0.01$.

Source: Author's calculations.



10.4.3 Estimates of Technical Efficiency

The mean technical efficiency of the overall sample was found to be 0.7834, implying that there is a 21.66% scope of increasing the smallholder tea production in the mid-country wet zone without using any additional inputs. The mean technical efficiencies of organic and conventional tea cultivation obtained with respect to the common frontier are 0.81 and 0.75, respectively. With respect to the common frontier, organic farmers outperform conventional farmers and the difference is statistically significant at the 1% level. The mean technical efficiencies with respect to individual frontiers are 0.86 and 0.65 for organic and conventional tea producers, respectively. Obviously, the difference is statistically significant at the 1% level (Table 10.3).

The distributions of technical efficiencies obtained with respect to common and individual stochastic frontiers are presented in Table 10.4. The class intervals represent different efficiency classes. The distribution of technical efficiencies with respect to the common frontier reveals that about 55% of organic farmers belong to the 80%–90% technical efficiency range. In conventional farming, there were more farmers with a lower efficiency level (<70%) than in the organic group, but there was also a larger percentage of farmers in the highly efficient range (90-100%): 23.2% for conventional and 12.5% for organic tea growers.

Table 10.4 also depicts the technical efficiency with respect to individual frontiers. In organic farming, 50% of producers lie above the 90th percentile, whereas the proportion is only 6% for conventional farmers. This high variability of technical efficiency distribution of conventional farmers (standard deviation of 0.1638) can be attributed to lack of organization and guidance in production activities.

Table 10.3 Mean Technical Efficiency with Respect to Common and Individual Frontiers

Comparison	Organic	Conventional	t-ratio	p-value
With respect to common frontier	0.81 (0.10)	0.75 (0.15)	2.96	0.003
With respect to individual frontier	0.86 (0.09)	0.65 (0.16)	-10.86	0.00

Note: Figures in parentheses are standard errors.

Source: Author's calculations.



Table 10.4 Distribution of Technical Efficiency with Respect to Common and Individual Frontiers

Percentile	With Respect to Common Frontier		With Respect to Individual Frontier	
	Organic	Conventional	Organic	Conventional
21–31	–	–	–	1.22
31–40	–	1.22	–	2.44
41–50	1.04	4.88	–	13.41
51–60	2.08	9.76	1.04	26.83
61–70	10.42	21.95	8.33	17.07
71–80	18.75	20.73	13.54	14.63
81–90	55.21	18.29	27.08	18.29
91–100	12.50	23.17	50.00	6.10

– = data not available.

Source: Author's calculations.

In comparing technical efficiencies, the proportion of farmers who perform above average is also of interest. In organic tea production, about 70% of producers had above average technical efficiency, while for conventional producers this was 43% with respect to the common stochastic frontier. The performance of organic farmers according to their organic experience was also examined. Organic tea growers were categorized as initial (0–2 years), transitional (2–4 years), and permanent (over 4 years), following Setboonsarng, Leung, and Cai (2006).

Comparison of the technical efficiency of experience categories of organic farming with conventional farming revealed that initial organic farmers are not efficient compared to conventional farming. However, the difference escalates with organic farming experience and the technical efficiency significantly improves (Table 10.5).

10.4.4 Factors Explaining Inefficiency

The socioeconomic and farm-specific factors that determine the efficiency were also estimated and shown in the lower panel of Table 10.2. The prior expectation regarding the signs of these variables is worthwhile to mention here. Farming experience by a number of family members available for farm work, full-time involvement,

**Table 10.5 Comparison of Technical Efficiency by Experience**

Experience Category	Technical efficiency		t-ratio with Conventional Agriculture
	Mean	Standard Deviation	
Initial (0–2 years)	0.7135	0.1287	-0.8846
Transitional (2–4 years)	0.8241	0.0838	2.2252*
Permanent (over 4 years)	0.8221	0.0905	3.1752**
Conventional	0.7535	0.1485	

Note: *significant at $p = 0.05$, ** significant at $p = 0.01$.

Source: Author's calculations.

education, and experience in organic farming (only for contract farming) are expected to be positively related to technical efficiency. This study revealed that full-time farmers are more technically efficient compared to part-time tea growers in this region. Full-time farmers can spend more time on various production operations and use resources more efficiently than conventional growers as the former derive their incomes mainly from farming. On education levels, whether tea growers have completed primary education was significant at the 10% level, and secondary education influences efficiency, as does experience in organic production.

10.5 CONCLUSION

As a leading tea producer in the world, Sri Lanka possesses an enormous potential to expand its organic tea production. Several private firms and nongovernment organizations have promoted organic tea cultivation in the mid-country wet zone of Sri Lanka. In this context, this chapter analyzed the comparative efficiency of organic tea cultivation with special reference to its development implications.

The analysis revealed that substantial inefficiencies prevailed in smallholder tea production areas under study. The mean technical efficiency of the contract organic and conventional tea cultivation was 81% and 75%, respectively. The difference was statistically significant, implying that organic tea growers use resources more efficiently. Organic farmers were found to be more homogeneous and 70% of organic farmers lie above the overall mean compared to 43% of conventional



farmers. Moreover, the analysis identified that primary and secondary education, full-time farming, and experience in organic farming (only for contract growers) positively influenced efficiency.

Improved efficiency in organic cultivation was mainly attributed to the institutional intervention of contract farming. Contract farmers use fewer resources, thus cutting down their cultivation costs; they also utilize family and environmental resources efficiently. The driving force behind this is institutional support that provides market access and price premiums, and reduces transaction costs.

REFERENCES

- Aigner, D.J., C.A.K. Lovell, and P. Schmidt. 1977. Formulation and Estimation of Stochastic Frontier Production Function Models. *Journal of Econometrics*. 6. pp.21–27.
- Arrow, K.J., H.B. Chenery, B.S. Minha, and R.M. Solow. 1961. Capital–Labor Substitution and Economic Efficiency. *Review of Economics and Statistics*. 43. pp. 225–250.
- Battese, G.E., and G.S. Corra. 1977. Estimation of a Frontier Model: With Application to the Pastoral Zone of Eastern Australia. *Australian Journal of Agricultural Economics*. 21. pp. 167–179.
- Bauer, P. 1990. Recent Development in the Econometric Estimation of Frontiers. *Journal of Econometrics*. 46. pp. 39–56.
- Bravo-Ureta, B.E., and A.E. Pinheiro. 1993. Efficiency Analysis of Developing Country Agriculture: A Review of the Frontier Function Literature. *Agricultural and Resource Economics Review*. 22. pp. 88–101.
- Coelli, T.J. 1995. Recent Development in Frontier Modeling and Efficiency Measurements. *Australian Journal of Agricultural Economics*. 39. pp. 219–245.
- Farrell, M.J. 1957. The Measurement of Productivity Efficiency. *Journal of Royal Statistical Society*. 120 (3). pp. 253–281.



- Greene, W.H. 1980. Maximum Likelihood Estimation of Econometric Frontier Functions. *Journal of Econometrics*. 13. pp. 27–56.
- Griliches, Z., and V. Ringstad. 1971. *Economics of Scale and the Form of the Production Function*. Amsterdam: North Holland.
- Heady, E.O., and J.I. Dillon. 1969. *Agricultural Production Functions*. Ames, IA: Iowa State University Press.
- Kawagoe, T., and Y. Hayami. 1985. An Inter-country Comparison of Agricultural Production Efficiency. *American Journal of Agricultural Economics*. 67. pp. 87–92.
- Marshall, G.R., I.W. Patrick, A. Muktasam, and I.G.A.A. Ambarawa. 2006. Alleviating Poverty by Linking Smallholders with Agribusiness: Roles of Social Capital and Common Property. Paper presented at the 11th Biennial Conference of the International Association for the Study of Common Property, Ubud, Bali, Indonesia.
- Meeusen, W., and J. Van Den Broeck. 1997. Efficiency Estimation from Cobb-Douglas Production Function with Composite Error. *International Economic Review*. 18 (2). pp. 435–444.
- MPI (Ministry of Plantation Industries, Government of Sri Lanka.). 2012. Progress Report: 2012 Performance. <http://www.plantationindustries.gov.lk/dwnlds/plantation/english%20budget%2021%2011%202012%20Final.pdf>
- Setboonsarng, S., P.S. Leung, and J. Cai. 2006. Contract Farming and Poverty Reduction: The Case of Organic Rice Contract Farming in Thailand. In J. Weis and H. A. Khan, eds. *Poverty Strategies in Asia: A Growth Plus Approach*. Cheltenham, UK: Edward Elgar.

**PART III: Organic Agriculture,
the Environment,
and Current Debates**



Chapter 11 | Carbon Sequestration in Organic Agriculture and Climate Change: A Path to a Brighter Future

Paul Reed Hepperly and Sununtar Setboonsarng

11.1 INTRODUCTION

According to the 2007 Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report, the global surface temperature has risen by about $0.74^{\circ}\text{C} \pm 0.18^{\circ}\text{C}$ between 1906 and 2005. This warming trend has been more rapid over the past 50 years, intensified by increasing greenhouse gas (GHG) emissions, mainly carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). Based on the Law of Q10 (temperature coefficient), a 10°C increase in temperature can increase metabolic activities or chemical reactions by 2–3 times. The delicate balance of life-supporting elements in our ecosystem is greatly sensitive to temperature, such that even a 1°C increase has tremendous implications.

Forest fires have become bigger and more frequent in the last 15 years. This is expected to worsen as some climate models even predict the average global temperature to increase between 1.8°C and 4.0°C at the end of the 21st century (Niggli, Earley, and Ogorzalek 2007). In agricultural food systems, for instance, tropical tomato production is greatly inhibited when summer temperatures exceed the tolerance of pollen and male sterility results. Oats and corn are also well known for their pollen sensitivity to hot temperatures, hampering their production in a warming world.

Large-scale industrialization in the last 150 years has increased GHG emissions by about 25%. In the past 20 years, roughly three-quarters of



anthropogenic¹ emissions came from the burning of fossil fuels, others from change in land use, and agricultural intensification in the case of CH₄ and N₂O (Fliebsbach 2007).

A warming climate is also projected to affect water quality and exacerbate many forms of water pollution from sediments, nutrients, dissolved organic carbon, pathogens, pesticides, salts, and thermal pollution. Sea-level rise is expected to salinate groundwater and estuaries, decreasing freshwater for humans and ecosystems in coastal areas (IPCC 2007).

Given the potentially fatal consequences of unabated global warming, several proposals have been put forward to mitigate the leading cause of the greenhouse effect. One major untapped resource is the soil's carbon sequestration capacity, which is a function of agricultural practices. For farmers to adopt agricultural practices that offer GHG mitigation benefits, such agricultural practices that have a positive sequestration impact should be able to offer financial, as well as social and environmental benefits. One such practice is organic agriculture, which has been recognized as a market-based development strategy for poverty reduction and contributions to the Millennium Development Goals (MDGs; see Setboonsarng [2006] and chapter 1 of this volume). In this chapter, we discuss one relatively unexplored aspect of organic agriculture: its contribution to climate change.

11.2 SOIL CARBON SINK AND CLIMATE CHANGE

Just like greenhouses that let light in but keep the sun's heat from escaping in order for plants to grow, mainly in the winter, our planet has been trapping heat due to an overabundance of atmospheric gases aptly called greenhouse gases, preventing heat from being radiated back into space.

GHGs include water vapor, CO₂, CH₄, and N₂O. The latter two gases are relatively less-known compared to CO₂ but are considerably more powerful in their heat trapping capacity. According to the IPCC,

¹ Anthropogenic is defined as human-caused.



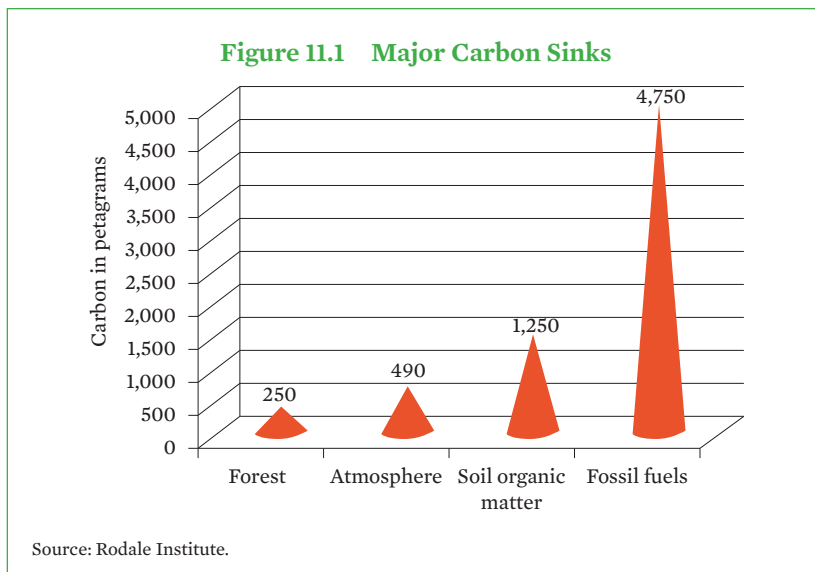
the global warming potential (GWP)² of CH₄ and N₂O are 21 and 289, respectively—meaning they trap 21 times and 289 times more heat than CO₂. Although GHGs are naturally present in the atmosphere, human activities have changed their concentrations over time. From the preindustrial ages in 1750 to 2004, CO₂ concentrations have increased by 35%, CH₄ by 143%, and N₂O by 18% (IPCC 2007).

Agriculture also plays an important role as a carbon “sink” through its capacity to sequester and store GHGs, especially as carbon in soils and in plants and trees. Carbon sequestration³ involves increasing carbon storage in terrestrial systems, either above or below ground. Changes in the utilization of land and soil can trigger a process of soil carbon accumulation over time. Eventually, the system will reach a new carbon stock equilibrium or saturation point, and no new carbon will be absorbed. Carbon sequestration presents both advantages and disadvantages as a means of mitigating climate change. The main advantage is that it is relatively low-cost and can be readily implemented. Moreover, it provides multiple associated benefits as the resultant increase in root biomass and SOM enhance water and nutrient retention, availability, and plant uptake, and hence land productivity. A major disadvantage is that, unlike other forms of climate change mitigation, carbon sequestration is reversible; indeed, changes in agricultural management practices can accelerate or reverse the degree of sequestration in a relatively short time frame (FAO 2007).

As shown in Figure 11.1, fossil fuels remain the world’s major carbon reserve, dwarfing that of soil. However, soil’s carbon trapping potential remains largely untapped as changes in land use release the soil’s carbon content into the atmosphere. Arable areas have been depleted by over 50% of their carbon content, which points to the huge reservoir that needs refilling.

² GWP is defined as the ratio of the time-integrated radiative forcing from the instantaneous release of 1 kilogram of a trace substance relative to that of 1 kilogram of a reference substance, which is CO₂ (IPCC 2001).

³ Sequestration is the process of increasing the carbon content of a carbon pool other than the atmosphere (IPCC 2001).



11.2.1 Carbon Sequestration and Soil Organic Matter

Removing CO₂ from the atmosphere by trapping carbon in major sinks is one way of mitigating the warming of the planet. Forests, which include vegetation, soils, and harvested wood, accounted for about 84% of total carbon sequestration. Soil's capacity to capture or sequester carbon is dependent on many factors. It has been shown in several SOM studies that the combination of clay minerals with humic materials (humus) or organic matter works to stabilize them. The rate of soil organic carbon sequestration depends on soil texture and structure, rainfall, temperature, farming system, and soil management, among others. Examples of carbon-trapping soil management techniques include reduction in summer fallow areas, adoption of conservation tillage or no-till farming, addition of organic fertilizer to restore soil, woodland regeneration, cover crops, nutrient and water management, agroforestry practices, and growing of energy crops on spare lands (Lal 2004).

Rattan Lal, a noted soil carbon expert revealed that the world's agricultural lands, including degraded and restored lands, can store between 0.4 and 1.2 petagrams of carbon (pg C) per year, constituting less than 0.1% of the existing soil carbon reserves. Data based on long-term experiments at the Rodale Institute in the United States show much higher rates of carbon sequestration than projected by Lal.

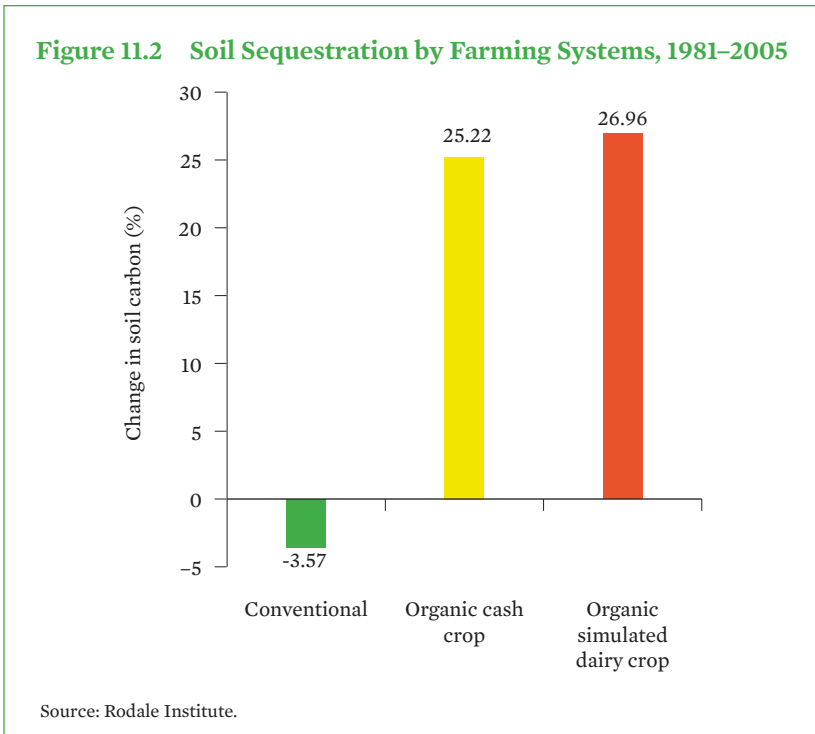
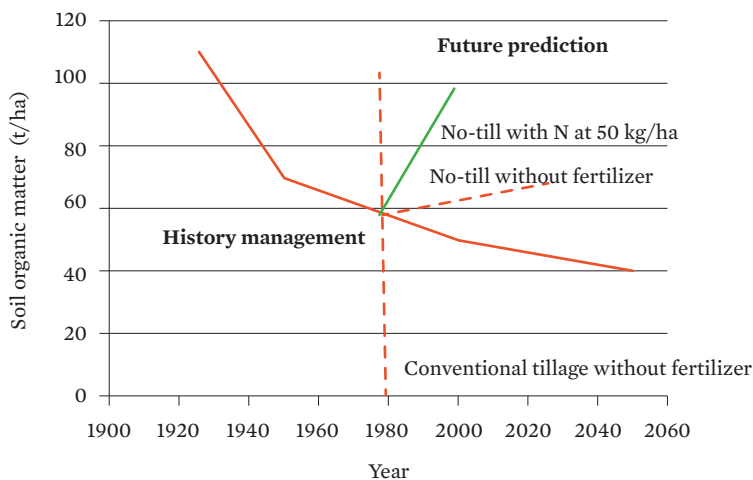


Figure 11.2 shows the percentage change in soil carbon in farm trials of three farming systems from 1981 to 2005, revealing that conventional agriculture decreased the soil carbon content by about 4% while organic farming, with and without animal manure, increased soil carbon by about 25% over a span of 25 years (Hepperly et al. 2008).

As shown in Figure 11.3, SOM decreases over time under conventional tillage without fertilizer, but no tillage can reverse the downward trend. From a number of studies in the North American grain belt, SOM decay has been estimated at about 1% per year on average. After 20–40 years, the SOM destruction rate starts to decrease, bottoming out at about 25%–50% of the original value. Carbon release is also augmented by land cultivation (e.g., plowing and harrowing), destroying a large portion of SOM content. Just as tilled agriculture can reduce SOM by about 1% per year, a similar accrual rate is possible with cover crops under organic management as demonstrated by the long-term results of the Rodale Institute Farming Systems (RIFS) Trial.



