Chapter 6 | Organic Crops or Energy Crops? Options for Rural Development in Cambodia and the Lao People's Democratic Republic[1]

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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 Oceania[3] 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

Ethanol			Biodiesel		
Country	Billion gallons	Share (%)	Country	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 Paolo 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 (kg CO_2eq/MJ) if there was no land conversion involved, and 0.143 kg CO_2eq/MJ if there was. By contrast, conventional low sulfur fuel generates 0.091 kg CO_2eq/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 2000b).

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 Paolo 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**
• 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	• 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	• 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 (CEDAC[10]) 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

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[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, Mondulkiri, 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, CO_2 = 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 CO_2 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 rice[22] 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.

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