

Markandya, Anil; Setboonsarng, Sununtar; Hui, Qiao Yu; Songkranok, Rachanee;  
Stefan, Adam

## Working Paper

# The costs of achieving the millennium development goals through adopting organic agriculture

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## **ADB Working Paper Series**

### **The Costs of Achieving the Millennium Development Goals through Adopting Organic Agriculture**

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Anil Markandya,  
Sununtar Setboonsarng,  
Qiao Yu Hui,  
Rachanee Songkranok, and  
Adam Stefan

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Anil Markandya is with the University of Bath in the United Kingdom and the Basque Centre for Climate Change in Spain. Sununtar Setboonsarng is with the Asian Development Bank in Manila. Qiao Yu Hui is at the Agro-ecology Research Institute, College of Resources and Environment China Agricultural University in Beijing. Rachanee Songkranok is in the Office of Agriculture Economics at the Ministry of Agriculture and Agriculture Cooperatives, Thailand. Adam Stefan is a former research associate at the Asian Development Bank Institute in Tokyo.

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Asian Development Bank Institute  
Kasumigaseki Building 8F  
3-2-5 Kasumigaseki, Chiyoda-ku  
Tokyo 100-6008, Japan

Tel: +81-3-3593-5500  
Fax: +81-3-3593-5571  
URL: [www.adbi.org](http://www.adbi.org)  
E-mail: [info@adbi.org](mailto:info@adbi.org)

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**Abstract**

This paper provides estimates of the costs of organic agriculture (OA) programs, and sets them in the context of the costs of attaining the United Nations' Millennium Development Goals (MDGs). It analyzes the costs of OA programs in four case studies: Wanzai, PRC; Wuyuan, PRC; Kandy, Sri Lanka; and Ubon Ratchathani, Thailand. The results show considerable variation across the case studies, suggesting that there is no clear structure to the costs of adopting OA. Costs do depend on the efficiency with which the OA adoption programs are run. The lowest cost programs were more than ten times less expensive than the highest cost ones. A further analysis of the gains resulting from OA adoption reveals that the costs per person taken out of poverty was much lower than the World Bank's estimates, based on income growth in general or based on the detailed costs of meeting some of the more quantifiable MDGs (e.g., education, health, and environment).

**JEL Classification: Q01, Q18, Q56**

## Contents

1.	Introduction.....	1
2.	The MDGs and the Costs of Attaining Them.....	1
3.	Costs of OA Programs: Conceptual Issues.....	4
4.	Costs of Actual OA Programs in PRC, Thailand, and Sri Lanka.....	6
	4.1 PRC Case Studies.....	6
	4.2 Sri Lanka Case Studies.....	8
	4.3 Case Studies in Thailand.....	11
5.	Evaluating the Cost Effectiveness of Adopting OA in PRC, Thailand, and Sri Lanka.....	13
6.	Conclusions.....	16
	Appendix 1: Millennium Development Goal 8.....	18
	Appendix 2: Targets and Indicators for the Millennium Development Goals.....	19
	Appendix 3: Estimating the Cost per Household Taken Out of Poverty by OA.....	20
	References:.....	21

## 1. INTRODUCTION

This paper looks at the costs of achieving improvements in farmers' lives through the adoption of organic agriculture (OA). Specifically we estimate the public and private costs that are incurred and evaluate whether or not they represent good value when compared to the gains in terms of individual incomes and other benefits as defined in the Millennium Development Goals (MDGs). Other studies have found that while there are strong links between OA and the MDGs (Setboonsarng and Markandya 2009), these can be complex and not always quantifiable. Hence the comparison of the costs of adopting OA with the benefits has to be in part a qualitative exercise, but it is one that still needs to be carried out. This paper is a contribution to that comparison.