Figure 11.3 Generalized Soil Organic Matter Bath Tub Model



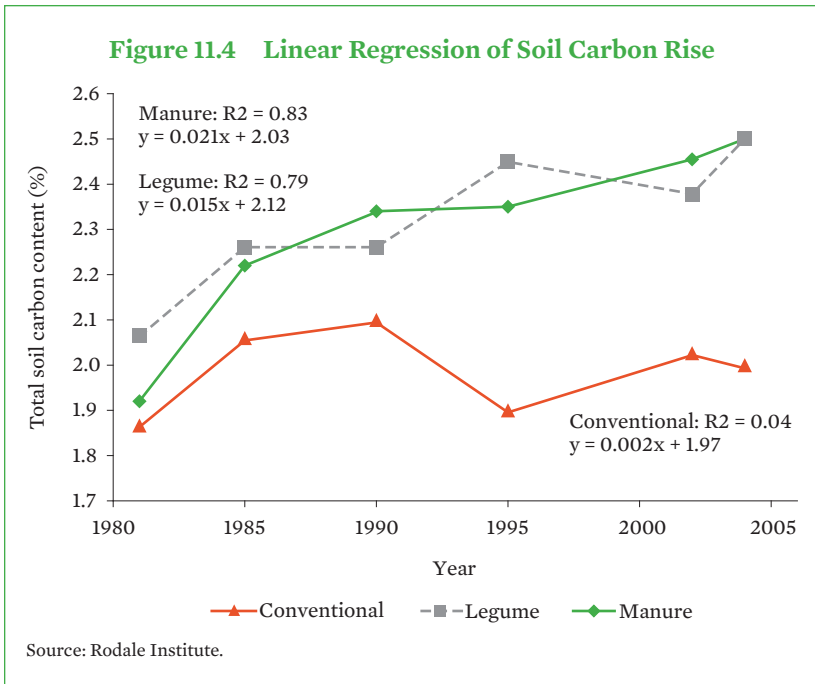
ha = hectare, kg = kilogram, N=nitrogen, t = ton.

Source: Rodale Institute.

A review of the 100 years of data from the University of Illinois Morrow Plots⁴ revealed no evidence of the widely accepted paradigm that increased biomass under nitrogen fertilizer application would automatically lead to greater SOM (Khan et al. 2007). On the contrary, the Morrow Plots showed that increased fertilizer applications did not quell continuing SOM loss. It appears from this study that the purported fertilizer solution to SOM decline is actually the cause of the problem.

The various experiments at the Rodale Institute show that the storing capacity of soil and carbon stabilization in soil has until now been greatly underestimated, affecting our awareness in supporting it as a remediating global warming strategy. In the 9-year Rodale Compost Utilization (RCU) Trial, raw manure, synthetic fertilizer, and compost were compared as soil amendments. While raw manure provided soluble nutrients well, it did not increase SOM very effectively. Synthetic fertilizer caused a slight decline in SOM reserves, while compost markedly increased the long-term SOM reserve, resulting in a

⁴ The Morrrows Plots are the world's oldest experimental site under continuous corn (Khan et al. 2007).



30% increase in SOM after 9 years. Low-input cover crop, by contrast, requires 25 years to obtain a similar increase.

This trial suggests the effectiveness of compost amendment in soil carbon sequestration in the form of stabilized organic matter. Figure 11.4 shows the results of the tests of soil carbon and nitrogen accumulation between 1981 and 2002. Statistically significant differences were found between the organic and conventional systems but not between the two organic systems, i.e., manure and legume. The soil carbon content in conventional soil by contrast exhibited similar carbon levels over a span of a quarter of a century.

The addition of organic matter in the form of compost, the use of cover crops, use of manure and the reduction and elimination of tillage are the principal practices that increase SOM on tillable land. It should be noted that the levels of carbon, SOM, and CO_2 are all dynamic and therefore changing. They are vulnerable to impact from energy efficiency, alternative energy, and carbon sequestration strategies and are indeed manageable under proper motivation and incentives.



11.3 ORGANIC AGRICULTURE AND GREENHOUSE GASES

According to the 2007 Fourth IPCC Report, the agriculture sector emits between 5.1 and 6.1 gigatons⁵ of CO₂ equivalent in 2005, roughly about 10%–12% of total GHG emissions. These figures, however, do not include the CO₂ equivalent that units emit in the process of chemical fertilizer production, which is counted under the industry sector. Taking this into account, land-use change (i.e., deforestation) accounts for 20% of annual anthropogenic CO₂ emissions.

Numerous studies have shown that CO₂ emissions from organic farming are, in general, 15%–30% lower per hectare than conventional systems (Soil Association 2005). Table 11.1 summarizes the organic practices that directly reduce GHG in the atmosphere. By avoiding the use of synthetic nitrogen fertilizers and better management of soil nitrogen, organic practices substantially reduce N₂O. Significant to this is that the reduction of one unit of N₂O is equivalent to the reduction of 289 units of CO₂.

Table 11.1 Organic Farming and Greenhouse Gas Emissions

	CO ₂	CH ₄	N ₂ O
No synthetic nitrogen fertilizers	✓		✓
Best manure recycling	✓		✓
Enhanced use of legumes	✓		✓
Enhanced use of composts	✓		✓
Better crop rotations	✓		
High proportion of hedge rows, field margins, etc.	✓		✓
Careful and reduced soil tillage	✓		✓
Reduced mineral nitrogen concentrations	✓		✓
Less soil compaction	✓	✓	✓
Less erosion	✓		
Enhanced soil carbon stock	✓	✓	

CH₄ = methane, CO₂ = carbon dioxide, N₂O = nitrous oxide.

Source: Aubert (2007).

⁵ 1 gigaton = 1 billion tons. One ton is equal to 1,000 kilograms.

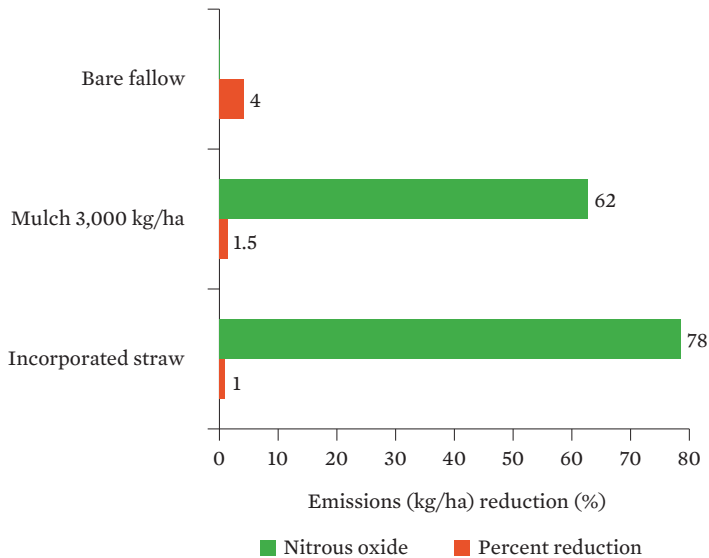


11.3.1 Nitrous Oxide (N₂O)

Nitrous oxide is produced by biological processes that occur in soil and water by human activities. N₂O emissions are lower than those of CO₂, but global N₂O emissions have increased by 18% since 1750. In the United States, the major N₂O anthropogenic source is agricultural soil management, accounting for 78% of N₂O emissions in 2005 and releasing 365.1 teragrams (Tg) of CO₂ equivalent (IPCC 2007). Other emission sources include fuel combustion in transportation and production, manure management, nitric acid production, and wastewater treatment.

N₂O emissions are directly linked to the concentrations of mobile nitrogen in soils. The more nitrogen is fixed biologically, the less N₂O is released into the atmosphere. Organic soils have a significantly lower mobile nitrogen concentration and are more aerated. Both of these factors reduce N₂O emission considerably (Niggli, Earley, and Ogorzalek 2007). As shown in Figure 11.5, N₂O emissions are reduced by over 75% with organic practices, such as mulching and straw incorporation. Fallow land, on the other hand, offered no reduction in N₂O emissions.

Figure 11.5 Carbon Amendment and Nitrous Oxide Losses

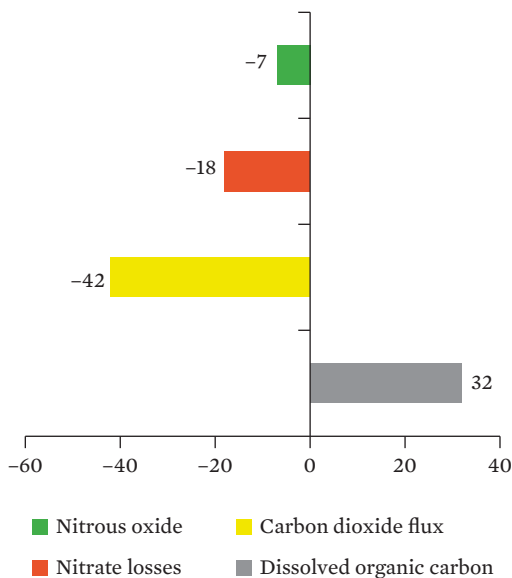


ha = hectare, kg = kilogram.

Source: Rodale Institute.



Figure 11.6 Soil Organic Matter and Mycorrhizae in Soil



Source: Rodale Institute.

According to the IPCC, with every application of nitrogen fertilizer, an average of 1.25% of N_2O is emitted by soil. In a Swiss DOK⁶ trial, total nitrogen applied with manure in organic farms was found to be 36% lower than in conventional ones with mixed mineral and manure fertilizer. Mineral nitrogen application was also lowered by 67%.

Moreover, nitrogen is prevented from running off in organic systems as SOM is conducive for the growth of mycorrhizae,⁷ which improves the ability of plants to absorb nutrients from the soil, thus increasing plants' resilience in adverse growth environments. As shown in Figure 11.6, mycorrhizae enhance dissolved organic carbon in the soil and reduce its release into the atmosphere. Mycorrhizae also reduce nitrate and N_2O loss

⁶ The DOK trial compares the consequences of biodynamic (D), organic (O), and conventional (K) farming systems. The DOK field trial was started in 1978 at Therwil, Switzerland.

⁷ Mycorrhizae is a kind of fungus that attacks the root and forms a symbiotic relationship with it.



mitigating GHG emissions. Nitrogen, which is the major source of plant nutrient, is water-soluble. Without SOM, nitrogen runoff is substantial, which can contaminate water sources. This causes eutrophication⁸ of water bodies stimulating excess plant growth reducing dissolved oxygen levels and eventually causing other organisms to die.

11.3.2 Methane (CH₄)

In the last 250 years, concentrations of CH₄ in the atmosphere increased by 143%. CH₄ accounts for about 14% of the GHGs, two-thirds of which is anthropogenic. In agriculture, methane emissions stem to a large extent from enteric fermentation⁹ and manure management. It is thus directly proportional to livestock numbers, although methane production is believed to be similar in both conventional and organic agriculture, depending on the types of feed. While organic farming systems may have lower CH₄ emissions due to longer production lives of cattle, the higher proportion of animals in organic agriculture (due to greater use of mixed farming systems) and lower productivity of ruminants in organic agriculture may lead to higher CH₄ emissions. However, CH₄ emissions from manure fermentation are lower in organic than in conventional breeding, since composting is an aerobic fermentation. The conventional way of keeping manure by contrast is mainly anaerobic (Aubert 2007). In general, organic farms are believed to emit less GHG per hectare due to nonsynthetic fertilizer inputs and livestock that are on average 25% less dense than conventional systems.

Anthropogenic sources of CH₄ include landfills, natural gas and petroleum systems, agricultural activities, coal mining, and wastewater treatment. Landfills are the major contributor of CH₄ in the United States, at 132 Tg CO₂ equivalent. The International Rice Research Institute studies showed that there has been a rise in CH₄ emissions due to the removal or reduction of the crop sink mechanism (Wassmann and Dobermann 2006).

⁸ Eutrophication is a process where water bodies receive excess nutrients that stimulate excessive plant growth.

⁹ Enteric fermentation is the fermentation that takes place in the digestive systems of ruminant animals.



11.4 ORGANIC AGRICULTURE AND WATER

Carbon sequestration not only mitigates atmospheric GHG but also affects water flows. With climate change, annual average river runoffs are projected to increase, so are flooding and drought. Water supplies stored in glaciers and snow cover are projected to decline, reducing its availability during dry periods in regions supplied by meltwater from major mountain ranges, where more than one-sixth of the world's population resides. These environment-friendly practices can help reverse the grim predictions for the middle of the 21st century. Soil carbon also affects water resources and has the ability to improve water movement and retain SOM, not only mitigating GHG concentrations but also improving the movement of water into soil, its transfer to aquifers, and its retention for use in crop production.

The trials at the Rodale Institute revealed that the amount of water percolating through the top 36 centimeters was 15–205 times greater in organic systems compared to conventional systems. In these organically improved soils, water percolation¹⁰ is found to be 25%–50% higher based on extensive measurement of leachates¹¹ from lysimeters.¹²

This increase in water percolation capacity can improve river flows and is important in filling underground water supplies. In addition, water percolation has the same erosive nature, taking the finest, more fertile components of mineral soil as sediment pollution. SOM helps cement soil particles into aggregates that not only conserve organic matter but also give a more permeable structure. The bulk density of soil is reduced to give space for water to be stored. The humic¹³ material is also very absorptive in nature. Between better percolation and water retention in SOM, charged soils needs for irrigation and energy requirements are greatly reduced.

As shown in Figure 11.7, water percolation is only 10% in conventional soil, while it is four times more in mulched organic soil with compost. Conventional soil has the highest water runoff at about 72% and has the lowest percolation and water content. By contrast, for organic soil where environment-friendly practices have been employed, i.e., mulching or compost, runoff is zero (Figure 11.8).

¹⁰ Percolation refers to the movement and filtering of fluids through porous materials.

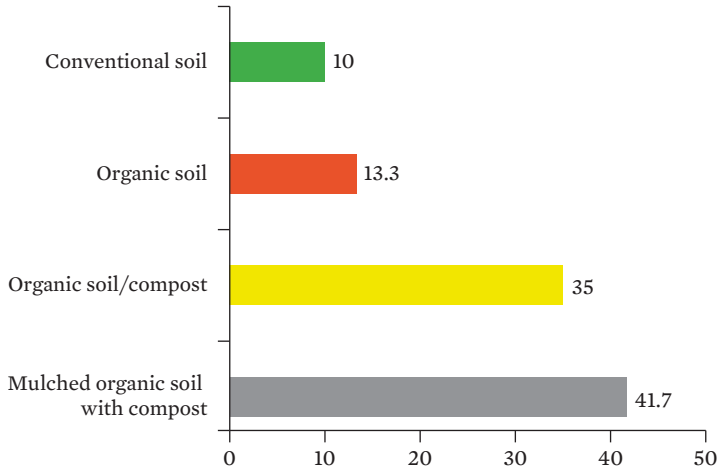
¹¹ Liquids percolated through waste piles. Leachate can include various minerals, organic matter, or other contaminants, and can contaminate surface or groundwater.

¹² An instrument for measuring the water that percolates through a certain depth of soil.

¹³ Humic material or humus enhances nutrient uptake at the root zone.

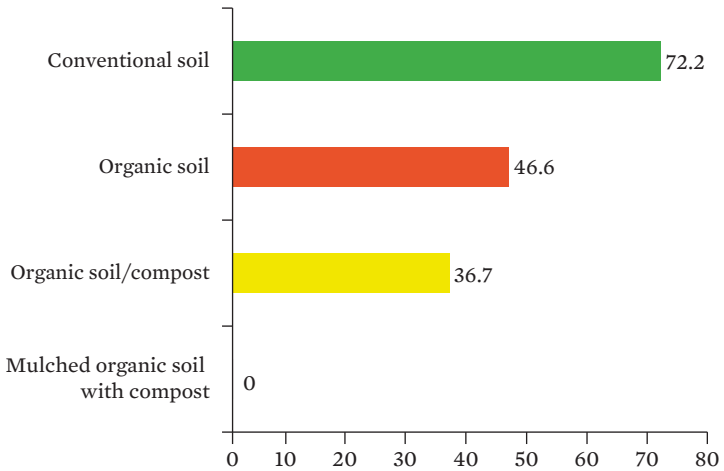


Figure 11.7 Water Percolation in Various Soil Types (%)



Source: Rodale Institute.

Figure 11.8 Water Runoff in Various Soil Types (%)



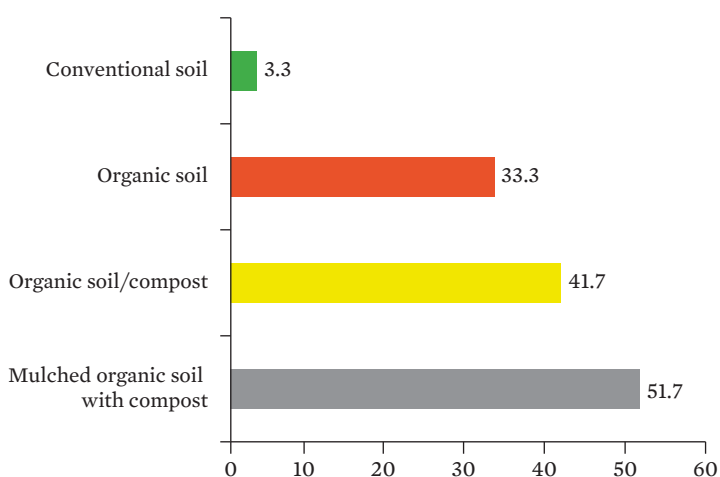
Source: Rodale Institute.



The increased organic matter in soil not only yields healthier harvests but also maintains productivity levels even in adverse climate conditions, i.e. droughts, irregular rainfalls, rising temperatures, or floods. In temperate areas, higher yields for maize and soy were recorded in organic farms in the dry season (Pimentel et al. 2005). Organic soils held 816,000 liters of water per hectare in the upper 15 centimeters of soil, which has increased corn and soybean yields even in dry years (Pimentel et al. 2005). As SOM has a sponge-like structure, soils under organic agriculture retain significantly more rainwater. Shown in Figure 11.9, conventional soil retains only 3.3% of water, while mulched organic soil with compost has the highest water retention rate of over 50%. Figure 11.10 shows the overall higher capacity of organic soil over conventional soil to hold water or moisture which helps plants adapt to a warming climate.

This sponge-like absorptive capacity was described for heavy loamy soils in temperate areas in Switzerland. Soil structure stability is also 20%–40% higher in organically managed soils than in conventional soils. The result indicates that organic farming practices of investing in soil fertility by means of green manure, leguminous intercropping, composting, and recycling of livestock manure could contribute considerably to global food productivity.

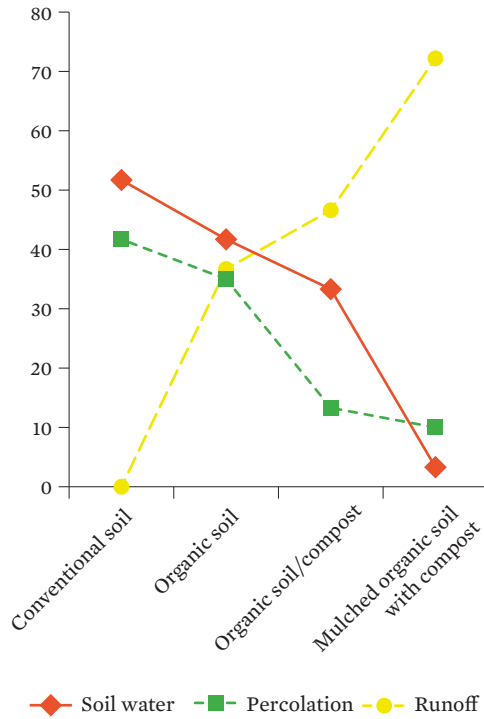
Figure 11.9 Water Retention in Various Soil Types (%)



Source: Rodale Institute.



Figure 11.10 Soil Organic Matter and Overall Effects on Soil (%)



Source: Rodale Institute.

11.5 OTHER BENEFITS OF ORGANIC AGRICULTURE

11.5.1 Energy Use in Farming Systems

Nitrogen fertilizer production accounts for almost half of all energy used in agriculture in developed countries. Since organic agriculture prohibits the use of chemical pesticides and fertilizers, GHG emissions in organic systems are already significantly lower than in conventional ones. This is supported by studies in Europe which show that organic agriculture uses about half the energy requirements of conventional agriculture (Aubert 2007). In the United Kingdom, the Department for Environment, Food, and Rural Affairs (DEFRA 2000) concluded that energy usage is lower in organic systems. Some vegetables only consume a fourth of energy consumed in conventional farms while



beef production consumes roughly 50% less. In France, organic grain production consumes only 6% of energy of conventional farms, as fertilization in grain production requires so much energy. The use of machineries in conventional farming could lead to higher use in fossil fuel resulting in GHG emissions.

Organic farms need less energy than conventional farming systems since the former are less mechanical and do not use artificial fertilizers. For example, energy use in a Swiss organic system was found to be 46%–49% lower than in a mineral fertilizer-based system; and 31%–35% lower than in conventional manure-based system (Nemecek et al. 2005). Greenhouse warming potential in organic systems was 29%–32% lower than in a mineral fertilizer-based system and 35%–37% lower than in a conventional manure-based system (Fliessbach 2007). Energy consumption per unit of land has been shown to be 10%–70% lower in all organic crops in five European counties (Niggli, Earley, and Ogorzalek 2007). As shown in Table 11.2, organic no-tilled systems produce the largest reduction in energy utilization compared to conventional tilled systems.

Research at Cornell University pegged the reduction in fossil fuel requirement at about 33% less than conventional corn and soybean production systems. When conventional no-tillage using chemical fertilizers and pesticides is compared to organic production, not only is carbon sequestration higher but energy requirements are also lower (Pimentel 2006). As shown in Table 11.2, conventional systems utilize more overall energy than organic systems due to heavy reliance on energy-intensive fertilizers and chemicals using nonrenewable fossil fuels. Organic agriculture uses on-farm fertilizers such as compost, manure, and green manure and nature-derived pesticides, thus less CO₂ is released (See Appendix for more information on results of experiments at the Rodale Institute).

Table 11.2 Agricultural Systems and Energy Requirement

Practice	Energy Requirement (MCal/ha)	Reduction (%)
Conventional tillage	19,488	0
Conventional no-tillage	15,368	21.1
Organic tillage	10,005	48.7
Organic no-tillage	6,373	67.3

ha = hectare, MCal = megacalorie.

Source: Rodale Institute.



11.5.2 Evidence on Economic and Environmental Benefits from the Field

Aside from benefits to the environment and for climate mitigation, empirical studies commissioned by the Asian Development Bank Institute in six Asian countries as documented in this volume reveal some evidence of the economic and social aspects of organic practices on organic farmers. In the case of Thailand, for example, in terms of both certified¹⁴ organic farmers and noncertified organic farmers growing various crops, due to the price premium and lower production costs of organic agriculture, organic production is more profitable than conventional farming in all 10 case studies investigated. In addition, more farmers employing organic agriculture in Thailand reported better soil quality than those employing conventional agriculture with highly significant values (See Table 1.20, chapter 1 of this volume). Soil quality, in turn, affects a crop's nutrient content, resilience to stressful conditions, and biodiversity in the soil. Organic farmers reported that with improved soil quality, organic crops were noticeably sturdier, thus able to withstand minor floods and droughts. Moreover, improvements in soil health also lead to considerably lower disease incidence.

In Sri Lanka and the People's Republic of China (PRC), the case studies reveal that organic farmers employ more environment-friendly farming practices than conventional farmers. These practices include mulching, terracing, contour-cropping, crop residue return, green manure, manure and/or compost, and straw residue return after feeding. Organic farmers use more soil conservation and soil carbon sequestration methods than conventional farmers. By doing so, organic farmers are not only mitigating GHG emissions by avoiding chemical fertilizers that emit CO₂ and N₂O, but also contributing to soil carbon sequestration. Conventional farming, by contrast, is responsible for GHG emissions and other negative environmental and health consequences.

In all 10 empirical studies, the environment as well as the organic farmers fared better, and are all under market-driven contract farming arrangements largely for the export market. While the majority of the

¹⁴ "Certified organic" means the item has been grown according to strict uniform standards that are verified by independent state or private organizations. Certification includes inspections of farm fields and processing facilities, detailed record keeping, and periodic testing of soil and water to ensure that growers and handlers are meeting the standards that have been set (OTA 2012).



farmers are interested in expanding organic areas, due to the high cost of the certification system and difficulties in marketing noncertified organic produce at a premium price, the areas under organic agriculture remain limited. An added incentive in the form of compensation for soil carbon sequestration would lead to wider adoption of environment-friendly agriculture such as organic agriculture.

11.5.3 Environmental Payments to Organic Farmers

In developed countries such as the United States and Canada with assistance from local agencies, farmers adopting no-till practices that mitigate GHGs are selling carbon credits in the carbon market, i.e., the Chicago Carbon Exchange (CCX).¹⁵ Such mechanisms allow correction of market failure and provide an incentive for farmers to participate in the production of global public goods, i.e., GHG reduction and carbon sequestration into soil. However, a carbon credit mechanism to reward farmers who adopt climate-friendly practices in developing countries has yet to be established, as organic farming has still not been recognized under the Clean Development Mechanism (CDM).¹⁶

With more research conducted on how carbon can be stabilized in the soil and initiatives carried out to identify cost-effective mechanisms to establish a carbon baseline, monitor farming practices, and, most importantly, measure the amount of sequestered carbon, it is likely that a well-functioning carbon market can emerge for organic farmers in developing countries as well. However, establishing a cost-effective system of monitoring, reporting, and verification (MRV) is the main obstacle to including commitments on mitigation in the agriculture sector in future carbon markets (Kasterine 2010 cited in Willer and Kilcher 2010).

The potential use of land sequestration is very significant. If we can demonstrate with sufficient empirical evidence, for instance, how much farmer A with x land size can sequester in 1 year and multiply that with the

¹⁵ For details, please see relevant websites (<https://www.theice.com/ccx.jhtml> and https://www.theice.com/publicdocs/ccx/CCX_Fact_Sheet.pdf)

¹⁶ CDM is an arrangement under the Kyoto Protocol allowing industrialized countries with a GHG reduction commitment to invest in projects that reduce emissions in developing countries as an alternative to more expensive emission reductions in their own countries.



potential number of farmers, the message can be more powerful. This can be achieved using several approaches: (i) certification based on processes employed on the land, (ii) actual soil measurements over time lapses to calculate the rates, (iii) remote sensing methods, or (iv) a combination of these methods or new methodologies. In this regard, monitoring and recording standards for sequestered carbon for organic farmers should be developed to provide farmers the incentives to adopt environment-friendly practices. As certified organic farmers have undergone training to comply with strict certification standards—and have records of all their farm inputs and practices—the recognition of mechanisms under the CDM will give organic farmers more chances of being qualified than conventional farmers. Thus, an additional overlay of documentation to record sequestered carbon would be acceptable to organic farmers, provided the marginal benefits will exceed marginal costs.

11.6 GAPS IN KNOWLEDGE AND APPLICATION

It has been said that we can only improve that which we can accurately measure. According to Lal (2004), the science of soil is sufficiently advanced to allow implementation of a market in carbon credits that can be effectively monitored and managed. However, measuring soil organic accrual is plagued by wide variability of the soil environment, which complicates the statistical prediction of trends and the precise measurement of soil sequestration. Although the technical know-how is sufficient to measure levels of carbon sequestration, the costs and accuracy of measuring sequestration credits have delayed the development of carbon credit schemes for agriculture.

Due to this complication, most sequestration values used for carbon markets are very conservative estimates from long-term trials. These can be criticized as too imprecise and conservative to drive a successful effort to have soil play its maximum role. With the immediate need to make advancements on the key challenge of climate change, research on practical methods of soil carbon monitoring should be prioritized.

In agriculture, there is a need to index the GHG contributions of different land management practices, i.e., organic practices, to mitigate emissions and improve performance measurement to base carbon credits. As legumes in crop rotation immensely improve the soil's nitrogen content, further research on optimal utilization and rotation techniques is recommended.



Beyond scientific research, since organic agriculture is currently practiced by the majority of poor farmers in remote areas of developing countries, research on institutional arrangements to connect them to the urban and export markets where premium prices prevail, should be prioritized. Where carbon credits cannot be given to the farming systems due to the issues highlighted, there are successful experiences of providing carbon credit for farmers for compost making and for biogas digesters. These experiences should be reviewed for wider adoption.

11.7 CONCLUSIONS AND RECOMMENDATIONS

This chapter has shown that the GHG-storing capacity of soil has until now been greatly underestimated, affecting our awareness in supporting it as a remediating global warming strategy. Compared to forests, the potential capacity of soil to store atmospheric carbon is almost double. With a simple technique of adding organic matter to soil, farmers around the world can participate in mitigating and reversing climate change, improving water quality, and improving long-term farm productivity.

The various experiments at the Rodale Institute show that the storing capacity of soil and carbon stabilization in soil has until now been greatly underestimated. Soil carbon improves water movement, mitigates GHG, and also increases soil structure stability. Investing in soil fertility through environment-friendly practices could contribute significantly to global food productivity. The awareness of agriculture's role in global warming remediation and support for it is, therefore, essential.

11.7.1 Information Dissemination

Governments and the private sector can help in the information dissemination drive in various ways. Multimedia production of model farmers for others to draw inspiration from and to emulate can be one avenue. As organic techniques can be adopted on conventional farms, support must be given by governments and nongovernment organizations to encourage such practices, especially in terms of reducing GHGs. Awareness by consumers and farmers on how their actions and decisions affect the environment and, in particular, GHG emissions should be promoted.



As most organic farms in developing countries are often under contract, there is a need to support this institution for the continued practice of standardized organic farming that is both financially and environmentally rewarding. Governments must provide firms with the necessary social and physical infrastructure to facilitate their businesses.

Governments often treat environmental concerns with less urgency, if not expediently, only dealing with them as they arise without a comprehensive understanding of future implications. Yet, as the effects are often cumulative and, in the long term, this makes policy implementation politically unrewarding, there is all the more need for an international incentive mechanism to induce these governments to tackle environmental issues.

11.7.2 Development of Carbon Payment Schemes

Rules, modalities, and guidelines on measuring change in soil carbon in relation to GHG levels must be developed. Procedures, technology, and incentive schemes must also be developed to facilitate payment to organic farmers for their eco-practices. As organic farmers have undergone the process of getting certification, this makes them receptive to other monitoring schemes. To measure the capacity of organic agriculture to sequester carbon, comparisons should be done at the regional level taking into account the change in soil utilization. Developing a comprehensive analysis will not only mitigate present GHG impacts by providing better information to base policy and aid consumer choices, but also lead to multiple beneficial side effects for the environment, wildlife, and human health.

11.7.3 A Change of Lifestyle

Consumers, on the other hand, may take part in this climate-friendly revolution by reexamining their lifestyles. To minimize carbon footprints, there is a need to reduce the consumption of goods from production systems that are harmful to the environment. Organic agriculture is currently practiced by the majority of poor farmers in developing countries. Support for such small-scale farmers may come not only from consuming organic produce but also from buying less-processed food with less packaging.



Agriculture has largely been influenced by economic and political factors. There has been little concern about its impacts on global warming until recently. Adaptation to climate change should be put in place as elements of overall risk management strategy and for the continuation of diverse life-forms on earth.

REFERENCES

- Aubert, C. 2007. *Can Organic Farming Mitigate the Impact of Agriculture on Global Warming*. International Conference on Organic Agriculture and Food Security. Italy: Food and Agriculture Organization of the United Nations.
- DEFRA (Department for Environment, Food and Rural Affairs of the United Kingdom). 2000. *Energy Use in Organic Farming Systems*. March. http://randd.defra.gov.uk/Document.aspx?Document=OF0182_181_FRP.pdf
- Fliessbach, A. 2007. *The Role of Organic Agriculture in Climate Change-Scientific Evidence*. BioFach 2007. Shanghai: Research Institute of Organic Agriculture FiBL.
- FAO (Food and Agriculture Organization of the United Nations). 2007. *The State of Food and Agriculture 2007: Paying Farmers for Environmental Services*. Rome. <ftp://ftp.fao.org/docrep/fao/010/a1200e/a1200e00.pdf>
- Hepperly, P. 2003. *Carbon and Nitrogen Sequestration in Agricultural Systems*. Kutztown, PA: Rodale Institute.
- Hepperly, P., Moyer, J., Pimentel, D., Douds Jr, D., Nichols, K. And Seidel, R. 2008. Organic Maize/Soybean Cropping Systems Significantly Sequester Carbon and Reduce Energy Use. In D. Neuhoff, N. Halberg, T. Alföldi, W. Lockeretz, A.Thommen, I.A. Rasmussen, J. Hermansen, M. Vaarst, L. Lueck, F. Caporali, H. Høgh Jensen, P.Migliorini, and H. Willer, eds. *Cultivating the Future Based on Science. Volume 2 – Livestock, Socio-economy and Cross disciplinary Research in Organic Agriculture*. Proceedings of the Second Scientific Conference of the International Society of Organic Agriculture Research (ISO FAR), held at the 16th IFOAM Organic World Congress in Cooperation with the



- International Federation of Organic Agriculture Movements (IFOAM) and the Consorzio ModenaBio, 18–20 June. Modena, Italy.
- IPCC (Intergovernmental Panel on Climate Change). 2001. *Climate Change 2001: Impacts, Adaptation And Vulnerability*. 3rd Assessment Report. New York, NY: Cambridge University Press.
- . 2007. *Climate Change 2007: Mitigation of Climate Change*. Working Group III Contribution to the IPCC 4th Assessment Report. New York, NY: Cambridge University Press.
- Kasterine, A. 2010. Organic Agriculture and Carbon Markets. Cited in *The World of Organic Agriculture: Statistics and Emerging Trends 2010* by FiBL and IFOAM. Bonn and Frick.
- Khan, S.A., R.L. Mulvaney, T.R. Ellsworth, and C.W. Boast. 2007. The Myth of Nitrogen Fertilization for Soil Carbon Sequestration. *Journal of Environmental Quality*. 36. pp. 1821-32.
- Lal, R. 2004. Soil Carbon Sequestration Impacts on Global Climate Change and Food Security. *Science*. 304. pp. 1623-27..
- Niggli, U., J. Earley, and K. Ogorzalek. 2007. *Organic Agriculture and Environmental Stability of the Food Supply*. International Conference on Organic Agriculture and Food Security. Italy: FAO.
- Nemecek, T., D. Dubois, O. Huguenin-Elie, and G. Gaillard. 2006. Life Cycle Assessment of Swiss Organic Farming Systems. Aspects of Applied Biology 79. Zurich, Switzerland: Agroscope Reckenholz-Tänikon Research Station ART.
- OTA (Organic Trade Association). 2012. Questions and Answers About Organic. <http://www.ota.com/organic/faq.html>
- Pimentel, D. 2006. *Impacts of Organic Farming on Efficiency and Energy Use in Agriculture*. http://www.organicvalley.coop/fileadmin/pdf/ENERGY_SSR.pdf
- Pimentel, D., P. Hepperly, J. Hanson, D. Douds, and R. Seidel. 2005. Environmental, Energetic, and Economic Comparisons of



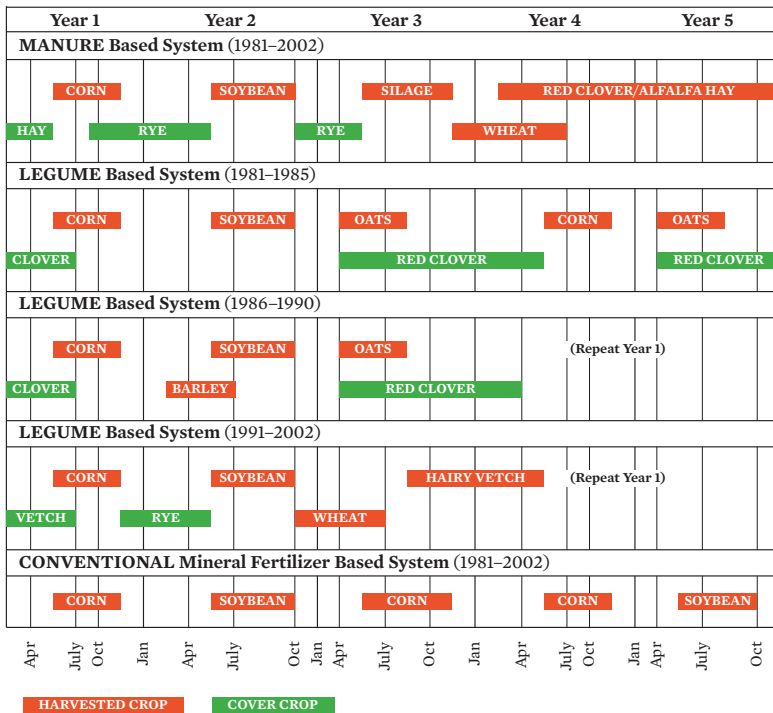
- Organic and Conventional Farming Systems. *Bio Science*. 55 (7). pp. 573-82.
- Setboonsarng, S. 2006. Organic Agriculture, Poverty Reduction, and the Millennium Development Goals. ADBI Discussion Paper No. 54. Tokyo: Asian Development Bank Institute.
- Soil Association. 2005. Organic Farming and the Environment. Information Sheet. Bristol, UK.
- Teasdale, J.R., and M.A. Cavigelli. 2008. Performance of Organic Grain Cropping Systems in Long-Term Experiments. Presented at the 16th IFOAM Organic World Congress, Modena, Italy. 16–20 June. <http://orgprints.org/11539>
- Veenstra, J.J., W.R. Horwath, J.P. Mitchell, and D.S. Munk. 2006. Conservation Tillage and Cover Cropping Influence Soil Properties in San Joaquin Valley Cotton-Tomato Crop. *California Agriculture*. 60 (3). p. 53.
- Wassmann, R., and A. Dobermann. 2006. Climate Change and Rice Cropping Systems: Potential Adaptation and Mitigation Strategies. Los Baños, Philippines: International Rice Research Institute.
- West, T.O., and G. Marland. 2000. Full Carbon Cycle Analysis in Agriculture: Balancing Carbon Emissions, Carbon Sequestration, and Agricultural Productivity. American Geophysical Union 2000 Fall Meeting. 15–19 December. San Francisco, CA.
- Willer, H., and L. Kilcher. 2010. *The World of Organic Agriculture: Statistics and Emerging Trends 2010*. Frick: Research Institute of Organic Agriculture (FiBL) and Bonn: International Federation of Organic Agriculture Movements.



Appendix

As shown in this appendix, cover crops are planted between periods of regular crop production, to provide increased biomass production and to reduce soil erosion and soil organic matter decay, stimulating the increase of soil carbon reserves, i.e., carbon sequestration.

Figure All.1 Crop Rotations in the Rodale Institute Farming Systems Trial



Source: Rodale Institute.

It is noteworthy that in organic crop systems (the top four illustrations), increased diversity and plant coverage have been observed, compared to the conventional corn and soybean crop system. The fallow gaps in the conventional crop pattern contribute to carbon losses rather than assuring soil carbon gains.



Table A11.1 Practices in the Rodale Institute Farming Systems Trial

Cultural Practices	Manure	Legume	Conventional
Crops	Maize, soybeans, small grains, hay, Cover crops, rye	Maize, soybeans, small grains, hay, Cover crops, rye	Maize, soybeans
Nitrogen inputs	40 kg/ha/yr manure + legume hay (198 kg N/ha on maize and silage)	40 kg/ha/yr legume cover crop (140 kg N/ha on maize)	88 kg/ha/yr mineral fertilizer (146 kg N/ha on maize)
Ground cover	Living: 70% Dead: 20% Bare: 7%	Living: 70% Dead: 22% Bare: 8%	Living: 42% Dead: 50% Bare: 8%
Primary tillage	Moldboard plow 0.8/yr (4 times/5 yr rotation)	Moldboard plow 1.3/yr (4 times/3 yr rotation)	Moldboard/chisel plow 1.0/yr (5 times/5 yr rotation)
Weed control	Rotary hoeing cultivation, rotation	Rotary hoeing cultivation, rotation	Herbicides
Insect control	None	None	Insecticides (only in 1986–1989 and 1993)

ha = hectare, kg = kilogram, N = nitrogen, yr = year.

Source: Rodale Institute.

Table A11.2 Agricultural Practices and Carbon Sequestration (kg carbon/ha/yr)

Practices	Rodale ^a	Teasdale USDA ^b	Veenstra UCD ^c	West and Marland ^d
No tillage			-330	330
Cover crops	~800	~900	~1,200	
Cover crops/ manure	~1,000	~2,200		
Cover crops/ compost	~2,800			

kg = kilogram, ha = hectare, UCD = University of California Davis, USDA = United States Department of Agriculture, yr = year.

^aRodale Institute Farming Systems (RIFS) Trial 1981 to present and Compost Utilization Trial (CUT) 1993–2002 (Hepperly 2003; Pimentel et al. 2005; and Hepperly et al. 2008).