This paper is part of a series of papers on organic agriculture and the MDGs published by the Asian Development Bank Institute. Section II describes the MDGs and reports what public expenditures are foreseen as necessary to achieve these goals world-wide. These expenditures are also reported in terms of the cost per person: who benefits with regards to poverty reduction, education levels, child mortality reduction, etc. As far as we are aware, this is the first time such estimates have been made for a range of MDGs. They provide the background against which benefits from the OA programs can be assessed. Section III discusses the items of cost that arise in implementing OA. Different types of costs have different implications for policy purposes; for example, costs undertaken by the farmers themselves are netted out of the benefits and only the net benefit figure is looked at when measuring gains. On the other hand, public expenditures require access to external funds and have to be evaluated in terms of 'value for money'. Section IV reports the estimate costs of the programs in case studies undertaken in the People's Republic of China (PRC), Sri Lanka and Thailand. It explains the methodology used in deriving these estimates, and comments on the differences in costs between countries. Section V compares these costs in terms of the benefits gained and, indirectly, in terms of the MDGs. Section VI concludes the chapter with some recommendations for future work.

## 2. THE MDGS 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 of them and they are defined as follows (Table 1). More details of the associated targets and indicators are given in Appendix 1.

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

Having signed up for 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 US\$40–70 billion a year from 2000 to 2015 (Devarajan, Miller, and Swanson 2002). The estimates were derived in two ways: the first is based on the additional

investment needed to achieve the growth level necessary to reduce poverty and thereby meet MDG1 (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 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 US\$54–62 billion a year. The second method is 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 US\$35–76 billion annually. A more accurate estimate of the costs for the water and sanitation targets, however, is available from Markandya (2006: 316). If we take those figures, the second method gives a cost range of US\$84–109 million a year.

The authors warn that these two approaches do not provide numbers that can be added up to get the total cost of meeting the MDGs. As stated above, 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 of achieving the income poverty goals, however, will also result in the other non-income MDG goals being achieved. Conversely, if specific programs are implemented to meet these non-income MDG goals, they will also result in overall poverty being reduced substantially. While it is correct to say that the numbers cannot be added up, it is difficult to know the extent to which they overlap. Hence an overall cost estimate for all MDGs is not available.

Based on these estimates, we report in Table 1 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 between US\$550 and US\$880<sup>1</sup>. The costs of attaining the education target come out to between US\$486 and US\$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 US\$760 and US\$1,064; for water and sanitation, the additional costs range from US\$5 to US\$11.<sup>2</sup>

Note these are additional costs to meeting these goals, and there are already considerable aid funds that indirectly support them. Roughly speaking, donor-aided existing programs provided in 2000 roughly similar amounts of money (i.e., US\$60 billion) to developing countries. Hence the addition of aid needed to meet the MDGs is of the order of 100 percent.

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<sup>1</sup> 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.

<sup>2</sup> 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 in the period 2000–2015. By that measure the additional cost is between US\$2 and US\$6. Likewise the additional cost per child reduction who survives beyond 5 years of age 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 in the period 2000–2015. By that measure the additional cost is between US\$9 and US\$12. Note also that we do not have an estimate of the unit cost for maternal mortality or decline in other disease. This is because of a lack of either a both baseline or predicted 2015 values for maternal mortality, HIV/AIDS and other communicable diseases.

**Table 1: Additional Costs of Attaining MDGs: 2000–2015**

	Total Annual Costs \$US Billion		Population (Million)		Change <sup>a</sup> (Million)	Cost Per Person in \$US <sup>b</sup>	
	High	Low	2000	2015		High	Low
MDG1	62	54	2145	1382	-763	880	554
Other MDGs							
Education <sup>c</sup>	10	30	167	836	668	1,459	486
Under 5 Mortality <sup>d</sup>	5	8.5	119	47	-71	1293	760
Maternal Mortality	5	8.5	-	-	-	-	-
HIV/AIDS	4	6.5	-	-	-	-	-
Other Communicable Diseases	1	1.5	-	-	-	-	-
Access to Safe Water <sup>e</sup>		15	1354	4498	3144		4.8
Access to Improved Sanitation <sup>e</sup>		39	3886	3465	3465		11.3

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

<sup>a</sup> The change is the reduction in the number of people in that category in 2015 less the number in 2000.

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

<sup>c</sup> The additional cost per child per year of education is US\$1.9 to US\$5.7.

<sup>d</sup> 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 US\$8.8 and US\$12.3.

<sup>e</sup> 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 (2004).