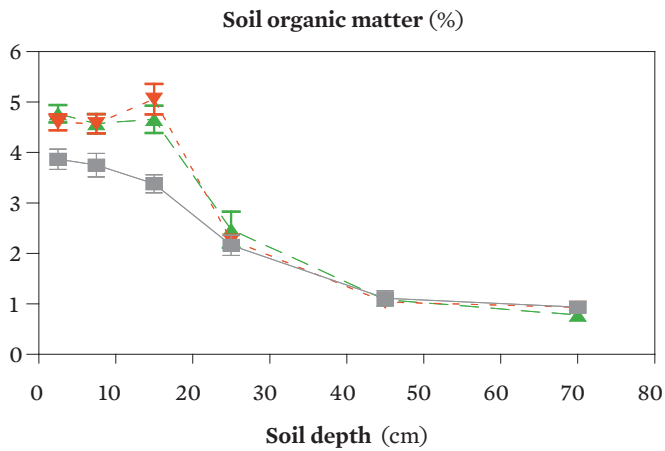
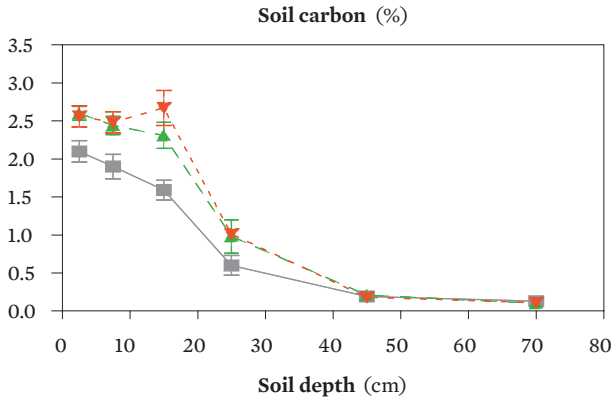
^bTeasdale and Cavigelli (2008).

^cVeenstra et al. (2006).

^dWest and Marland (2002).



Figure A11.2 Soil Carbon and Organic Matter
(RIFS 2006 Trial Pennsylvania)



—■— Conventional -▲- Legume -▼- Manure

cm = centimeter, RIFS = Rodale Institute Farming Systems.

Source: Rodale Institute.



Table A11.3 Rodale Institute Farming Systems Trial (1981–2006)

Year	Farming Systems		
	Conventional	Organic Cash Crop	Organic Dairy Simulation
1981	1.85 ^a	1.92 ^a	2.04 ^a
1985	2.05 ^a	2.20 ^b	2.28 ^b
1990	2.08 ^a	2.31 ^b	2.26 ^b
1995	1.88 ^a	2.33 ^b	2.45 ^b
2003	1.98 ^a	2.45 ^b	2.36 ^b
2005	1.95 ^a	2.50 ^b	2.50 ^b
2006	1.79 ^a	2.41 ^b	2.59 ^b

Note: Within a year, a different superscript letter denotes a statistically significant difference $p < 0.05$. The values (numbers) represent the means of the treatments. The letters next to values represent the significance. Means followed with same letters are similar and such treatments are not significantly different, but they are significantly different from means with other letters. The significance is horizontal, that is, the reader compares the values along the row. For example, in same row treatments with values followed with letter *a* are similar; however, they are different from means of a treatment with letter *b*.

Source: Rodale Institute.

Table A11.4 Mean Soil Profile Depths (RIFS Trial, Kutztown, Pennsylvania)

Mean Depth (cm)	Conventional	Organic Cash Crop	Organic Dairy Simulated
10	2.00 ^b	2.51 ^a	2.45 ^a
30	0.50 ^b	0.75 ^a	0.86 ^a
50	0.35 ^a	0.35 ^a	0.45 ^a
70	0.20 ^a	0.20 ^a	0.20 ^a

cm = centimeter, RIFS = Rodale Institute Farming Systems.

Note: Within any depth, a different superscript denotes statistically significant difference ($p < 0.05$) between the systems.

The values (numbers) represent the means of the treatments. The letters next to values represent the significance. Means followed with same letters are similar and such treatments are not significantly different, but they are significantly different from means with other letters. The significance is horizontal, that is, the reader compares the values along the row. For example, in same row treatments with values followed with letter *a* are similar; however, they are different from means of a treatment with letter *b*.

Source: Rodale Institute.



Table A11.5 Water Stable Soil Aggregates
(RIFS 2006 Trial Pennsylvania)

Farming Systems			
Year	Conventional	Organic Cash Crop	Organic Dairy Simulated
2006	21 ^b	26 ^{ab}	28 ^a

RIFS = Rodale Institute Farming Systems.

Note: A shared superscript letter denotes a statistically significant difference ($p < 0.05$) between the farming systems compared.

The values (numbers) represent the means of the treatments. The letters next to values represent the significance. Means followed with same letters are similar and such treatments are not significantly different, but they are significantly different from means with other letters. The significance is horizontal, that is, the reader compares the values along the row. For example, in same row treatments with values followed with letter *a* are similar; however, they are different from means of a treatment with letter *b*.

Source: Rodale Institute.

Table A11.6 Soil Carbon and Nitrogen Accumulation (in kg/ha/yr)

	Carbon	Nitrogen
Manure	981 ^b	86 ^b
Legume	574 ^b	41 ^b
Conventional	293 ^a	-2 ^a

ha = hectare, kg = kilogram, yr = year.

Note: Letters denote differences in significance level, highly significant at $p=0.05$.

The values (numbers) represent the means of the treatments. The superscript letters next to values represent the significance. Means followed with same letters are similar and such treatments are not significantly different, but they are significantly different from means with other letters. The significance is horizontal, that is, the reader compares the values along the row. For example, in same row treatments with values followed with letter *a* are similar; however, they are different from means of a treatment with letter *b*.

Source: Rodale Institute.

Table A11.7 Carbon Sequestration and Agricultural Practices
(kg of carbon/ha/yr)

Parameters	Conventional no-till ^a	Cover crops till ^b	Biological no-till ^c parameters
Gross carbon sequestration	+330	+1,000	+1,330
Carbon emissions	-148	-78	-59
Net carbon sequestration	+182	+924	+1,271
Gross C-sequestration ratio	1	~3	~4
Net C-sequestration ratio	1	~5	~7

^a Meta-analysis of conventional no-till in West and Marland (2000).

^b Hepperly (2003), Pimentel et al. (2005), Teasdale and Cavigelli (2008), and Veenstra et al. (2006).

^c Value projected using on additive model for carbon sequestration and input adjustments based on system requirements.



Chapter 12 | **Enhancing Biodiversity through Market-Based Strategy: Organic Agriculture¹**

Marie Mondeil and Sununtar Setboonsarng

12.1 INTRODUCTION

The protection and sustainable management of biodiversity, in particular plant genetic resources (PGRs) is an important part of achieving Goal 7 of the Millennium Development Goals (MDG), specifically Target 9, which integrates the principles of sustainable development into country policies and programs and aims to reverse the loss of environmental resources. The protection of PGRs is crucial to the adaptation of the agriculture sector as PGRs are declining worldwide due to changes in land use, land degradation, monocrop practice in intensive agriculture, pollution, contamination by genetically engineered genes, and other environmental changes. According to the Plant Conservation Report, two-thirds of the world's plant species are in danger of extinction with pressure from the growing human population, habitat modification and deforestation, overexploitation, the spread of invasive alien species, pollution, and the growing impacts of climate change (Convention on Biological Diversity 2009). Policy makers are becoming more aware that the decline of PGRs will reduce the ecosystem's ability to produce food, resist pests and diseases, and withstand the stress brought about by climate change.

The remaining PGRs are preserved in limited areas, such as ecological reserves and other protected areas under public funding. However, since such systems are very costly, to date, no country has put in place

¹ First published as Mondeil, M. and S. Setboonsarng. 2009. "Enhancing Biodiversity Through Market-Based Strategy: Organic Agriculture" ADBI Working Paper 155. Tokyo: Asian Development Bank Institute. Available: <http://www.adbi.org/working-paper/2009/10/15/3347.biodiversity.organic.agriculture/marketbased.strategy/>



a comprehensive system to protect its PGRs. A set of promising, but generally forgotten, sources of PGRs are those protected by poor farmers practicing traditional farming, largely in the remote marginal areas of developing countries. With globalization and rapid infrastructure development in developing countries, these marginal areas are fast opening up, and traditional farming systems are being transformed into commercial systems based on monocrop cultivation of high-yielding varieties, leading to a rapid decline of PGRs. While poverty reduction through modernization of farming systems is imminent, alternative agricultural development strategies to enhance and preserve PGRs must also be identified. Priority should be given to market-based strategies that can achieve a sustainable and wide range of positive impacts.

12.2 USEFULNESS OF AND THREATS TO PLANT GENETIC RESOURCES

For millennia, living species have been evolving, dispersing, and scattering beyond their native areas. Confronted with various habitats, they gradually adapted to their new environment and climate under constraints, natural and human-made, which created a very broad genetic diversity within each species. This forms what we call PGRs and they are of particular importance to humans, particularly those PGRs that comprise food and agriculture, including the diversity of genetic material contained in traditional seed varieties and modern cultivars, as well as wild plant species that can be used as food, feed for animals, fiber, shelter, energy, etc. Until now, this broad diversity was considered a free and available commodity available for common use.

In 1995, it was estimated that among the 250,000 species of higher plants identified, about 30,000 are edible and about 7,000 plant species have been used as food in agriculture. Thus, several thousand species with extensive diversity are considered to contribute to food (Wilson 1992).

Cultivated PGRs are classified into three broad categories:

- (i) *modern varieties* (sometimes called high-yielding varieties) are the products of plant breeding in the formal system. They typically have a high degree of genetic uniformity.
- (ii) *farmers' varieties* (otherwise known as traditional varieties) are the product of breeding or selection carried out by farmers, either deliberately or not, continuously over many generations.



Farmers' varieties tend not to be genetically uniform² and contain high levels of genetic diversity (Tomooka 1991; Ceccarelli et al. 1992; Alika, Aken'Ova, and Fatoukan 1993).

- (iii) *landraces and wild relatives' species*³ which can be recognized morphologically. Farmers have names for them and different landraces differ in adaptation to soil type, time of seeding, date of maturity, height, nutritive value, and use, as well as in hue, taste, nutrition, preservability, and medicinal quality, and in pest, drought, and flood resistance (Harlan 1975).

12.2.1 Benefits of Plant Genetic Resources and Genetic Diversity to Smallholder Farmers

Farmers in fertile and/or irrigated areas who can afford to invest in appropriately improved crop varieties and external inputs are usually rewarded with increased yields and incomes. The majority of farmers in developing countries, however, particularly poor farmers in rainfed ecosystems, cannot afford expensive external inputs such as fertilizers, pesticides, or enhanced seeds for profitability. So it is thanks to the genetic diversity of traditional plants—both at intra- and interspecific levels—that are well adapted to locally poor conditions that such farmers continue to survive.

The majority of poor farmers live in arid zones with low soil fertility and unpredictable conditions, such as poor or erratic rainfall, very long or short growing seasons, and lack of external inputs. In such environments, it is the local varieties and landraces that provide smallholder farmers with a more reliable crop yield.

12.2.2 Contribution of Plant Genetic Resource Diversity to Modern Varieties

PGR diversity represents a vast genetic “library” from which we can obtain many useful genes. Each variety of plant possesses value that remains undiscovered to humankind, so PGR diversity represents a true

² This depends to some extent on whether the species is open- or self-pollinating.

³ Landrace refers to varieties selected and improved by farmers. Landraces are adapted to specific ecosystem environments of farmers' farms.



“resource” that humankind can continue to turn to for agriculture, food, medicine, industry, and other future uses.

Specific genes or gene combinations provide valuable benefits, including agronomic qualities such as resistance to pests, diseases, and drought; adaptations to abiotic stresses such as salinity tolerance, plant stature, and other factors affecting productivity; quality factors such as higher oil or protein content; as well as culinary and other factors of cultural importance. These traits are both important to farmers and of major global significance as they are introduced into many modern varieties.

For example, wild relatives, together with weedy species that have evolved over a long period of time and have coevolved with pests and diseases, contributed greatly to plant improvement (Harlan 1981). Plant breeders commonly use wild species as gene donors to improve pest and disease resistance among cultivated species.

12.2.3 Rapid Decline of Plant Genetic Resource Diversity

The loss of genetic diversity (also called “genetic erosion”) includes the loss of individual genes and the loss of particular combinations of genes. This causes reduced biological fitness and increased chances of extinction. The International Union for Conservation of Nature (Vié et al. 2008) Red List revealed that of 12,055 species of plants assessed as endangered, only 8,457 have been categorized and only 4% of total plant species have been evaluated.

Since the 1960s, a significant decline of varieties and plant species cultivated in agriculture has led to the rapid loss of PGRs that hold less economic interest or solely local interest. The ongoing erosion of PGRs has decreased the intra-specific genetic diversity of many crops. According to Food and Agriculture Organization of the United Nations (FAO) estimates (1997), 8.75% of the genetic diversity of crop plants was lost in the 20th century. A survey by the Erosion Technology and Conservation (ETC) group estimated that approximately 97% of PGRs have been lost in the last 80 years.

12.2.4 Causes of Plant Genetic Resource Decline

According to data from the FAO, the causes of genetic erosion in crops in countries are tabulated in Table 12.1.

**Table 12.1 Top Causes of Genetic Erosion**

Cause	Number of Countries N=154
Replacement of local varieties	81
Land clearing	61
Overexploitation of species	52
Population pressure	46
Environmental degradation	33
Overgrazing	32
Legislation/policy	22
Changing agricultural systems	18
Pests/weeds/diseases	9
Reduced fallow	6
Civil strife	6

N = sample size.

Source: FAO (1997).

Concerning food crops, genetic vulnerability and genetic erosion are mainly caused by (i) excessive genetic uniformity of a few high-yielding modern varieties, (ii) collateral damages caused by conventional agriculture, (iii) contamination by genetically engineered crops, and (iv) global climate change, discussed in detail below.

Genetic erosion resulting from excessive genetic uniformity in crops. Perhaps the most important factor affecting PGR decline is the displacement of local cultivars by improved varieties and of cash crops. Other factors include habitat destruction affecting the wild gene pool, changing cropping patterns, and the effects of long periods of droughts. As old varieties in farmers' fields are replaced by newer ones, genetic erosion frequently occurs because the genes and particular combinations of genes (e.g., of gene complexes) found in the diverse farmers' varieties are not contained in the modern high-yielding varieties.

Today's widely planted modern varieties of food crops are genetically uniform and are, therefore, vulnerable. The extent of uniformity is not always apparent because pedigrees are not always available. In addition, data on areas sown with different cultivars of the same crop are not usually available. Uniformity per se is not dangerous, as some crop



cultivars are remarkably stable.⁴ Planting large areas with a genetically uniform crop variety, however, may render crops susceptible to new pathogen races and to being wiped out, as what happened in the potato famine of 1845–1848 in Europe and North America which decimated the regions' population.

Collateral damage caused by conventional agriculture. The absence of genetic variation in hybrid varieties has increased the incidence of plant pests and diseases that caused the gradual and widespread extinction of traditional varieties and landraces grown nearby and those not receiving pesticides. Few scientists foresaw the resulting displacement of indigenous genetic resources or their eventual extinction. The role of the farmer as protector of crucial gene species such as sorghum, millet, buckwheat, and beans was forgotten. Every effort was made to replace local varieties with high-yielding ones, viewing the former as primitive.

Genetic vulnerability caused by cross-contamination through genetically engineered crops. It is impossible to have zero contamination of landraces and traditional seeds by DNA sequences derived from genetically engineered crop varieties. Gene flow is a regular and natural occurrence among plants in any ecosystem. If a gene is released, it will escape to other varieties of the same crop or to its wild relatives. There is no way to ensure that food crops are not contaminated, for example, by errant pollen that possibly contain new drug genes or herbicide-resistant genes. According to the degree of gene flow, the serious possibility of a healthy gene pool erosion exists if genes from pharmaceutical and industrial crops contaminate the seeds of food crops at a significant level.

In the United States and other North American and European countries, genes from genetically modified varieties have been found at low levels in nongenetically modified varieties of some major crops grown nearby. Among the potential contaminants are genes from crops engineered to produce drugs, plastics, and vaccines. This has broad implications, as will be discussed.

First, seeds reproduce and carry genes into future generations. Every season of seed production offers new opportunities for the crossing

⁴ By broadening the diversity of resistance genes and “pyramiding” multiple genes from different sources, breeders can strengthen resistance even in genetically uniform varieties.



and exchange of genes or the introduction of new genes. In the case of genetic engineering, transgenic sequences that enter the seed supply of traditional crop varieties will be perpetuated and will accumulate over time in plants where they are not expected and could be difficult to control.

Second, seeds are the wellspring of our food system, the base upon which we improve crops and the source to which we return when crops fail. Noncontaminated seeds will be our only recourse if prevailing beliefs about the safety of genetically engineered seeds prove wrong.

Unless some part of our seed supply is preserved with a broad genetic base and free of genetically engineered sequences, our ability to change course if genetic engineering goes awry will be severely hampered. Prompt action is needed to protect traditional and landraces seed production from such sources of contamination.

Threat of global climate change. Climate change is already forcing plant species to adapt either by shifting habitats, changing life cycles, or developing new physical traits. The species that are unable to adapt are facing extinction. Climate change threatens food crops, and the few remaining landraces and wild relatives of key crops, which are valuable sources of genetic diversity. As a result, human dependence on wild relatives will intensify as the climate becomes harsher.

Farmers—especially smallholder farmers—are among the first to suffer from climate change as extreme weather events increase destruction of farmlands, stock, crops, and rural dwellings. Plant species are disappearing at an unprecedented pace already. Farmers have to adjust to these changes by adapting their seeds and usual production systems to an unpredictable situation.

Given the importance of the climate–biodiversity link, conservation through sustainable use of the traditional and landrace varieties that are especially resilient to climate change can strengthen and improve the ability of ecosystems to deal with increasing climatic pressures. At the same time, the increased flood and drought risk under climate change is contributing to higher level of species loss and, therefore, conservation efforts are ever more important.



12.2.5 Consequences of Gene Pool Erosion

The erosion of PGR diversity poses a severe threat to the world's food security in the long term as the loss of landraces and traditional varieties will negatively affect the ability of agriculture to adjust itself to climate change and its effects. The extinction of plants in a species could potentially mean an undiscovered cure for cancer, an overlooked new antibiotic drug (like the antibiotic discovered in the soils of the threatened New Jersey Pine Barrens Natural Area), or a forgotten disease-resistant plant species (like the perennial disease-resistant corn found in Mexico), and therefore is a serious problem. If lost, the particular combination of genes in a well-adapted landrace may be difficult or impossible to rebuild.

12.3 PLANT GENETIC RESOURCE PRESERVATION AND ORGANIC AGRICULTURE

Most of the countries have recognized the need for appropriate conservation strategies to protect cultivated and traditional PGR, wild relatives, ecosystems, and the traditional knowledge associated with them. The threat to biological diversity was, in fact, a key concern over a decade ago at the UN World Summit for Sustainable Development in 2002, with participants united in their hope to a Global Conservation Trust to help maintain plant collections.

Efforts for preserving PGRs are either *in situ* or *ex situ*. Some believe both types of conservation are required to ensure sound preservation. *In situ* conservation is considered the most desirable conservation strategy, but sometimes it cannot be done. The destruction of rare or endangered species' habitats also requires *ex situ* conservation. Both methods of preservation should ensure the perpetuity and guarantee the quality of a large gene pool, not just of "useful" genes but also including highly diversified resources that are capable of providing for future needs.

12.3.1 Ex Situ Preservation Including Seed Banks

The response of the international community to the loss of biodiversity has been the establishment of seed banks. According to the FAO, there were about 1,300 banks in 2002 containing around 6 million (plant accession) acquisitions from around the world, which has increased



to 7.4 million in 1,750 banks in 2010 (FAO 2012). There is now growing public awareness of the importance of genetic diversity, which can help ensure dietary diversity and tackle future production challenges.

The “Doomsday Vault,” which opened on 26 February 2008 in Norway’s remote Svalbard archipelago near the North Pole, is an example of a global *ex situ* conservation effort. It was planned with the climate change factor taken into consideration and will be frozen 200 years from now. This top-security repository was designed to protect and preserve samples of valuable seeds and is aimed at providing humankind with food in case of a global catastrophe. The vault can store more than 4 million batches of seeds from all known varieties of the planet’s crops. The hope is that the vault will make it possible to reestablish crops that are endangered or obliterated by major disasters. The seeds will be maintained at a temperature of -18°C . Each box will contain about 400 samples in envelopes made of polyethylene and each sample will contain around 500 seeds.

There are serious drawbacks to this approach for conserving biodiversity. Varieties stored in seed banks are small-sized populations adapted to the conditions of cold storage and could become extinct if they are not regularly sown and replanted outside to generate viable seeds. For example, the most important wheat collection in Asia (held at the University of Kyoto) grows only five plants per variety for regeneration. Stored varieties become very uniform and adapted to the artificial environment of cold storage. Small samples are more prone to extinction than large populations as they are more sensitive to genetic drift due to the random variation in their gene pool resulting from their limited genetic base. Each plant has many unique genes (resistant to diseases, drought, flood, or high or low temperatures) which are lost when the plant dies without getting the chance to breed naturally and produce offspring.

Could the seeds in the Doomsday Vault adapt to their new environment once removed out of the seed bank 200 years from now? The fact is that there is a serious lack of contextual knowledge about the material stored in seed banks. Without information about the farming systems in which these crops were grown and the planting rotations they formed, these varieties cannot be of use to future farmers. Therefore, seed banks’ effectiveness could be limited due to genetic drift of small-sized populations and limited adaptability to future environments,



as well as the lack of capacity by national agricultural research centers and universities to reproduce or multiply seeds regularly on a sufficient scale to preserve variability and adaptability.

12.3.2 In Situ Preservation

In contrast to ex situ conservation, in situ conservation permits populations of plant species to be maintained in their natural or agricultural habitat, allowing the evolutionary processes that shaped genetic diversity and the adaptability of plant populations to continue to operate (Frankel and Soule 1991). In situ conservation includes (i) specific conservation measures for crop wild relatives and wild food plants, particularly in protected areas; and (ii) conservation and sustainable utilization of landraces or traditional crop varieties on-farm and in home gardens. Details about these two will be discussed.

12.3.2.1 Conservation of plant genetic resources in protected areas

Protected areas number 9,800 worldwide and cover approximately 926 million hectares of the earth's surface (IUCN 1999). The number and coverage of protected areas has expanded by approximately 30% in the past decade which increased protection of crop wild relatives (CWR) (FAO 2012).

Among the countries that have initiated projects to conserve in situ are Turkey and Israel. The former has concentrated on cereals, medicinal plants, and forest trees with support from the Global Environment Facility. The latter has pioneered research on in situ conservation strategies for wild emmer wheat.

However, these examples are rare despite the importance of wild and semi-wild food plants to the livelihood of many poor communities. Moreover, many problems exist in "protected areas," including inadequate knowledge of the distribution of wild relatives, a lack of clear research priorities and methodologies, and insufficient management tools for ensuring minimum viable population sizes of target species.

As a result, PGR conservation in protected areas is not really safe unless special measures are taken to ensure the active participation and involvement of local communities in the selection, establishment, and management of such areas. Most importantly, since the approach



requires large amounts of public funding, continued political support is necessary to sustain long-term conservation.

12.3.2.2 On-farm conservation

Conservation by farmers of landraces and traditional crop varieties differs in important respects from in situ conservation of wild material in protected areas. A landrace has generally been selected to suit the environment in which it is cultivated and to satisfy the particular needs of its growers, such as flavor and cooking qualities. Through the particular case of on-farm conservation, landraces continue to evolve, influenced by natural selection as well as by the farmer-induced selection processes, thus providing opportunities for continuous crop adaptation and improvement.

The biological features of different types of crops influenced smallholder farmers' ability to experiment with local PGRs and to maintain landraces. Landraces are safeguarded and constantly developed through farmer selection. On-farm conservation, which is a dynamic form of PGR management, offers many opportunities to combine genetic diversity conservation with agricultural development.

Although there are few instances of formal on-farm conservation, smallholder farmers around the world continue to cultivate local varieties whose taste, cooking quality, and storage characteristics of traditional varieties are preferred over the improved varieties. According to the Plant Genetic Resources Center of Ethiopia, Ethiopia probably has the most advanced program of on-farm conservation of landraces to maintain crop diversity and the production of food for local consumption and local markets. In most parts of the world, many of the traditional diversity-based farming systems are disappearing. Landraces and local varieties persist but many are in isolated and marginal areas.

Home gardens also constitute a valuable part of an in situ PGR conservation system, but their importance in genetic resource conservation is still not widely recognized and few inventories have been carried out.

12.3.3 Capacity to manage plant genetic resource preservation

The main factors that strongly favor the involvement of smallholder farmers in PGR preservation are (i) the level of exposure to external influence such as agricultural modernization or other socioeconomic



changes, and (ii) the indigenous knowledge of landraces and their technical skills.

Exposure to external influence. Local capacity for PGR preservation can vary greatly between different geographical locations. Communities located in centers of plant genetic diversity that have managed local PGR for centuries, more or less uninfluenced by outside developments, have a high capacity to manage PGRs.

Indigenous knowledge. Smallholder farmers are usually located in remote areas, far from genetic pollution, and their knowledge on traditional varieties and landraces is extensive and could thus contribute greatly to their safeguard (Warren, Slikkerveer, and Titilola 1989). This knowledge ranges from traditional uses of plants to strategies for the management and conservation of landraces, differences among landraces in their resistance to pests and knowledge of pests and pest control methods, traditional selection and breeding methods, and environmental monitoring and early warning systems for ecological change (Altieri 1993).

Local people not only have knowledge of the distribution of particular wild plants but may also have “sanctuaries” of high diversity that are often actively protected by the communities as sacred groves that function as both spiritual centers and biodiversity and food security insurance for surrounding communities (Raishankar et al. 1994; Chambers 1999). An understanding of local seed production and exchange systems can help characterize the origin, genetic base, and degree of adaptation of germplasm (Cromwell 1990). Folk classifications often correspond to scientific classifications, at both the interspecific and intra-specific levels (Berlin 1992; Berlin, Breedlove, and Raven 1974; Alcorn 1984; Quiros et al. 1990). There are also numerous cases of the names of landraces reflecting not just appearance but intrinsic qualities such as cooking characteristics (Boster 1984).

Evidence also shows that farmers can evaluate varieties for desirable characteristics. For instance, farmers in Kordofan (Sudan) associate sorghum varieties with the type of soil in which they grow best (Oughenor and Nazhat 1985). Farmers in the Lao People’s Democratic Republic know which of the local varieties are more suitable for a dry year with a short growing season. There is evidence that farmers are aware of differences among landraces in their resistance to pests, and



that they have considerable knowledge of the biology of pests and pest control methods (Altieri 1993).

The keepers of much of this knowledge are often the elders, and there is a danger that it may not be passed on to younger generations and could be lost forever. Hence, recognition, documentation, and use of indigenous knowledge are very important to the safeguarding and utilization of PGRs for food and agriculture.

12.4 PARTNERSHIPS BETWEEN FARMERS AND PUBLIC SECTOR TO PRESERVE PLANT GENETIC RESOURCES

PGR diversity is generally agreed upon as a global public good. Therefore, policies and regulations that promote sustainable on-farm conservation of crops must be considered at the international and national levels.

12.4.1 At the International Level

The International Treaty on Plant Genetic Resources for Food and Agriculture, entered into force in June 2004, recognizes the rights of farmers involved in the preservation of PGR diversity. The treaty aims at (i) recognizing the enormous contribution of farmers to the diversity of crops that feed the world; (ii) establishing a global system to provide farmers, plant breeders, and scientists with access to plant genetic materials; and (iii) ensuring that recipients share benefits they derive from the use of these genetic materials with the countries where they have been originated.

Article 9.2 of the treaty reads:

The Contracting Parties agree that the responsibility for realizing Farmers's Rights, as they relate to plant genetic resources for food and agriculture, rests with national governments. In accordance with their needs and priorities, each Contracting Party should, as appropriate, and subject to its national legislation, take measures to protect and promote Farmers's Rights including:

- (a) *protection of traditional knowledge relevant to plant genetic resources for food and agriculture;*



- (b) *the right to equitably participate in sharing benefits arising from the utilization of plant genetic resources for food and agriculture; and*
- (c) *the right to participate in making decisions, at the national level, on matters related to the conservation and sustainable use of plant genetic resources for food and agriculture. (FAO 2009)*

The treaty leaves governments with the responsibility of measures to bolster PGR farmers. It also has provisions for financial resources provided by developed countries to support priority activities plans and programs for the conservation and sustainable use of PGRs.

12.4.2 At the National Level

Governments should support farmers involved in PGR preservation through cooperation with research institutes and sponsoring of relevant legislation and regulation.

Collaboration with research institutes. Research institutes can support farmers especially in preserving and maintaining landraces and traditional varieties. Farmers actively select varieties on the basis of phenotypic characteristics (easy to observe visually), rather than the associated genotype characteristics used in scientific plant breeding. Cooperation may be needed to improve the farmers' ability to select for increased yield and other characteristics that they desire. One example is the work of the Biodiversity Institute in Ethiopia, which screens local landraces of sorghum for drought tolerance and returns the most drought-tolerant varieties to farmers. In addition, comprehensive inventories of ecosystems must be carried out in collaboration with farmers to identify sites where specific species can be conserved in situ. These inventories can help identify and avoid duplication and redundancy of traditional varieties and landraces and instead promote the preservation of abundant biodiversity.

Further work in collaboration with farmers is needed with regard to the development of protocols for conservation of wild relatives with a special focus on on-farm conservation and studies of farmer management of PGRs (meeting the minimal quantity required to maintain a large genetic base of PGRs). Farmers can assist research centers in the development of breeding objectives, in germplasm characterization, conservation,



and evaluation, and in testing the capacity of varieties to germinate and produce seeds.

Legislation/regulation. Governments should introduce specific legislative, regulatory, and financial measures for encouraging the local production, storage, and marketing of landraces and varieties that are naturally adapted to the local and regional conditions. Governments should integrate in situ conservation programs with national development plans and policies. There is also a need to review and adapt agricultural development policies and regulatory frameworks for variety release and seed certification to understand their impact on PGRs.

12.5 ROLE OF ORGANIC AGRICULTURE IN PROTECTING PLANT GENETIC RESOURCES

As mentioned in preceding sections, among the different approaches to protect and maintain the remaining PGRs, on-farm conservation by smallholder farmers can be more effective and less costly compared to the option of preserving them in protective areas. To do so, beyond having an international regulatory framework, incentive systems must be put into place for researchers and farmers to collaborate with each other, as well as to enable farmers to continue maintaining the PGRs in a more effective manner, while pulling themselves out of poverty. The conventional development strategy of introducing poor farmers to high-yielding commercial varieties to improve incomes has had mixed results on poverty reduction but has definitely led to a rapid decline of PGRs. An alternative strategy where the value of the PGRs can be taken into consideration must be urgently identified.

Among the various commercial farming systems practiced by smallholder farmers is organic agriculture,⁵ particularly certified organic agriculture,⁶ which is technologically appropriate for PGR conservation by farmers while allowing market instruments to provide incentives and rewards. Since organic farmers tend to produce to serve niche markets where traditional varieties are often promoted as being more nutritious, they are likely to cultivate older, native varieties that

⁵ See Chapter 1 of this book for the definition of organic agriculture.

⁶ See Chapter 1 of this book for the definition of certified organic agriculture.



have greater resistance to disease and pests and are better adapted to climatic stresses in the local ecosystems. These locally adapted, open-pollinated varieties are more appropriate for organic agriculture than hybrid varieties, and are an important genetic resource for poor farmers in marginal areas. By utilizing traditional varieties, there is significant potential for organic agriculture to restore and preserve PGRs (Sciallaba, Grandi, and Henatsch 2002).

Organic farms grow a wide variety of crops, in contrast to the monocropping typically found on conventional farms. In many cases encountered during a series of field visits in Thailand (see Chapter 1 of this volume), organic farmers responded to the call for increased biodiversity under organic certification and grew underutilized species as rotation crops or intercropping species. They also grew indigenous varieties according to their culinary preference. These practices lead to increased soil fertility and reduced costs of pest and disease management, and have a positive impact on crop biodiversity (Setboonsarng 2006). Thus, organic agriculture not only reduces erosion of agrobiodiversity but also creates a healthier gene pool—the basis for future adaptation. Moreover, as certified organic farms are located sufficiently far from areas where genetically engineered plants are grown, the risk of germplasm cross-contamination is minimized.

The market-based incentives are also in place as the global organic trade has increased rapidly, growing from \$11 billion in 1997 to about \$64 billion in 2012 (Willer and Lernoud 2014). The exponential growth rate of 18%–23% annually in recent years is caused by the increased awareness that organic products are better for health and the environment. The growing demand for organic products has increased the economic value of a number of traditional or underutilized crops, and has provided livelihoods to poor communities in marginal areas of developing countries. Evidence shows that private sector firms are investing in remote areas where chemical use has been limited and a transition period to obtain certified organic status is not required. Poor farmers with traditional knowledge of managing ecosystems without using chemicals have a competitive advantage in growing organic crops. With the organic farmers receiving a premium price for their products, economic incentives are in place for them to adopt sustainable practices and maintain a high level of biodiversity on the farm as required by the certification system (Setboonsarng 2008).



The promotion of organic agriculture to maintain PGRs can be done in two ways. One is to promote the commercialization of traditional varieties by finding markets for crops. Increasing consumer demand for specialty products, motivated by health concerns and culinary tastes, has led to the restoration of varieties at risk of genetic erosion. The development of a market for specialty products has been successful in certain cases, such as the promotion of the nutritional value of gluten-free quinoa⁷ from Peru or the marketing of traditional potatoes in Peru by a nongovernment organization (Sciallaba, Grandi, and Henatsch 2002).

Since the majority of poor farmers have a taste preference toward local varieties, another way to use organic agriculture to maintain PGRs is to introduce commercial organic production of new crops demanded by the market on part of the farmers' farm, while encouraging the farmers to maintain production of traditional crops for consumption on another part of the farm. In that way, farmers can earn income from commercial crops while preserving the traditional crops in situ.

Organic farmers could possibly be more willing to work closely with researchers to systematically document PGRs than conventional farmers. This is because organic farmers need to find new ways to manage their farms using modern organic practices to achieve higher levels of production while conserving the environment. If designed appropriately, the price premium and the added income from organic produce could become market-based incentives to involve poor farmers worldwide to participate in the preservation of PGRs.

12.6 CONCLUSION

Biologists and environmentalists have sounded convincingly the alarm regarding the urgency of conserving biodiversity and, in particular, PGRs. A better understanding of the adaptation and development of crop species to changes in the environment are fundamental to safeguarding PGR diversity effectively. At the global level, there is consensus about the fast genetic erosion of PGR diversity and the urgent need for the preservation of a large genetic base of cultivated crops in order to ensure food security for future generations.

⁷ Quinoa is a nutritious cereal grown on the harshest land of the Andes in South America.



A global architecture and mechanisms have been set up to these ends, including the International Treaty on Plant Genetic Resources for Food and Agriculture and seed banks. At the national level, a number of national agricultural research systems are already working on ways to preserve and develop PGRs. At the grassroots level, smallholder farmers and rural communities in developing countries who have not adopted the conventional farming practices of the Green Revolution have instead been maintaining and continuously adapting their indigenous crop resources (including traditional varieties and landraces) and preferred varieties on-farm.

It is impossible to truly estimate the importance of the crop materials that smallholder farmers are using and conserving, but there are sound reasons to think it is important. In the first place, this genetic diversity is crucial for the farmers themselves. Their crop varieties are probably the only ones that can take the farmers and their families through the periods of drought. They also provide for year-round harvest security in the harsh conditions under which farmers in most developing countries are trying to get some food from their land. Plant breeders worldwide look for commercial varieties with characteristics that have a potential economic value. For instance, when screening gene bank materials, they repeatedly find seed samples of Ethiopian origin to be particularly rich. In the context of globalization of agricultural trade, genetic diversity also helps farmers and companies in other parts of the world.

While the formal sector normally tends to pay little attention to this innovative capacity of smallholder farmers or local communities to save plant genetic diversity, an alternative strategy involving smallholder farmers in several stages of the seed-saving and breeding process is a valuable option for preserving genetic diversity. There is an urgent need to maintain landraces growing under field conditions in order to preserve a large genetic base, and for use in crop improvement programs. Landraces adapt gradually to the changing environment and climate, and this is probably best achieved through on-farm conservation programs. However, the direct benefits for peasant farmers are likely to be quite limited, in particular for food crops and especially for farmers in semi-arid areas.

As public funds are limited, in order to encourage farmers to participate in long-term sustainable safeguarding of genetic diversity through their traditional landrace varieties, incentives must be created.



Certified organic agriculture could be one of the most promising: it is technologically appropriate—smallholder farmers favor local varieties not only for their greater resistance to disease but also for the taste and cooking quality—and financially rewarding, due to the rapidly increasing global organic trade and the growing demand for health and specialty foods.

Through the development of market incentives for cultivating traditional and underutilized varieties, and the promotion of sustainable practices, certified organic agriculture is a potentially effective means of preserving plant genetic resources in situ. The role of the public sector in this process will be to develop markets for organic and traditional products, encourage pro-poor private investment in organic agriculture, and establish research centers to collaborate with farmers to identify and document indigenous varieties.

By assisting farmers in using techniques for certified organic food, we involve farmers not only in conserving germplasm but also in restoring and enhancing the performance of traditional varieties, as well as in developing and maintaining elite landraces. Farmlands act not only as sources of food but also as village gene banks for a wider range of landraces, which can be used as a depository for a wide range of useful genetic characteristics.

In an era when climate change, poverty, food safety, and other environmental concerns are high on the international agenda, promoting trade of pro-poor and pro-environment goods such as organic products should be promoted in all economic development efforts.

REFERENCES

- Alcorn, J.B. 1984. *Huastec Mayan Ethnobotany*. Austin, TX: University of Texas Press.
- Alika, J.E., M.E. Aken'Ova, and C. A. Fatoukan. 1993. Variation among Maize (*Zea mays L.*) Accessions of Bendel State, Nigeria. *Multivariate Analysis of Agronomic Data*. *Euphytica*. 66. pp. 65–71.
- Altieri, M.A. 1993. *Ethnoscience and Biodiversity: Key Elements in the Design of Sustainable Pest Management Systems for*



- Smallholder Farmers in Developing Countries. *Agriculture, Ecosystems and Environment*. 46. pp. 257-272.
- Berlin, B. 1992. *Ethnobiological Classification: Principles of Categorization of Plants and Animals in Traditional Societies*. Princeton, NJ: Princeton University Press.
- Berlin, B., D.E. Breedlove, and P.H. Raven. 1974. *Principles of Tzeltal Plant Classification*. New York, NY: Academic Press.
- Boster, J.S. 1984. Classification, Cultivation and Selection of Aguaruna Cultivars of *Manihot esculenta* (*Euphorbiaceae*). In G.F. Prance and J.A. Kallunki, eds. *Ethnobotany in the Neotropics*. New York, NY: New York Botanical Garden.
- Ceccarelli, S., J. Valkoiun, W. Erskine, S. Weigland, R. Miller, and J.G. van Leur. 1992. Plant Genetic Resources and Plant Improvement as Tools to Develop Sustainable Agriculture. *Experimental Agriculture*. 28. pp. 9-98.
- Chambers, R. 1999. *Microenvironments Unobserved*. Gatekeepers Series 22. London: International Institute for Environment and Development.
- Convention on Biological Diversity. 2009. *Plant Conservation Report: A Review of Progress in Implementing the Global Strategy of Plant Conservation (GSPC)*. http://www.cbd.int/doc/publications/plant-conservation-report-en.pdf?bcsi_scan_B90AE85AF6AB15C6=vxkw0ZSCdt/8j0FBjA7RdCkAAADn7Osf&bcsi_scan_filename=plant-conservation-report-en.pdf
- Cromwell, E. A. 1990. *Small Farmer Seed Diffusion Mechanisms: Lessons from Africa, Asia and Latin America*. ODI Agricultural Research and Extension Network Paper 21. London: Overseas Development Institute.
- FAO (Food and Agriculture Organization of the United Nations). 1997. *The State of the World's Plant Genetic Resources for Food and Agriculture*. Rome.