In terms of value for money, a more complex exercise is required in comparing the benefits of the improvement against the costs. While this is almost impossible to do for poverty, it can be done for the other non-income MDGs. The only assessment we are aware of that makes this calculation is for water and sanitation (Markandya 2006), which shows 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.<sup>3</sup> In order to see whether the targets under the MDGs are justified in economic terms, it is necessary to compare the costs of meeting those targets with the benefits, which requires a value to be placed on the DALY. Based on recent ranges of values for this 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; for similar countries in the Eastern Mediterranean, the costs lie between the lower and the upper bounds. The above calculations apply in the cases of both the safe water and the sanitation goals taken together. However, when the cost of each of the goals is separated, the study finds that 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 OA program is concerned, the costs per person obtained above provide markers against which we can compare the costs of the programs relative to the benefits. As noted earlier, a full comparison will not be possible because the impacts of OA on the non-poverty MDGs are not quantified in enough detail for this purpose. Nevertheless, a partial comparison of the costs of the OA program against the global costs does yield some insights. Before discussing the costs of the OA programs in detail, we note the progress of the following with respect to progress on the MDGs (World Bank 2008):

<sup>3</sup> For details, visit [http://www.who.int/quantifying\\_ehimpacts/global/en/dalys.pdf](http://www.who.int/quantifying_ehimpacts/global/en/dalys.pdf) (accessed 27 October 2009).



- Although the poverty goal was on track to be met at the global level, thanks to the remarkable surge in global economic growth in the late 1990s and first half of the first decade of this century, it may be derailed for two reasons: the increase in food prices in late 2007 and early 2008, and the global economic downturn we are witnessing currently.
- There are likely to be serious shortfalls in MDG2—fighting hunger and malnutrition.
- Prospects are gravest for the goals of reducing child and maternal mortality, but shortfalls are also likely in the primary school completion, empowerment of women, and sanitation MDGs.
- Within this overall picture, there is considerable variation across regions and countries. At the regional level, Sub-Saharan Africa lags on all MDGs, including the goal for poverty reduction, though many countries in the region are now experiencing improved growth performance. South Asia lags on most human development MDGs, though it will likely meet the poverty reduction MDG. At the country level, on current trends most countries are off track to meet most of the MDGs, with those in fragile situations falling behind most seriously.

Thus any contributions that can be made by programs such as OA are to be welcomed, as long as they do not entail excessive costs relative to their benefits. It is this issue that we explore in the remaining sections.

### 3. COSTS OF OA PROGRAMS: CONCEPTUAL ISSUES

The costs of adopting OA programs fall into the following categories:

- Training costs and costs of organizing smallholder groups
- Subsidies on inputs to organic farmers
- Transition costs
- Inspection and certification costs

In each case, we need to distinguish between costs borne by the farmers, costs borne by the private sector, including non-government organizations (NGOs) and costs borne by the public sector, including from donor funds.

#### *Training Costs*

Farmers need to be trained in organic methods, if they are to adopt these successfully. Usually, the training is done in two stages. First, 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 these trainers to train individuals. These costs can be borne by the state, or by the promoters of the organic program (which may be firms or NGOs, frequently foreign but sometimes domestic).

In calculating the training costs per farmer, it is important to allow for an attrition rate: not all farmers maintain their training, and efforts and resources expended on those that do not complete the training are considered wasted. These attrition rates can be as high as 50% but can also be as low as zero. In the Thai experience the rate has been less than 5%. Depending on the training methodology and participant selection, we can improve attrition rates significantly. If we invest adequately in the training of trainers and training methodology development, it should be possible to maintain the overall attrition rate at 20% or less.

In addition, we have to account for the lost earnings of farmers when they are participating in the training. This is usually valued at the wage rate applicable to the sector in which they are active. However, this is probably an overestimate of the costs. If the training is organized

during the slack season when there is no farming activity, the opportunity costs are much lower than the wage rate.

Finally, it is important to include any costs of organizing smallholder groups. They are sometimes included as part of the training costs but focusing on non-technical related matters, such as dealing with administrative matters and social functions.

We can consider the initial training as a capital investment, followed by additional ‘top-up training’ which is provided every year. The costs of this, of course, need to be included in the cost assessment. All costs are amortized over 10 years to derive an annual cost of the training.

#### *Subsidies on Inputs to Organic Farmers*

In many OA 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 OA farmer, but in some cases, the state can also provide inputs. In our case studies, these input subsidies vary considerably—from as low as 10% of all costs to as much as 57%. Note that the subsidies are not always or even mainly provided by the state. In many cases, they are provided by private firms that buy the products. Where available, we have provided a breakdown of the share of the subsidy coming from each source.<sup>4</sup>

#### *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 here, promoters may provide some financial support to ease the burden. We have estimated the transition costs as between 6 and 20% of total costs.<sup>5</sup> The decline in income, however, should be viewed together with the reduction of production costs and the transition costs measured in terms of loss of net income. Depending on organic production technologies available to farmers, the net income may not decline during transition, e.g., the rain-fed rice production system has been shown to have a positive gain of net income during transition.

#### *Inspection and certification costs*

The last category of costs is those arising from inspection and certification of the organic production process. This can be most problematic when they have to be borne by the farmer, and can act as a market-entry barrier. Inspection and certification can be carried out by local agents or can require foreign specialists or their local-based counterparts representing the target market. If products are to be sold in more than one market, separate certifications may be required for each market. While the costs of foreign certification can be substantial, there are two mitigating factors as far as the farmer is concerned. First, in commercial projects, produce buyers generally pay certification costs, and second, while farmers bear the initial burden the premium price in the foreign market reflects the costs of certification. In other words, if certification costs were lower, so would be the premium on the product. We should also note that there are ways of reducing these costs. With large-scale<sup>6</sup> organic conversion, the inspection-certification costs are cheaper as inspectors can combine several inspections in one visit. Also, organizing farmers into grower groups (with an internal control system) will reduce inspection-certification costs. Finally, with more organic

<sup>4</sup> It can be argued that in fact these subsidies are not always necessary and that they are provided 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 sold their produce. In this case the input subsidy would be the interest cost of the fund.

<sup>5</sup> 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.

<sup>6</sup> Large-scale in this case does not refer to mono-crop large-scale farming but village or countywide conversion of collective numbers of smallholder farmers.

conversion a local certification body will start to develop, bringing the inspection-certification costs down significantly.

In our case studies, the costs of inspection and certification ranged from as little as 3% to as much as 57% of total costs. The high end of the range emerges from Sri Lanka, where internal control costs are very high. In the cases of the People's Republic of China (PRC) and Thailand, these costs are much more modest. From the experience in Thailand, certification costs should not exceed 5% when the organic project grows to optimum size. If costs are higher than 10%, the cause is either bad management or too-small project size. With large-scale conversion to organic, the costs should be between 2–10%.

## 4. COSTS OF ACTUAL OA PROGRAMS IN PRC, THAILAND, AND SRI LANKA

In this section, we report on the actual costs of moving to OA and producing organic produce in PRC, Thailand, and Sri Lanka.

### 4.1 PRC Case Studies

There are two case studies from PRC: Wanzai County and Wuyuan County (both in Jianxi Province).

#### *Wanzai County*

The organic producers specialize in mixed horticulture crops with ginger, strawberry, and green soya bean as main crops. They also grow some organic rice. There are 2,400 farmers, covering some 1,950 hectares. For convenience and comparability of data, all costs are reported in US dollars. The breakdown of the costs by category is given in Figure 1. The estimated costs are shown in Table 2, based on data provided by a team that carried out this study.

**Table 2: Costs of Transferring to OA in Wanzai County  
(US\$ 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

Notes:

1. Training of trainers is undertaken initially, followed by training of 'village leaders', who in turn train the farmers for one day, repeated annually. Lost wages are RMB40 (US\$5) per day. The farmer's costs of 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. Rice yield is pre-paid at US\$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 300kg/ha for 3 years.
4. Inspection costs are US\$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. An exchange rate of US\$0.125 to 1RMB was used, being the prevailing rate during the survey in 2006.