- . 2009. *International Treaty on Plant Genetic Resources for Food and Agriculture*. Rome. <ftp://ftp.fao.org/docrep/fao/011/i0510e/i0510e.pdf>
- . 2010. *The Second Report on the State of the World's Plant Genetic Resources for Food and Agriculture*. Rome.
- . 2012. *The Second Global Plan of Action for Plant and Genetic Resources for Food and Agriculture*. Rome.
- Frankel, O.H., and M.E. Soule. 1991. *Conservation and Evolution*. New York, NY: Cambridge University Press.
- Harlan, J. R. 1975. Our Vanishing Genetic Resources. *Science*. 188. pp. 618–621.
- . 1981. *Evaluation of Wild Relatives of Crop Plants*. Report of the Food and Agriculture Organization of the United Nations/United Nations Environment Programme/International Board for Plant Genetic Resources Technical Conference on Crop Genetic Resources. 6-10 April. Rome.
- IFOAM (International Federation for Organic Agriculture Movement). 2005. <http://www.ifoam.org/en/organic-landmarks/definition-organic-agriculture>
- IUCN (International Union for Conservation of Nature). 1999. *United Nations List of National Parks and Protected Areas*. Gland, Switzerland and Cambridge, UK.
- Oughenor, C.M., and S.M. Nazhat. 1985. *Recent Changes in Villages and Rainfed Agriculture in North Central Kordofan*. Institute of Agriculture and Natural Resources, Nebraska Report 4. Lincoln, NE: International Sorghum/Millet CRSP, University of Nebraska.
- Quiros, C.F., S.B. Brush, D.S. Douches, K.S. Zimmerer, and G. Huestis. 1990. Biochemical and Folk Assessment of Variability of Andean Cultivated Potatoes. *Economic Botany*. 44. pp. 254–266.



- Raishankar, T., L. Vedaalli, A. Nambi, and V. Selvam. 1994. *Role of Tribal Communities in the Conservation of Plant Genetic Resources*. Madras: MS Swaminathan Research Foundation, Centre for Research on Sustainable Agricultural and Rural Development.
- Sciallaba, N., C. Grandi, and C. Henatsch. 2002. *Organic Agriculture and Genetic Resources for Food and Agriculture*. Rome: FAO.
- Setboonsarng, S. 2006. Organic Agriculture, Poverty Reduction, and the Millennium Development Goals. ADBI Discussion Paper 54. Tokyo: Asian Development Bank Institute. <http://www.adbi.org/files/2006.09.dp54.organic.agriculture.mdgs.pdf>
- _____. 2008. Can Ethical Trade Certification Contribute to the Attainment of the Millennium Development Goals? A Review of Organic and Fair-Trade Certification. ADBI Discussion Paper 115. Tokyo: Asian Development Bank Institute. <http://www.adbi.org/files/2008.08.organic.fairtrade.certification.pdf>
- Tomooka, N. 1991. *Genetic Diversity and Landrace Differentiation of Mungbean, Vigna radiata (L) Wilczek, and Evaluation of its Wild Relatives (the Subgenus Ceratotropis) as Breeding Materials*. Technical Bulletin of TARC 28. Tsukuba, Japan: Tropical Agricultural Research Centre.
- Vié, J.-C., C. Hilton-Taylor, C. Pollock, J. Ragle, J. Smart, S.N. Stuart, and R. Tong. 2008. The IUCN Red List: A Key Conservation Tool. In J.-C. Vie, C. Hilton-Taylor, and S. N. Stuart, eds. *The 2008 Review of The IUCN Red List of Threatened Species*. Gland, Switzerland: IUCN. http://http://data.iucn.org/dbtw-wpd/edocs/RL-2009-001.pdf?bcsi_scan_D4A612CF62FE9576=W9gY/pgeUp1QRNn9VlbIHCoAAAB0FB0p&bcsi_scan_filename=RL-2009-001.pdf
- Warren, D., L. Slikkerveer, and S. Titilola. 1989. Indigenous Knowledge Systems: Implications for Agriculture and International Development. *Studies in Technology and Social Change*. 11. pp. 21–32.



Willer, H., and J. Lernoud, eds. 2014. *The World of Organic Agriculture: Statistics and Emerging Trends 2014*. Bonn: International Federation of Organic Agriculture Movements and Frick: Research Institute of Organic Agriculture (FiBL).

Wilson, E. O. 1992. *The Diversity of Life*. London: Penguin.



Chapter 13 | No Through Road: The Limitations of Food Miles¹

Els Wynen and David Vanzetti

13.1 INTRODUCTION

Consumers and environmentalists in developed countries have understood the concept of “food miles” for years, but its popularity has recently begun to increase. This has implications for developing country exporters. The focus on distance traveled is an attempt to highlight the hidden costs of energy use. This is based on the notion that most energy is derived from nonrenewable sources, and is underpriced. The food miles concept’s rise in popularity reflects the globalization of the food sector and increasing demand for out-of-season and exotic foods, rising fuel and food prices, greater awareness of the link between transport and carbon emissions, and the desire to limit greenhouse gas (carbon) emissions, and other environmental concerns. Producers in importing countries have an incentive to encourage the food miles movement as a means of protecting themselves from foreign competition. The focus of this chapter is aspects of food miles associated with the import of products from developing countries. As the concept of food miles has been an issue in organic agriculture since before the early 1990s, many of the examples quoted are from that sector.

The Soil Association, which sets organic standards in the United Kingdom (UK), has encouraged consumption of locally produced food for some time. Its policy is to refuse certification of airfreighted produce as organic, unless “it also meets the Soil Association’s own Ethical Trade or the Fairtrade Foundation’s standard” (Soil Association 2008). This stance is likely to increase prices for local consumers and lead to loss of market to foreign producers. The major beneficiaries will be local

¹ First published as Wynen, E. and D. Vanzetti. 2008. “No Through Road: The Limitations of Food Miles.” ADBI Working Paper 118. Tokyo: Asian Development Bank Institute. Available: <http://www.adbi.org/working-paper/2008/10/30/2735.limitations.food.miles/>



producers in the importing countries. For goods imported by sea, rail, or road, it is likely that a switch from imported to locally produced goods could increase global energy use and pollution, in contrast to stated aims (Vanzetti and Wynen 2002). This is because the energy used in international transport is generally relatively small compared with the additional use of energy and other resources in local production.

While the food miles idea has some merit, we argue that the concept is fundamentally flawed and that its advocates are not only misguided, but may be doing more harm than good. There are three reasons for this: (i) although locally produced goods may generate less pollution in transport than imported goods, the production phase may generate more pollution, for example, through the use of energy in greenhouses; (ii) mode and scale of transport are important, with sea and rail transport being more efficient than road or air; and (iii) the concept of food miles emphasizes one factor (energy) but ignores others, such as pesticides, labor, and capital.

13.2 THE CONCEPT OF FOOD MILES

In its simplest form, “food miles” refer to the distance food travels from the farm to the consumer. The concept of food miles has existed for some time, at least within the organic movement, where environmental issues have always been a priority.² In 2005, the UK Department for Environment, Food and Rural Affairs (DEFRA) published a major study, *The Validity of Food Miles as an Indicator of Sustainable Development*, in which it quoted only one earlier report on the topic using the name “food miles” (SAFE Alliance 1994). More sophisticated versions of the concept relate to energy use, carbon emissions, or other measures of environmental damage.

If food supply chains are similar in other respects (e.g., production and storage costs), it makes sense for the consumer to purchase the product that uses the smallest amount of energy in transportation. However, this does not necessarily favor the item that has traveled the fewest miles, as different modes of transport require differing amounts of energy per

² An earlier version of Vanzetti and Wynen’s 2002 paper, the topic of which was the effect of food transport on the environment, was presented at the 8th Conference of the International Federation of Organic Agriculture Movements in Budapest, 27–30 August 1990.



unit of produce. In addition, other factors are rarely equal, as production methods and costs in different countries vary a great deal. In the absence of market failure, or sound policies to address any failures, differences in energy use are reflected in the consumer price, and so influence consumer behavior.

There are various environmental and perhaps social costs that may not be incorporated in the product price however. Transport involves several externalities, such as emissions, accidents, and noise, which may not be taken into account. The relation between these externalities and distance traveled is a complex one. Indeed, consumers may be inadvertently encouraged by environmentalists to buy goods that may contribute to greater environmental pollution. Buying locally produced goods is an oversimplified way of addressing the issue of unpriced externalities.

13.3 THE RISE OF FOOD MILES

The popularity of the food miles concept can be attributed to several factors:

- (i) increased trade in food due to declining transport costs, new technologies, and lower tariff barriers; and growing demand for out-of-season, processed (prepackaged), and perishable products;
- (ii) environmental concerns, such as climate change;
- (iii) rise in protectionist sentiment in developed countries and a growing concern among farmers' organizations about the impact of increased imports on local producers; and
- (iv) food security concerns caused by rising food prices.

There is no doubt that international trade has increased in recent years. In food products alone, global trade almost doubled in 5 years, from \$739 billion in 2006 to \$1.3 trillion in 2011 (WTO 2012). However, transport costs have fallen over the long term, in spite of recent fluctuations of fuel prices.³ Ocean freight rates for grain are around

³ Energy intensity on road freight transport in the United States halved between 1960 and 1990, and has continued to decline slowly (Bureau of Transportation Statistics 2008). However, recent increases in oil prices are likely to have a dampening effect on trade, particularly of low-value goods (Rubin and Tal 2008).



\$20–\$35 per metric ton for large shipments, perhaps 10% of the import price.⁴ A major factor in calculating transport costs is switching from one mode of transport to another, for example, from ship to rail or rail to road. Improved ports and large distribution centers have facilitated cost reductions; larger vehicles have also helped to lower the average transport costs by spreading fixed costs over a larger number of units.

Lower tariffs have further decreased the cost of delivering goods to the consumer. Average agricultural tariffs in the European Union and the United States are now around 15% and 5%, respectively (WTO, ITC, and UNCTAD 2007). There has been a switch, in recent times, away from border measures (tariffs and export subsidies) to domestic support; this has been driven, in part, by international agreements such as the Uruguay Round, but also by numerous regional and bilateral trade agreements.

As more consumers demand out-of-season products, with international trade, this means some seasonal products can be made available all year round. In general, expenditure on food as a proportion of income has fallen to around 10% in Organisation for Economic Co-operation and Development (OECD) countries (*The Economist* 2008), making food relatively cheap.⁵ As a result, consumers perceive imported foods as less exotic and are therefore accustomed to buying items that have traveled large distances.

In the last few years, concerns about climate change have risen, and the focus of food miles has shifted general environmental impact to carbon emissions. At the same time, support for open markets (trade liberalization) has declined in OECD countries as concerns about stagnant wages, job losses and instability, growing income inequality, and environmental degradation has risen (Warwick Commission 2007).⁶ Some consumers feel that the purchase of locally produced products may address these issues.

The price of food has risen substantially in the recent past, driven by increasing prices of primary (unprocessed) commodities. The

⁴ With the rise in oil prices, freight prices have increased. The October 2007 rate for shipments from the Gulf of Mexico to the European Union was \$75 per ton (FAO 2008b).

⁵ But there was a reversal of this trend, explained later in this section.

⁶ The situation worsened with the outbreak of the 2008 financial crises in the United States, which crippled major European economies.



international price of rice, admittedly a thin market, doubled in the 12 months to May 2008 to reach \$963 per ton before falling back to \$764 per ton in September (FAO 2008a). Commodity prices were driven up by increased demand from the People's Republic of China (PRC) and India, decreased supply due to a shift away from food crops in favor of biofuels, droughts in some producing countries, and increased cost of inputs such as fuel, fertilizer, and pesticide. Primary commodity prices are only a fraction of what the consumer spends on processed foods such as bread, but higher prices nonetheless encourage consumers to think about where their food is coming from. Indeed, some governments have voiced concerns about food security and the need to increase self-sufficiency. Taxes, and even bans, on rice and wheat exports encouraged this line of thought.

13.4 IMPACTS

For exporters, the food miles movement can seem a transparent attempt by producers in some European countries (UK, France, and Germany) and the United States to protect their local markets from foreign suppliers. Producers in importing countries certainly have an incentive to favor policies that support local consumption.

Assuming consumers are primarily concerned about distance, rather than favoring local products over imports, the exporters most adversely affected by the food miles movement would be those who are furthest from Europe and the United States and who supply a large share of their food exports to those countries. Many developing countries with agricultural industries focused on the export market would fall in this category, including those in Africa, South America, and Asia and the Pacific.⁷

Purchasing local goods also changes the location of pollution associated with production. Some pollutants, such as methane gas (produced by cattle and sheep), respect no boundaries, making the location of emissions irrelevant from a global perspective. However, others, such as nitrogen from manure that leaches into the soil on livestock farms, directly affect the place of production. Since countries vary in the

⁷ See Section 13.6 for a detailed review of New Zealand as a case study for remotely located countries affected by the food miles concept.



absorptive capacities of their local environments, minimizing food miles by moving the place of production will not necessarily lessen the overall environmental impact, and could, in fact, be more damaging, especially for the formerly importing country. Purchasing locally produced goods is effectively importing the associated pollution along with the beneficial effects. Whether these effects are trivial or significant depends on the nature of the industry. A problem arises because those bearing the costs of additional local pollution are not those who are purchasing the final goods. In the absence of sound environmental policies, purchasing locally produced goods may actually increase both local and global pollution.⁸

13.5 FLAWS IN THE FOOD MILES CONCEPT

There are several flaws in the arguments that imports should be decreased on the grounds of food miles.

First, increased energy use in the local production and storage of goods may more than offset the energy saved in transport if, for example, greenhouses are used to grow warm weather crops in cool climates. A lifecycle analysis is required to compare these costs. Such an analysis should also address the impact of other pollutants ignored by the food miles concept, that need to be factored into decision making. These include those generated in the production of agricultural inputs such as chemical fertilizers, and in the production process itself, such as methane.

Second, the mode and scale of transport are important determinants of the quantity of energy used. Sea transport has a relatively low environmental impact, followed by rail, road, and air transport. Scale problems in measuring distance traveled relate to the size of the vehicle. For example, 10 tons (t) of grain traveling 1,000 kilometers (km) in a 10 t truck uses less energy than 10 t of grain traveling the same distance in 20 half-ton trucks. This example illustrates that a better measure would be energy use per ton of product, rather than distance traveled per item.

⁸ See Vanzetti and Wynen (2002) for further discussion on the issue of reallocated pollution effects caused by the food miles concept.



Third, food miles emphasize the use of one input (distance in its simplest form, and energy use or carbon emissions in the more sophisticated version), but ignore others, such as labor and capital. The concept also ignores negative externalities related to those inputs, such as the chemicals used in the production process.

13.5.1 Total Lifecycle Analysis: Transport and Other Pollutants

Using distance traveled as the sole indicator of resource consumption (reflected in the price of goods) disregards use of resources (and costs) of production outside the transport sector. An obvious example of this is the use of (subsidized) gas in some northern European countries to heat greenhouses for producing tomatoes that could be grown in natural sunshine in Spain or Morocco. A UK study undertaken for DEFRA (2005) compares the energy use and emissions in growing tomatoes in the UK versus importing them from Spain. The trade-off in this case is between the additional gas used in the UK for heating, and the fuel used in road transport.⁹ The study concluded that food miles alone are not an adequate indicator of energy use or carbon emissions, or even of more general environmental impact.

Given that the global warming potential of methane (CH_4) and nitrous oxide (N_2O) is over 20 and 289 times higher, respectively, than that of carbon dioxide (CO_2), these environmentally damaging substances generated during the production of certain agricultural inputs (N_2O in fertilizer production) and the farm production process (CH_4 in cattle raising) should be considered in overall evaluation. Pollution levels may vary in different countries due to natural variations such as soil type or climate. A lifecycle analysis can quantify these variations and take the various environmentally damaging substances into account.

13.5.2 Mode and Scale of Transport

The food miles concept, at least in its simplest form of calculating distance, does not address the financial and environmental costs of different transport modes. Carbon emissions for sea transport are 15% of those for transport by road. Grams of carbon emitted per ton per

⁹ The DEFRA-funded study concluded that carbon emissions were 2,394 kg/ton for locally produced tomatoes and 630 kg/ton for imported ones (DEFRA 2005).



kilometer (g/t/km) are 15 for sea and 98 for road transport, respectively. Air transport, however, emits 570 g/t/km according to DEFRA estimates, a figure that is subject to some uncertainty depending on the size of the vehicle, container, or ship (DEFRA 2005). Road transport also has associated costs, including congestion, infrastructure, accidents, and noise. These are real, if difficult-to-calculate, costs that should be taken into account. Nonetheless, the argument here is that it is primarily the mode of transport, not the distance, that matters.

13.5.3 No Account of Nontransport Costs

The idea that a single variable can be used as a basis for decision making is obviously flawed. It is reminiscent of Ricardo's labor theory of value (1817), in which the price of a commodity reflects the hours of labor gone into its production. According to this theory, if it takes 1 hour to catch a rabbit and 2 hours to catch a deer, the deer should be valued at twice the price of a rabbit in the market. The problem here is that no consideration is given to (i) other inputs, such as the capital needed to catch the animals; and (ii) demand for the product, that is, the value of a deer or rabbit to consumers. For an appreciation of the total resource use from production to consumption, calculating carbon emissions (in terms of fuel cost and environmental damage) is not enough; other factors, such as the cost of capital, land, and labor, also need to be taken into consideration (Gillespie 2008). The labor theory of value went out of fashion in the 19th century, when it was recognized that prices are determined by demand-side as well as supply-side considerations. The carbon theory of value suffers similar limitations.

The share of transport costs in the total of resources used in the production, processing, and transport process is important in determining whether to purchase locally produced goods. Although transport is relatively energy-intensive, the contribution of energy costs to total costs is low if the share of transport to total costs is low. Other costs related to noncarbon inputs (such as those associated with the use of pesticides in agricultural production) should also be considered.

13.6 ILLUSTRATIVE CASE STUDIES

Do consumers minimize energy use by purchasing products according to distance traveled? This is essentially an empirical issue. In addition



to the production method, distance traveled, and mode of transport, the retail system (e.g., supermarket or farmers' market), transport method to home (e.g., walk, bike, or car; distance; also, was the outing a specific trip for food or was it combined food shopping and other activities?), and food preparation methods (e.g., raw or roasted) are also important in an analysis of energy use.

Interestingly, some product lifecycle studies found that the greatest energy use occurred when moving the produce from the retailer to the consumer. This was because consumers often drive an empty car to the shop, then drive home with some kilograms of groceries in a 1 t vehicle. The energy use per kilogram on the trip between the retailer and the consumer's home was found to be greater than the cumulative production and distribution costs to that point.

Saunders and Hayes (2007) summarized some recent studies looking at energy use and greenhouse gas emissions. In some of the studies cited, energy use and emissions were discussed in the transport phase only, but a few also included other phases of the supply chain, such as farm production, the packing and packaging system, storage, distribution to wholesalers and retailers, transport to home, and household use. Few included all these stages.

Most of the studies focused on local energy use and emissions for production within developed countries, with some comparisons done between local goods and production and transport of items imported from abroad. For example, Van Hauwermeiren et al. (2005), as reported in Saunders and Hayes (2007), compared emission levels from farm to retailer of tomatoes grown in Belgium for local consumption (both organic and conventional, grown outdoors; and conventional grown in greenhouses), imported from Spain by truck (conventional), and imported from Kenya by air (conventional and organic) (Table 13.1).

Two features of Table 13.1 are the high emissions for produce grown in a greenhouse (third entry for Belgium, column 3) and for airfreight (both entries for Kenya, column 4). Emissions for tomatoes grown in a greenhouse (1,459 g CO₂/kg) are far greater than the emissions for tomatoes produced by the open-air method (18.6 g CO₂/kg for conventionally grown tomatoes). Organically grown tomatoes (11.5 g CO₂/kg) produce fewer emissions during the growing process, and importing from Spain (307 g CO₂/kg) pollutes less than buying locally grown

**Table 13.1 Comparison of CO₂ Emissions in Tomato Production and Transport within the Supply Chain (g CO₂/kg)**

Location	Type	Distribution			
		Farm	to Wholesale or Retail	Retailer	Total
Belgium	Conventional	18.60	78.53	4.73	101.86
Belgium	Organic	11.49	78.53	4.73	94.75
Belgium	Conventional (greenhouse)	1,459.41	78.53	4.73	1,542.67
Spain	Conventional	18.60	283.53	4.73	306.86
Kenya	Conventional	18.60	8,509.68	4.73	8,533.01
Kenya	Organic	11.49	8,509.68	4.73	8,525.90

CO₂ = carbon dioxide, g = gram, kg = kilogram.

Source: Adapted from Van Hauwermeiren et al. (2005), as reported in Saunders and Hayes (2007).

greenhouse tomatoes (1,543 g CO₂/kg). However, airlifting tomatoes from Kenya (8,510 gCO₂/kg) creates considerably more pollution than growing them locally in greenhouses. The only way to justify buying greenhouse or airfreight tomatoes is if energy comprises a small share of total resource use (expressed in retail price). For example, a carbon tax of €20.00 (\$27.20)¹⁰ per ton would raise the cost of airfreighted Kenyan tomatoes by €0.17 per kilogram on tomatoes with a retail value of €3.00–€4.00 per kilogram.