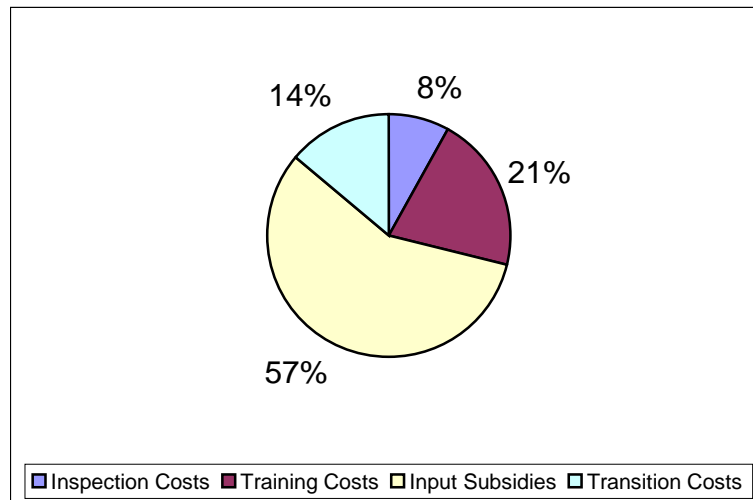
Source: Data Collected by the author from local sources.

The total costs of supporting OA are around US\$77 per farmer per year, made up mainly of input subsidies (57%), followed by training (21%), transition (14%) and

inspection/certification (8%). Of the total, the farmer bears about one third (33%), the private company bears 57%, and the state the rest (10%).

In the next section, we compare these costs with the additional gains to the farmers in terms of net Income and the MDGs.

**Figure 1: Share of Costs in Wanzai**



Source: Data Collected by the author from local sources.

*Wuyuan County*

In Wuyuan County, the OA production is exclusively tea. There are 508 farmers engaged in the production. Cost estimates have been provided directly by one of the authors of the study and are given in Table 3, and the breakdown is given in Figure 2. The figures are considerably lower than for Wanzai, with total costs per farmer of US\$13.5, compared to US\$30.5 for Wanzai. This is made up of training (22%), subsidies (22%) and inspection/certification (56%). There are no expected transition costs as there is no decline in tea yields. In terms of the shares across different agents, the farmer bears 15%, and the private company the rest (85%). There are no costs to the state, probably a reflection of the high profitability of the program.

**Table 3: Costs of OA Adoption in Wuyuan County (US\$ Per Farmer Per Year)**

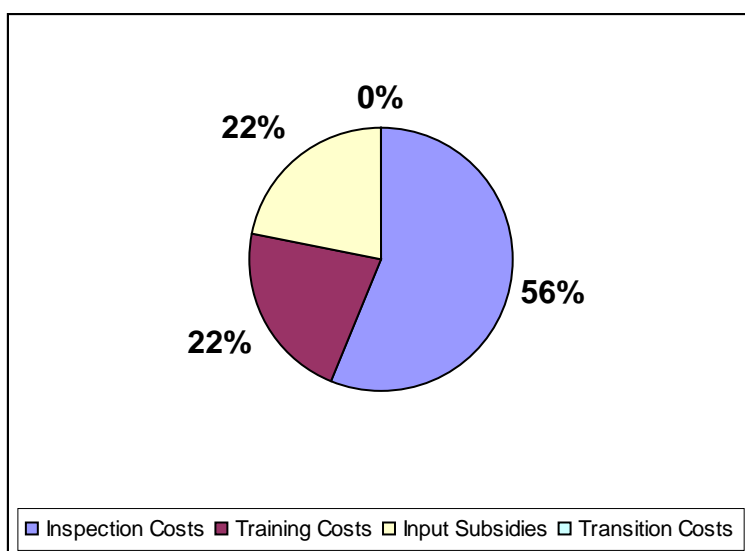
Cost Category	Farmer	State	Private	Total
Training	2.0	-	1.0	3
Subsidies	-	-	3.0	3
Transition	0	-	-	0
Inspection/Certification	-	-	7.5	7.5
Total	2.0	-	11.5	13.5

Notes:

1. Training of trainers is undertaken initially by the certifier. Each year, the private company sends 2 people to participate in the training course. The cost for trainers from the company is RMB 6000. This is followed by training of 'village leaders', who in turn train the farmers for one day, repeated annually. Lost wages are RMB40 (US\$5) per day.
2. Subsidies such as inputs for farming are not given to Wanzai farmers. But they receive support from the fair trade fund of the Fairtrade Labeling Organization (FLO) annually since 2005, when this project obtained fair trade certification. In 2006, they received RMB 189,000, of which RMB 140000 was spent. Expenditures covered:
  - a. Construction of a primary school (RMB 65,000)
  - b. Facility improvements for a tea primary processing factory (RMB11,920)
  - c. Pay the health insurance fee for each organic farmer associate member with RMB7500
  - d. Donation of RMB 5500 for a member with cancer
3. On transition costs, 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 US\$3821 per annum for a foreign certifier, shared equally across the 508 farmers. At a rate of 0.8 to one euro prevailing in 2006, this amounts to US\$7.52.
5. All capital costs are amortized at a rate of 10% over 10 years.
6. An exchange rate of US\$0.125 to the RMB was taken, being the prevailing rate in 2006, the year of the survey.

Source: Data Collected by the author from local sources

**Figure 2: Share of Costs in Wuyuan**



Source: Data Collected by the author from local sources.

## 4.2 Sri Lanka Case Studies

There are two programs in Sri Lanka, one run by a private company and one by an NGO. Each is considered in turn.

*Private Company Case Study*

This project focused on tea, cloves, and pepper (in order of importance) in the Kandy area. The data was collected in 2005–2006. There are about 1,000 organic farmers in the surveyed area and the average size of each farm is about one acre (0.45 ha.). The costs of OA are estimated as shown in Table 4. The breakdown of the costs by category is given in Figure 3.

**Table 4: Costs of Transferring to OA in Sri Lanka: Private Co. Project  
(US\$ Per Farmer Per Year)**

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

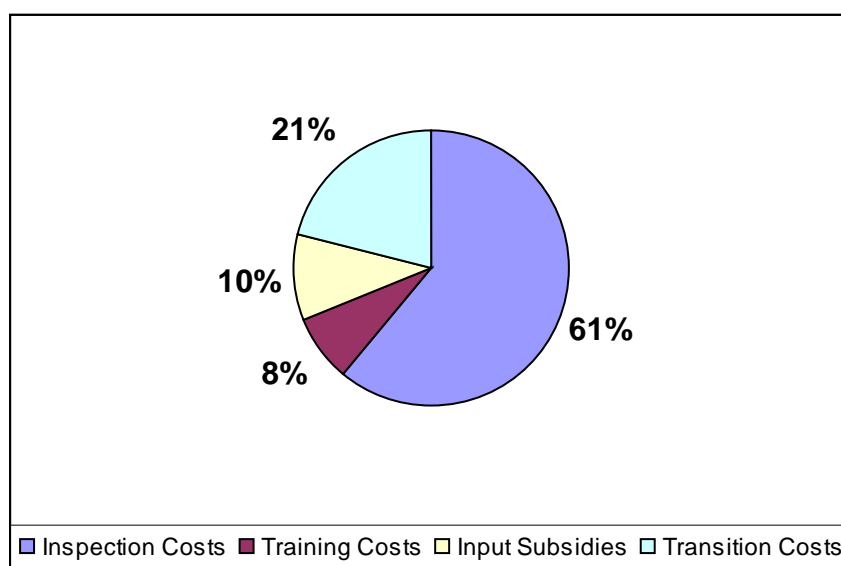
Notes:

1. Training of trainers is undertaken initially, followed by training of farmers for one day, repeated annually. Lost wages are Sri Lankan Rupee (SLRp) 350 (US\$3.4) per day for farmers but SLRp 2813 (US\$27.6) for the trainers. There is a 50% attrition rate in the training and each session trains 25 farmers.
2. Subsidies are given of US\$15.7 per acre for organic fertilizer and US\$2.2 per acre for planting materials.
3. Transition costs arise because of the decline in yields for 2 years (declines are about 20% lower for that period).
4. Inspection costs are €9,400 (US\$7,520) per annum for a foreign certifier, shared equally across the 1,000 farmers. In addition there are internal controls costing (ICS) US\$98 per farmer.
5. All capital costs are amortized at a rate of 10% over 10 years.
6. The average prevailing exchange rate through 2005 and 2006 was used in this survey (SLRp102 to US\$1).