In another study reviewed by Saunders and Hayes (2007), Jones (2006) described a similar situation for green beans grown in Kenya and airlifted to the UK. In his study, energy requirements for beans were similar at the two locations (0.82–1.38 megajoules per kg [MJ/kg] for production in the UK, and 0.69–1.72 MJ/kg in Kenya). With the same energy requirements for packaging at each location (3.92 MJ/kg), Jones calculated a total of 4.74–5.30 MJ/kg for beans produced and sold in the UK, and 62.51–63.54 MJ/kg for Kenya-grown beans exported to the UK. These figures, however, do not include storage costs. Examples of energy use (emissions) required to ship goods between two developed countries (including by sea), are given in Saunders, Barber, and Taylor (2006). They compared energy use (emission levels) in the production

¹⁰ Rate of the European Central Bank as of 3 December 2013: €1.00 = \$1.36



Table 13.2 Comparisons of Energy Use and Emission Levels in Various Industries

	Energy Use (MJ/t)		Ratio	Carbon Emissions (kg CO ₂ /t)		Ratio
	UK	New Zealand		UK	New Zealand	
			UK/New Zealand		UK/New Zealand	
Dairy	48,368	24,942	1.9	2,920.7	1,422.5	2.1
Apples	5,030	2,980	1.7	271.8	185.0	1.5
Onion	3,760	2,889	1.3	170.0	184.6	0.9
Lamb	45,859	10,618	4.3	2,849.1	688.0	4.1

CO₂ = carbon dioxide, MJ = megajoule, kg = kilogram, t = ton, UK = United Kingdom.

Note: New Zealand figures include transport from New Zealand to the nearest UK port.

Source: Adapted from Saunders, Barber, and Taylor (2006, Tables 7.1, 7.3, 7.4, and 7.5).

and transport of dairy products, apples, onions, and lamb from New Zealand to the UK (Table 13.2).

It is clear from the data in Table 13.2 that, when considering the total lifecycle of a product (in this case, production and transport from New Zealand to the UK, assuming similar costs for domestic transport and distribution within the UK), local consumption does not necessarily result in lower energy use or lower carbon emissions.

The ratios in Table 13.2 show that energy use (measured in MJ/t) and emission levels (measured in kg CO₂/t) for the production and transport of the four products can be considerably higher when production takes place in the UK than when it takes place in New Zealand. This is especially the case for lamb (with energy and CO₂ levels four times higher in the UK), although less so for onions. On the face of it, emission levels are higher for onions grown in New Zealand, but if energy used in storage during the months that onions are not produced in the UK were to be included, the UK energy use would be 30% higher than that in New Zealand. British consumers who wish to minimize energy use should be buying dairy products, apples, onions, and especially lamb from New Zealand, rather than from local producers. Other externalities, such as accidents and noise, should also be taken into account.

Some organic organizations have considered banning international trade in organic agriculture (by refusing the use of the logo of the dominant



certifier to the potential exporter). If this occurs, it is useful to examine how the importer and exporter are affected. Gibbon and Bolwig (2007) gave examples of the costs involved in exporting organic products to the UK from two African countries (Kenya and Ghana), if airfreight were to be banned by the Soil Association in the UK. A number of scenarios were examined. Outcomes depend on many factors, such as reactions to the ban from supermarkets in the UK; whether exporters and importers were wholly or partially dependent on organic produce; whether airlifted produce was for year-round supply, supplementing out-of-season produce, or to temporarily alleviate acute shortages in certain produce; and whether the enterprises examined in Kenya could revert to marketing of conventional produce after the ban, or whether they would need to close down.

If UK supermarkets accepted other certification schemes than the Soil Association's, the outcome was expected to be close to "business as usual," both in the UK and in Kenya. However, if supermarkets were to continue mainly or exclusively carrying products certified by the Soil Association, drastic changes could be expected in both countries. In the UK, changes would include the disappearance of virtually all airfreighted organic produce from supermarket shelves, losses in direct annual retail sales of £42.0 million, flow-on effects of another £4.9 million, and long-term effects of a similar scale.

For exporters in Kenya, the effects would also be drastic. A Soil Association ban on airfreight would affect two large fresh produce exporters, and at least three other operations certified as organic, although only the two large exporters are discussed here. For these two, organic produce comprises only a small part of their total operation: approximately 100 hectares (ha) certified organic, in addition to 25 ha under conversion, and 42 ha certified organic but without infrastructure. Exports are mainly bulk baby leaf salads and fine green beans.

If supermarkets ban the sale of airfreighted organic produce, both exporters said they would abandon organic production and go back to selling only conventional produce. This would result in a decrease in prices for their exports (loss of organic premiums). In the case of fine beans, these lower prices would be partly offset by an increase in productivity and a decrease in the number of workers needed for conventional management. In the case of baby leaf salads, the decrease in prices would not be offset by those same factors (reasons



not provided). Both exporters mentioned that, as their ability to supply both conventional and organic produce gave them increased bargaining power, it would be another area in which they would be affected.

A large part (60%) of the investment in infrastructure for organic farming (conversion period, certification, consultancies, and training) would be lost. Lack of cross-pollination of ideas from organic to conventional farming practices (i.e., adoption of some of the methods used in organic farming) was also seen as a potential loss. Losses suffered by contracted farmers would be even higher, as they would experience problems with rotations that would need to include different crops acceptable to local consumers.

Other effects of a ban on airfreighted exports would include those on farm employees (approximately 700), as half the workers at the two establishments would likely lose their jobs. This would particularly affect casual workers who, in Kenya, are often older women. Apart from loss of income, the workers would also lose benefits such as free lunches, medical care, and child care. An estimated six to eight people are dependent on a single worker's wages in Kenya, and, on average, for each worker employed, another half a person was further employed in support of the original worker's job. Knowledge about sustainable practices in organic agriculture could also be lost, such as knowledge about what to include in the rotations for soil and pest management, and about use of compost. In the words of one of the exporter-growers: "[It] would affect us technologically. It would be like going backwards. Organics is a business that has made us think outside the box. If conventional customers want us to move toward a residue-free product then the technical knowledge will have to come from organics" (Gibbon and Bolwig 2007).

Less direct, downstream effects were calculated, such as loss of sales within the community of local resources (e.g., straw and animal manure). These losses would have a significant impact on the local informal sector.

Of course, the loss of this sector in Kenya would create opportunities for countries closer to the market, such as northern Africa. However, this example serves to show that a ban based on distance or mode of transport may have unintended consequences.

Product-based studies do not capture the interactions between sectors and countries. A paper by Ballingall and Winchester (2008) looks at the



impact on importing and exporting countries of a shift in preferences in the UK, France, and Germany away from New Zealand and toward purchasing produce that has traveled shorter distances. The authors used a general equilibrium model, where imports are differentiated by country of origin, making New Zealand lamb a unique product, not only in relation to domestic (e.g., UK) lamb, but also in relation to lamb from competing countries, such as Australia. Ballingall and Winchester's paper incorporates a measure of distance traveled into consumer preferences. This enabled the authors to show the likely impact of changing preferences on trade flows.

In importing countries where preferences have shifted in response to the concept of food miles, domestic producers would benefit from higher domestic prices, but the overall economy would be worse off because consumers would be limited in their source of supply. Exporting countries (e.g., New Zealand) would be worse off as a result of lower export prices, while importing countries (e.g., Japan) that do not have a preference for locally produced goods, would benefit from the lower prices and increased supply of New Zealand lamb.

Empirical estimates indicate that the major negative impacts of a preference shift would be on poor, agriculture-dependent exporting countries, such as Malawi, which exports a high percentage of their production to Europe.¹¹ Countries located further away, such as South Africa, may be less affected as it has fewer exports to Europe. New Zealand could lose \$135 million (less than 1% of its gross domestic product) if 80% of European consumers switched to homegrown products. A region that would benefit from a preference shift in Europe is Southeast Asia because exports that had gone to Europe in the past would be diverted elsewhere, such as to Japan and the Republic of Korea, lowering import prices in the region. However, it is possible that individual countries and specific sectors within Southeast Asia would be worse off following an effective European food miles campaign. The general equilibrium framework highlights the gains and losses that flow from a shift in preferences.

¹¹ The preference shift is modeled as an 80% loss in New Zealand exports, and lower losses for other countries depending on distance from market. This is the so-called "iceberg" specification, where the good "melts" with distance (see Hertel, McDougall, and Itakura 2001 for a description of this specification). In the model, any increase in satisfaction consumers may enjoy from knowing they are contributing to improving the environment is not taken into account.



13.7 A BETTER APPROACH

It is reasonable to expect producers and supporters to encourage the consumption of locally produced goods, even under the pretext of improving the environment or achieving social objectives. On the demand side, the food miles idea is a concept driven by private groups, such as environmental organizations and consumers, rather than by governments. Consumers should be aware, however, that buying locally produced goods may have detrimental effects on local and global environments (*The Observer* 2008).

What can governments do? They could provide consumers and producers with objective information, which includes not only energy use and transport emissions, but also the direct and indirect effects of encouraging consumption of locally produced food. More comprehensive information should include other inputs such as labor and capital used in the production process and total environmental impact (i.e., a lifecycle approach), alternative uses of these inputs, and how they are reflected in the price of goods. Increased scarcity should be indicated by higher prices. Importing of goods would then occur when exporting countries could deliver goods for a lower price due to a comparative advantage (Vanzetti and Wynen 2002).

To the extent that some inputs (e.g., fuel) are underpriced, or that some emissions are not taken into account, appropriate policies should be to price these factors accordingly. Taxes could be levied on energy to combat waste or on road use if congestion, noise, or accidents are an issue. One pertinent example is the tax treatment of aviation fuel which could internalize these environmental effects. However, currently, there is no tax on aviation fuel in Europe and in some countries, as agreed in the 1944 Chicago Convention, resulting in aviation not being on equal footing with other transport services (European Commission 2008). Imposing a fuel tax in the airline industry would contravene existing international agreements and have adverse competitive effects; such inconsistencies do not represent sound policy.

Imposing a fuel tax to compensate for negative externalities, or developing a market for carbon credits, would increase the prices of goods produced with relatively high carbon emissions. Although fuel taxes, carbon credits, food miles, and lifecycle analysis all send the same message to the consumer—that is, that carbon emissions are undesirable—the last two (food miles and lifecycle analysis) rely on



the voluntary actions of consumers. With taxes or a carbon market, all consumers are involved as the message is conveyed via the market in which everybody is involved.

13.8 IMPLICATIONS AND CONCLUSIONS

The generally accepted concept of food miles, while simple to grasp, is flawed because it focuses primarily or exclusively on distance traveled. Even the more sophisticated version, which takes into account energy use and harmful emissions produced during transport, is misleading because reductions in these two factors may be offset by increased energy use and emissions in local production. A lifecycle analysis may address this problem, but still does not incorporate primary inputs such as labor, capital, and other intermediate inputs such as fuel and fertilizer with their polluting effects. Rather than restricting travel, a better approach would be to price all environmentally damaging inputs appropriately and promote alternatives that are less polluting.

Where airfreight is concerned, the evidence suggests that airfreighted goods may indeed use more energy in production and distribution, although this was not found to be the case with luxury items such as cut flowers, a case in point are the roses imported from Kenya for the cities in the Netherlands (William 2007). However, in other forms of transport (such as shipping), energy use for imports is not necessarily higher than for locally produced goods.

In addition, there is no sound rationale for banning the movement of goods on the basis of energy costs alone—including for environmental damage. Consumers are willing to pay the costs of imported goods because the transport costs are a relatively small share of the total costs. By banning imports (e.g., by denying organic certification to all airfreighted produce) or by espousing consumption of local goods, not only are importing countries reducing the options available to domestic consumers and hurting foreign producers to benefit local producers, but this practice may also actually increase pollution. Furthermore, they may effectively be importing pollution that could be better assimilated in less populated regions.



REFERENCES

- Ballingall, J., and N. Winchester. 2008. Miles and More: A Quantitative Assessment of the “Food Miles” Movement. Paper presented at the 11th Annual Conference on Global Economic Analysis, Helsinki, 12–14 June. https://www.gtap.agecon.purdue.edu/resources/res_display.asp?RecordID=2765
- Bureau of Transportation Statistics, United States Department of Transportation. 2008. *Energy Intensity of Class I Railroad Freight Service*. Table 4-25. http://www.bts.gov/publications/national_transportation_statistics/2007/html/table_04_25.html
- Department for Environment, Food and Rural Affairs of the United Kingdom (DEFRA). 2005. *The Validity of Food Miles as an Indicator of Sustainable Development: Final Report*. London: DEFRA. <http://statistics.defra.gov.uk/esg/reports/foodmiles/final.pdf>
- The Economist*. 2008. Tightening Belts. 18 April. http://www.economist.com/business/displaystory.cfm?story_id=11021146
- European Commission. 2008. *Taxation of Aircraft Fuel*. http://ec.europa.eu/taxation_customs/taxation/excise_duties/energy_products/aircraft_fuel/index_en.htm
- FAO (Food and Agriculture Organization of the United Nations). 2008a. *The FAO Rice Price Update – October 2008*. http://www.fao.org/es/esc/en/15/70/highlight_533.html
- . 2008b. *Food Outlook*. May. <http://www.fao.org/docrep/010/ai466e/ai466e14.htm#328>
- Gibbon, P., and S. Bolwig. 2007. The Economic Impact of a Ban on Imports of Air Freighted Organic Products. Paper presented to the UK. October. Geneva: International Trade Centre.
- Gillespie, R. 2008. Economics of Global Warming. Paper presented at the 52nd AARES Annual Conference, Canberra, 6–8 February 2007.



- Hertel, T., R. McDougall, and K. Itakura. 2001. *GTAP Model Version 6.0*. https://www.gtap.agecon.purdue.edu/resources/res_display.asp?RecordID=576
- Jones, A. 2006. *A Lifecycle Analysis of UK Supermarket Imported Green Beans from Kenya*. Fresh Insights No. 4. London, UK: International Institute for Environment and Development.
- The Observer*. 2008. How the Myth of Food Miles Hurts the Planet. 23 March. <http://www.guardian.co.uk/environment/2008/mar/23/food.ethicalliving>
- Ricardo, D. 1817. On the Principles of Political Economy and Taxation. McMaster University Archive for the History of Economic Thought. <http://socserv.mcmaster.ca/econ/ugcm/3ll3/ricardo/Principles.pdf>
- Rubin, J., and B. Tal. 2008. *Will Soaring Transport Costs Reverse Globalization?* *StrategEcon*. 27 May. <http://yaleglobal.yale.edu/about/pdfs/oil.pdf>
- SAFE Alliance. 1994. *The Food Miles Report: The Dangers of Long Distance Food Transport*. <http://www.sustainweb.org/page.php?id=549>
- Saunders, C., A. Barber, and G. Taylor. 2006. *Food Miles – Comparative Energy/Emissions Performance of New Zealand’s Agriculture Industry*. AERU Research Report 286.
- Saunders, C., and P. Hayes. 2007. *Air Freight Transport of Fresh Fruit and Vegetables*. Paper commissioned and published by the International Trade Centre. Geneva.
- Soil Association. 2008. *Ensuring Limited Organic Air Freight Is Fair and Ethical*. Press release. 6 March. <http://www.soilassociation.org/web/sa/saweb.nsf/89d058cc4dbeb16d80256a73005a2866/4cd8ffaf33bced18025740400535855?OpenDocument>
- Van Hauwermeiren, A., G. Coene, C. Claes, and E. Mathijs. 2005. Energy Lifecycle Inputs in Food Systems: A Comparison of Local versus Mainstream Cases. *Journal of Environmental Policy and Planning*. 9 (1). pp. 31–51.



- Vanzetti, D., and E. Wynen. 2002. *Does It Make Sense to Buy Locally Produced Organic Produce?* In D. Hall, ed. *Economics of Pesticides, Sustainable Food Production and Organic Food Markets*. Amsterdam: Elsevier. <http://www.elspl.com.au/OrgAg/Pubs/Pub-B-MktgTrade/OA-Mktg-B9-Hall-2002.htm>
- William, A. 2007. *Comparative Study of Cut Roses for the British Market Produced in Kenya and the Netherlands*. Bedford: Cranfield University. http://www.fairflowers.de/fileadmin/flp.de/Redaktion/Dokumente/Studien/Comparative_Study_of_Cut_Roses_Feb_2007.pdf
- Warwick Commission. 2007. *The Multilateral Trade Regime: Which Way Forward?* Coventry: The University of Warwick. http://www2.warwick.ac.uk/research/warwickcommission/report/uw_warcomm_tradereport_07.pdf
- WTO (World Trade Organization), ITC (International Trade Centre), and UNCTAD. 2007. *World Tariff Profiles 2006*. Geneva: WTO. http://www.wto.org/english/tratop_e/tariffs_e/tariff_profiles_2006_e/tariff_profiles_2006_e.pdf
- WTO. 2012. *International Trade Statistics*. Geneva. http://www.wto.org/english/res_e/statis_e/its2012_e/its2012_e.pdf



Chapter 14 | **The Myth of Declining Yields under Organic Agriculture**

Sununtar Setboonsarng

14.1 INTRODUCTION

Agricultural development in recent decades has been dominated by the Green Revolution model of intensive chemical use, extensive irrigation, and high-yielding monoculture. Although the Green Revolution has increased productivity in many developing countries, the gains have come at the expense of environmental degradation and health problems from exposure to agrochemicals. In addition, as greater attention is paid to climate change and energy scarcity, there is an increasingly urgent need to reduce energy use and greenhouse gas emissions of the current food production system.

The realization that the future will require more sustainable methods of food production has given rise to growing interest in alternative agricultural systems. Among them, organic agriculture stands out and has gained popularity among consumers in the last decade. There is now convincing anecdotal and empirical evidence showing that farmers can avoid the health costs associated with agrochemical use while moving toward environmentally sustainable practices by adopting organic agriculture, as shown in earlier chapters of this volume.

However, despite evidence of its potential environmental, health, and economic benefits, the mainstream view of organic agriculture is that it produces low yields insufficient to meet the global demand for food. Critics of organic agriculture contend that intensive methods are necessary to feed the growing world population and suggest that large-scale adoption of organic agriculture would increase world hunger and food insecurity (Vasilikiotis 2000). They further claim that widespread conversion to organic methods will lead to the loss of biodiversity as



ecosystems are converted to cropland to compensate for lower yields under organic agriculture (Soil Association and Sustain 2001).

This perception of low yields in organic systems arises from the fact that most studies on comparative yields are carried out on farming systems in temperate zones of developed countries. In tropical ecosystems, however, there is growing evidence that organic yields are often much higher than in conventional agriculture, which this chapter aims to substantiate empirically.

14.2 GREEN REVOLUTION

In the past 6 decades, the introduction of the Green Revolution in agriculture accelerated productivity by combining high-yielding seed varieties¹ with heavy application of fertilizer and pesticide, and controlled irrigation. This approach aims primarily at increasing productivity while ignoring the complex interaction between agricultural practices, natural resource systems (soil, water, biodiversity), and social implications for communities. Under these production systems, environmental and health costs have been ignored in calculations of profit and productivity.

While there is no doubt that the Green Revolution has eliminated starvation in many countries and raised yields at the national level, most farmers have not experienced dramatic gains in productivity (Hazell 2009).

First, agriculture in developing countries is typically low-intensity, especially in impoverished or resource-poor areas where farmers do not have access to modern inputs (Scialabba and Hattam 2002). Small farmers who cannot afford the modern inputs of the Green Revolution would be unable to compete with conventional farmers as agricultural prices dropped (FAO 2000).

Second, while intensive methods have increased yields in irrigated and agriculturally optimal areas, they have been largely ineffective in marginal or degraded areas. Marginal areas are characterized by poor soil fertility and inadequate access to water, and include the mountainous areas, forest margins, and semi-arid and rainfed areas where the majority of the rural

¹ Includes genetically modified seeds.



poor live (Zakri 2003). As Green Revolution technologies were developed on only a few varieties of major cereals, the use of agrochemicals on the local varieties that are adapted to marginal conditions is often ineffective and unprofitable (FAO 2000). In addition, while high-yielding varieties require adequate irrigation in order to produce high yields. As much as 93% of farmed land is rainfed in sub-Saharan Africa, 87% in Latin America, and 65% in East Asia. Most countries depend on rainfed agriculture for their grain production (FAO 2002).

Finally, many of the areas that increased yields through Green Revolution technologies in recent decades are now experiencing stagnating or even decreasing yields due to soil degradation, diminishing water resources, and growing pesticide-resistant pest populations (Rundgren 2002). Over time, as nutrients are consumed and the soil becomes degraded, ever increasing amounts of fertilizer are needed to increase or maintain yield levels. In addition, monocultures are more vulnerable to pests and disease, and require greater application of pesticides over time as pests develop resistance. As a result of the increasing cost of agrochemical inputs required to maintain productivity, many farmers have converted to low input and organic agriculture (IFAD 2005).