Source: authors' calculations.

The total costs of supporting OA are around US\$174 per farmer per year, made up of inspection/certification costs (61%), followed by input subsidies (21%), transition (10%) and training (8%). Of the total, the farmer bears about 23%, with the rest being paid by the private sector.

It appears that the Sri Lanka conversion program is highly inefficient as shown by its high attrition rate and significant yield drops of 20%. This is why the company needs to provide very high subsidies to farmers to ensure that farmers stay on with the organic project. All these factors make conversion costs very high. In addition, internal costs are very high. The internal controls costing (ICS) costs are very high. The external inspection cost is only US\$7.52 per farmer while the ICS is 13 times higher. This is unrealistic. With around 1,000 farmers, a maximum of 10 ICS staff is needed (1 staff responsible for 100 farmers). Assume the ICS staff wage is around US\$100 per month or US\$1,200 per year, the total ICS staff cost would be around US\$12,000, or average of US\$12 per farmer. Other ICS expense should not be more than US\$10 per farmer. Under optimum circumstances, the ICS cost should be around US\$15 per farmer, and at the maximum, not more than US\$25 per farmer. This makes a total cost per farmer of US\$105.6 per annum. For both these reasons, the case study is not an average one but rather an example of a very poor performance project.

**Figure 3: Costs in Sri Lankan Private Co.**

Source: Data Collected by the author from local sources.

### NGO Case Study

This project also focuses on tea, cloves, and pepper (in order of importance) in the Kandy area. The project was initially a tea project 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 previous one is that it is administered by an NGO. The costs of OA are estimated as shown in Table 5. The breakdown of the costs by category is given in Figure 3. The total cost is very similar to the private case (US\$172 against US\$174), but there are differences in the distribution between the different agents. In this case, a donor (Helvetas International, a Swiss NGO) provided the subsidy to the farmer and the NGO of US\$16 per farmer (the farmer gets US\$6.4 while the NGO takes US\$9.6 to defray its expenses). The distribution between categories of expenditure, however, is not dissimilar (see Figure 4).

**Table 5: Costs of Transferring to OA in Sri Lanka: NGO Project (US\$ Per Farmer Per Year)**

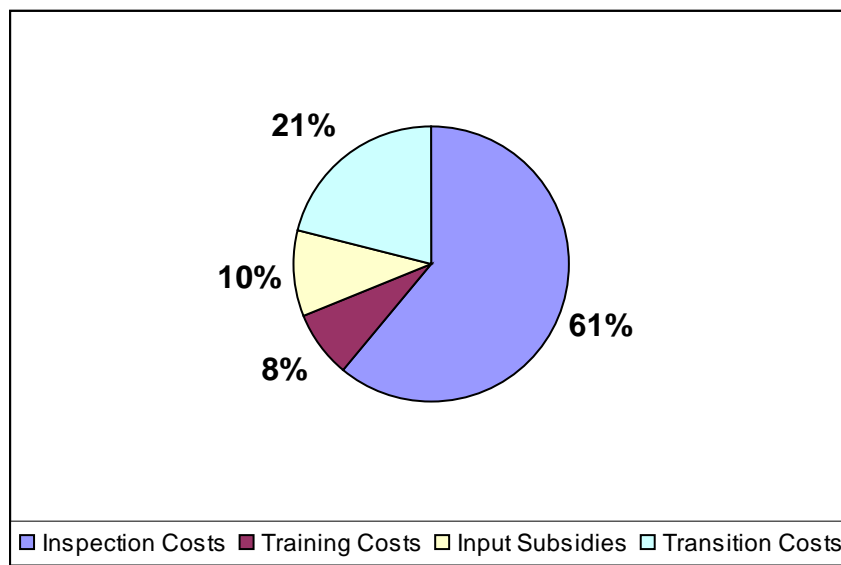
Cost Category	Farmer	State/Donor	Private	Total
Training	2.8	-	10.9	13.7
Subsidies	-	16.0	-	16.0
Transition	36.8	-	-	36.8
Inspection/Certification	-	-	105.6	105.6
Total	39.6	16.0	116.5	172.1