Although high-input, intensive agriculture will remain the dominant food production system in irrigated and agriculturally optimal areas, several studies have shown that organic agriculture has the greatest potential to increase yields in the marginal and degraded areas where the majority of the world's poor farmers reside.

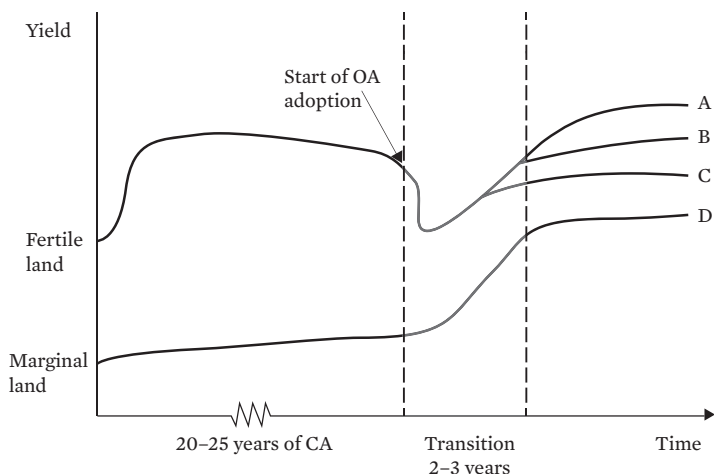
14.3 ORGANIC AGRICULTURE AND YIELDS

A survey of recent studies comparing the productivity of conventional and organic practices suggests that the impact of organic agriculture on yields depends largely on the agricultural system prior to adopting organic agriculture (IFAD 2005, 2003). Figure 14.1 illustrates the distinct yield trends following the conversion to organic agriculture from intensive and traditional systems.²

² It is important to note that such yield comparisons may be misleading. Although single crop yields may be lower under organic production, the total output per area under organic agriculture is often far higher than conventional monoculture. Organic farms are often composed of a dozen or more crops or animal products, while a monoculture is designed to produce high yields of a single crop while producing nothing else of value to the farm household (ISP 2003; IFAD 2005).



Figure 14.1 Yield Levels during Transition to Organic Agriculture



CA = conventional agriculture, OA = organic agriculture.

Note: The letters A, B, and C denote levels of possible yields after the transition period of conversion from CA to OA with A being the highest level. D represents the possible yield level after the transition period on marginal land.

Source: Author's illustration.

Farmers practicing intensive methods in agriculturally optimal or irrigated areas often experience a sharp decline in yields in the first year of organic production, as a transition period is usually required to reverse the damage caused by conventional farming (ISP 2003). After 2 or 3 years, as soil fertility is restored and pests are controlled with balance of the ecosystem improved, yields typically stabilize at levels that surpass (Figure 14.1, Line A), equal (Line B), or trail (Line C) conventional yields. The farmers' level of understanding and adherence to organic methods appear to be major factors behind these differences (IFAD 2005). Yields of marginal lands (Line D) can increase significantly.

For example, IFAD (2005) reported yield losses ranging from 21% in rice and 27% in sugarcane to 31% in banana during the first year of conversion to organic agriculture among conventional farmers in Karnataka, India. Following the 3-year transition period, yields stabilized and were consistently higher than conventional yields. In the case of banana, yields under organic agriculture exceeded the highest yield previously recorded under conventional management. In addition,



during the 2001–2002 drought, organic rice and sugarcane farmers saw significantly smaller losses than conventional farmers.

The Independent Science Panel (2003) found posttransition yield gains of 5%–10% for irrigated crops in 89 projects across Asia, Latin America, and Africa, while the Farming Systems Trial at the Rodale Institute showed comparable long-term yields between organic and conventional maize and soybeans, although organic yields were again significantly higher during years of drought (Vasilikiotis 2000). In Yunnan Province, People’s Republic of China (PRC), conventional rice farmers nearly doubled their yield by adopting organic methods, including intercropping, which controlled rice blast that had been unresponsive to agrochemicals (IFAD 2005; Soil Association and Sustain 2001).

In marginal, rainfed areas and on degraded land, farmers often achieve a significant increase in yields when converting to organic agriculture (Figure 14.1, Line D). As noted, traditional production by small farmers in marginal areas typically mirrors organic production, relying on labor rather than chemical inputs (IFAD 2003). Unlike intensive systems, traditional systems experience immediate gains in productivity during the transition to organic agriculture as organic methods improve soil fertility and reduce losses from pests and diseases.

Long-term research shows the potential of organic agriculture to dramatically increase yields on land with low productivity potential. For example, Cornell University’s International Institute for Food, Agriculture and Development observed increases in rice yields ranging from 50% in the PRC to 700% elsewhere (IFAD 2005). In Wardha, India, farmers were able to even triple their yields through organic management (FAO 1998), while the ISP (2003) reported average yield increases of 50%–100% for rainfed crops in its global case studies. Although these gains are due to very low initial yields, these studies suggest that increased yields under organic agriculture are more immediate and more significant on marginal or degraded lands.

14.4 CASE STUDIES ON CERTIFIED ORGANIC AGRICULTURE

The first case study looks at the impact of organic agriculture adoption on rice yields in marginal and chemically degraded areas in north and northeast Thailand. The second case study uses household recall data



from northeast Thailand to examine organic yields over time. The final case study compares the yields of organic and conventional tea gardens in degraded lands in Sri Lanka.

14.4.1 North and Northeast Thailand

The data used were from a 2003 household survey conducted in five provinces in the north (Phayao and Chiang Rai) and northeast (Ubon Ratchathani, Surin, and Yasothon) of Thailand.³ A total of 445 farmers were surveyed, including 168 in the north and 277 in the northeast. Approximately equal numbers of organic and conventional farmers were surveyed in each region. The sampled organic farms in northeast Thailand previously practiced high-input conventional agriculture until contract farming of organic rice was introduced by religious groups and nongovernment organizations (NGOs). In contrast, contract farming of organic rice in the north was initiated by private sector firms in marginal forest areas where agrochemicals had not been previously applied.

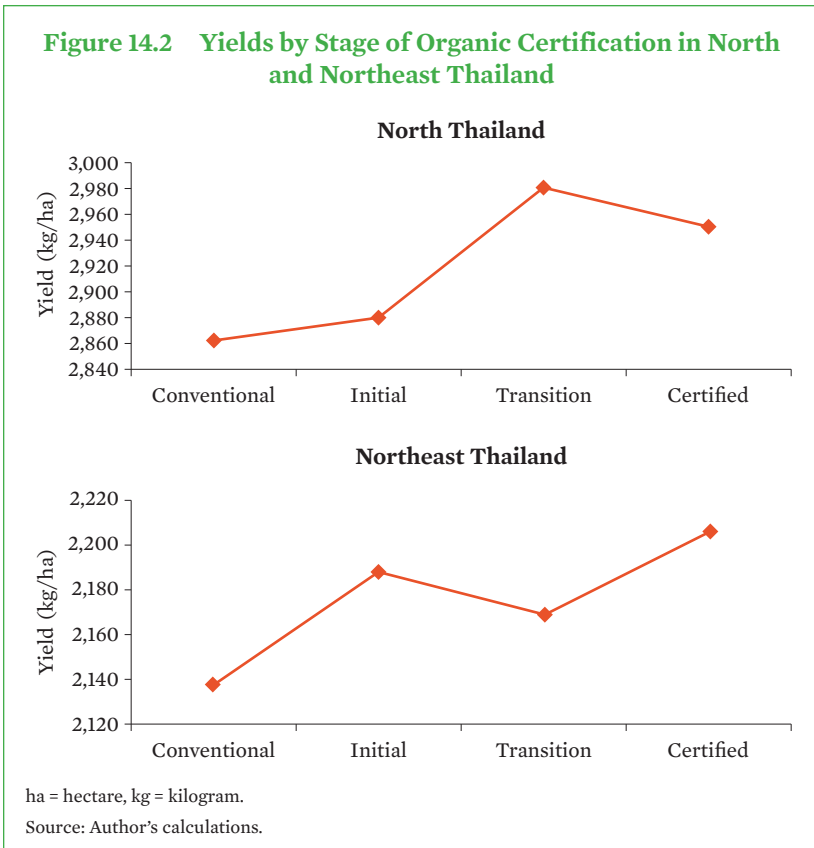
The organic farms are categorized into three groups according to their organic farming experience and the restrictions on farming practices. Farmers in the “certified” group have at least 4 years of experience in organic farming and completely avoided the use of chemical fertilizer, pesticides, and herbicides. The “transitional” organic farms are under transition to certified organic agriculture and typically have between 2 and 4 years of experience in organic agriculture, while the “initial” farms are the most recent adopters of organic agriculture, with less than 2 years of experience. The farmers in the “transitional” or “initial” organic groups should in principle stop using chemical fertilizer, pesticides, and herbicides, although due to an ineffective inspection system, some likely continue to use agrochemicals.

The yield results are presented in Figure 14.2. In the northeast where farmers converted from conventional farming on degraded land, average yields were significantly lower than in the north, where organic farming production was introduced on newly opened, marginal land. However, it is interesting to note that the two regions exhibited similar yield trends. Conventional farmers had average yields of 2,863 kilograms per hectare (kg/ha) in the north and 2,138 kg/ha in the northeast. Despite converting from intensive production, it appears that farmers in the northeast did

³ A detailed study of this case can be found in Setboonsarng, Leung, and Cai (2006).



Figure 14.2 Yields by Stage of Organic Certification in North and Northeast Thailand



not experience a decline in yields after adopting organic practices, as the initial and transitional organic farmers had similar yields. In the north, the initial and transitional groups had slightly higher yields than conventional farmers, suggesting that yields on marginal land do not decline and may, in fact, rise during the transition period. In both regions, the certified group had comparatively higher yields, averaging 2,950 kg/ha in the north and 2,206 kg/ha in the northeast. Farmers are still adapting to the processes involved in the certification process which can reduce efficiency resulting in some reduction in yields.

14.4.2 Northeast Thailand

The second case study uses data from a 2004 survey in Yasothon, Surin, and Mahasarakam provinces in northeast Thailand. The survey area is



characterized by low soil fertility and insufficient access to water. As noted, agricultural productivity in the northeast is significantly lower than in other regions, one result being that the northeast region is Thailand's poorest and is a major source of migration to Bangkok and other urban centers. The survey covered 52 organic and 41 conventional farmers with varying levels of farming experience. The conventional farmers were asked to recall their previous annual rice yields, while the organic farmers were asked to recall their previous annual rice yields under organic production only, since some farmers have both conventional plots and organic plots. The recall period for both groups was up to 10 years (1995–2004).

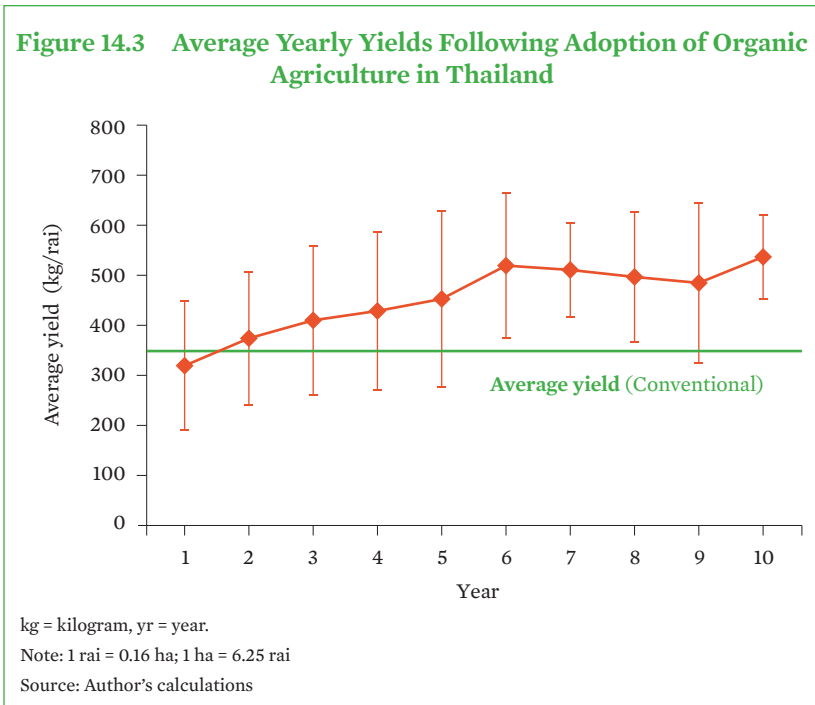
For the purpose of this study, conventional yields were averaged to show the average conventional yield during the 10-year period. The recalled organic yields were then grouped and averaged according to the farmers' experience level in organic agriculture. Therefore, "year 1" represents the first annual yield after converting to organic agriculture; "year 2" represents the second annual yield after conversion; and so on up to "year 10." As a rough indicator, "year 1" through "year 3" corresponds to the transition period, while "year 4" and beyond represent certified organic agriculture.

The results are presented in Figure 14.3, which illustrates a clear upward trend in yield following conversion to organic agriculture. The average conventional yield over the 10-year period was 350 kg/rai (2,188 kg/ha). Although the average yield of organic farmers in the first year after adopting organic practices was slightly lower than the conventional average, yields rose dramatically in succeeding years. The average yield of farmers in the second year of organic agriculture was 362 kg/rai (2,262 kg/ha), while the average fourth year yield was 417 kg/rai (2,606 kg/ha), an increase of 15%. In fact, yields increased steadily until year 6 (523 kg/rai or 3,270 kg/ha), at which point yields appear to stabilize at a high level.

Although long-term research should be conducted to determine if high yields can be maintained under organic production, especially when allowing for climate change factors that may affect rice yield, the findings of this case study are strong evidence that organic agriculture can lead to immediate and dramatic increases in yield in marginal and rainfed areas.



Figure 14.3 Average Yearly Yields Following Adoption of Organic Agriculture in Thailand



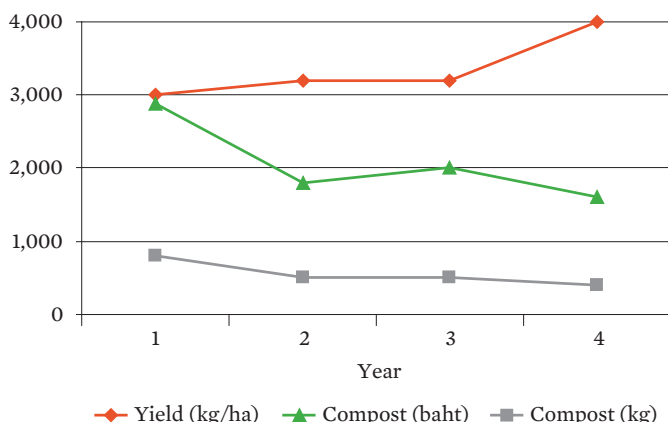
The yield and compost use of an organic farm during the first 4 years of organic practice are presented in Figure 14.4. As nitrogen is a limiting factor in an organic system, the initial low yield in the first year (3,000 kg/ha) is due partly to the inadequate availability of nitrogen in the soil. Although the soil likely contains sufficient total nitrogen, it is not yet in usable form. High inputs of organic fertilizer such as compost are required to build organic matter in the soil, especially in the first year (800 kg). The yield remains relatively stable during the first 3 years, as time is required for soil microbial activity to stabilize. In the fourth year, the level of soil organic matter stabilizes and the yield rises sharply (4,000 kg/ha), and lower input of compost is required (400 kg/ha).

14.5 CONCLUSION

One of the main criticisms of organic agriculture has been that an organic system produces lower yields than conventional, agrochemical-intensive production system. Yet, recent studies from around the world have shown that organic agriculture can produce yields comparable to



Figure 14.4 Yield and Compost Use of an Organic Farm in Northeast Thailand



ha = hectare, kg = kilogram.

Source: Author's calculations.

conventional agriculture, especially in marginal areas where the majority of impoverished farmers in developing countries reside. The findings of this chapter provide further evidence that in marginal, rainfed regions, yields in an organic system do not necessarily decline and in some cases are significantly higher than under a conventional production system.

This study compared yields in three cases of certified organic agriculture. Two cases of certified organic agriculture in northeast Thailand provide compelling evidence that the adoption of organic practices can lead to immediate and dramatic increases in yield. On marginal, rainfed land, organic rice farmers experienced a rise in yields without a decline during the transition period. In one case, yields increased steadily for 5 years before stabilizing at levels significantly higher than conventional farms.

On chemically degraded land in Sri Lanka, average organic tea yields were considerably lower than conventional yields, although individual growers were able to raise their yields to conventional levels after 4 years. On severely degraded land, therefore, it appears that a transition period is necessary before yields rebound to conventional levels. During this transition period, it is critical that farmers have access to organic inputs and receive training in organic methods.



In all cases, the most important factors determining the level of organic yields appear to be the farmers' level of understanding and adherence to organic methods, and the availability of organic inputs, particularly organic fertilizer and compost. Just as hybrid seeds, agrochemicals, and irrigation were necessary for the Green Revolution, organic fertilizer, organic pesticides, and high-quality seeds are necessary for successful adoption of organic agriculture. To obtain high yields under organic production, NGOs and firms that seek to promote organic agriculture among poor farmers in marginal areas should ensure that farmers have access to organic inputs and training.

REFERENCES

- FAO (Food and Agriculture Organization of the United Nations). 1998. Evaluating the Potential Contribution of Organic Agriculture to Sustainability Goals. IFOAM Scientific Conference in Mar del Plata, Argentina, 16–19 November.
- . 2000. *The State of Food and Agriculture*. Rome.
- . 2002. *The State of Food and Agriculture*. Rome.
- Hazell, P.B.R. 2009. The Asian Green Revolution. IFPRI Discussion Paper. Washington, DC: International Food Policy Research Institute.
- IFAD (International Fund for Agricultural Development). 2003. *The Adoption of Organic Agriculture among Small Farmers in Latin America and the Caribbean: Thematic Evaluation*. Rome.
- . 2005. *Organic Agriculture and Poverty Reduction in Asia: [the People's Republic of] China and India Focus*. Rome.
- ISP (Independent Science Panel) 2003. *The Case for a GM-Free Sustainable World*. Institute of Science in Society and the Third World Network. <http://www.indsp.org/A%20GM-Free%20Sustainable%20World.pdf>



- Rundgren, G.. 2002. Organic Agriculture and Food Security Dossier I. Approved by the IFOAM World Board. http://www.grolink.se/Resources/studies/117_Dossier_1_OA_and_Foodsecurity-1.pdf
- Scialabba, N., and C. Hattam, eds. 2002. *Organic Agriculture, Environment and Food Security*. Rome: FAO.
- Setboonsarng, S., P.S. Leung, and J. Cai. 2006. *Contract Farming and Poverty Reduction: The Case of Organic Rice Contract Farming in Thailand*. In J. Weiss and H.A. Khan, eds. *Poverty Strategies in Asia*. Cheltenham, UK: Edward Elgar. pp. 266–299.
- Soil Association and Sustain. 2001. *Myth and Reality. Organic vs Nonorganic: The Facts*. Bristol and London.
- Vasilikiotis, C. 2000. *Can Organic Farming “Feed the World”?* http://nature.berkeley.edu/~christos/espm118/articles/organic_feed_world.pdf.
- Zakri, A.H. 2003. Prospects of Agricultural Biotechnology for Marginal Areas. Paper presented at the International Symposium Alternative Approaches to Enhancing Small-Scale Livelihoods and Natural Resources Management in Marginal Areas – Experience in Monsoon Asia at the Institute of Advanced Studies, United Nations University, Tokyo, Japan, 29–30 October.

Organic Agriculture and Post-2015 Development Goals

Building on the Comparative Advantage of Poor Farmers

This compendium is released on the target year of the Millennium Development Goals (MDGs). While there has been remarkable progress on the MDGs, such as halving the population in extreme poverty 5 years ahead of schedule, much is still to be done to ensure meaningful change beyond 2015. Through this publication, a comprehensive assessment of organic agriculture reveals overarching themes of comparable yields with conventional farming which has significantly improved incomes, better health for farmers through chemical-free farming, and climate change mitigation and adaptation, building sustainable and resilient food production systems. Compelling empirical outcomes in the chapters as reported by the practitioners themselves show organic agriculture's significant contributions to the achievement of the MDGs which are expected to continue beyond 2015. This brings inclusive agricultural development to rural communities, particularly marginal farmers, making them part of the solution to the achievement of sustainable development goals in the post-MDG era.

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