Notes:

1. Training of trainers is undertaken initially, followed by training of farmers for one day, repeated annually. Lost wages are SLRp350 (US\$3.4) per day for farmers, and higher for the trainers at SLRp2813 (US\$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 US\$107 per annum. In addition, the NGO receives a subsidy of about US\$9.6 for each farmer from the capital budget of US\$29,400 provided for a group of 275 farmers.
3. Transition costs arise because of the decline in yield for 2 years (declines were about 20% lower for that period).
4. Inspection costs are €9,400 (US\$7520) per annum for a foreign certifier, shared equally across the 1,000 farmers. In addition there are internal controls costing US\$98 per farmer. This makes a total cost per farmer of US\$105.6 per annum.
5. All capital costs are amortized at a rate of 10% over 10 years.
6. The average prevailing exchange rate through 2005 and 2006 was used in this study (SLRp 102 to US\$1).

Source: Data Collected by the author from local sources.

**Figure 4: Costs of Sri Lankan NGO Project**



Source: Data Collected by the author from local sources.

For the same reasons as we gave in the previous Sri Lankan example, in our view this case study also represents an inefficient example of the adoption of OA. The attrition rate and yield declines are atypical. This is why the company needs to provide very high subsidies to farmers to ensure they stay on with the organic project. Likewise the ICS costs are far too high. The external inspection cost is only US\$7.52 per farmer while the ICS is 13 times higher. This is really unrealistic. With around 1,000 farmers, a maximum of 10 ICS staff is needed (1 staff responsible for 100 farmers). Assuming the ICS staff wage is around US\$100 per month or US\$1,200 per year, the total ICS staff cost would be around US\$12,000, or average of US\$12 per farmer. Other ICS expenses should not be more than US\$10 per farmer. In the optimum case, the ICS cost should be around US\$15 per farmer, and at the maximum, not more than US\$25 per farmer. For both these reasons the estimated conversion costs are very high, making this case study an example of a very poor-performing project.

### 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, or 2.7 ha. The products grown are mainly rice and some leafy vegetables. The costs estimates are given in Table 6, and the distribution of costs by category is given in Figure 5.



**Table 6: Costs of Transferring to OA in Thailand: Ubon Ratchathani (US\$ Per Farmer Per Year)**

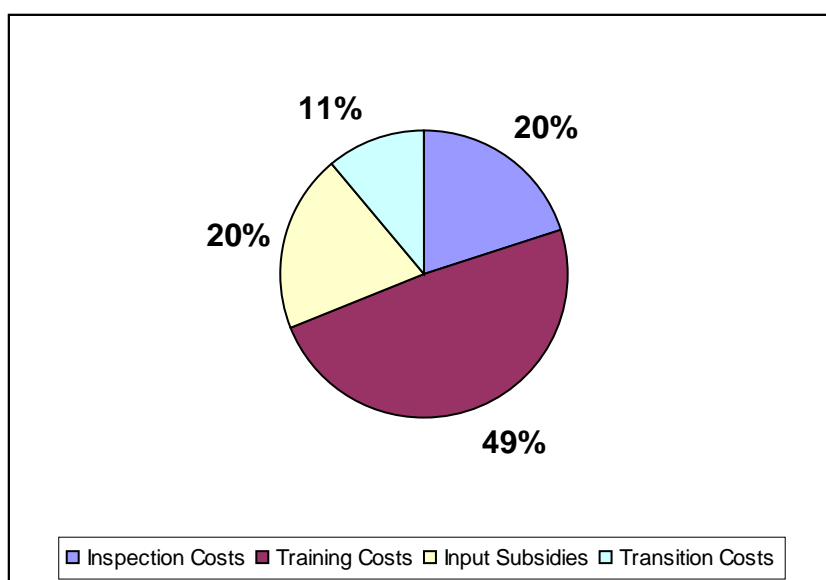
Cost Category	Farmer	State	Private	Total
Training	9.0	4.0	-	13.0
Subsidies	-	3.0	-	3.0
Transition	5.0	-	-	5.0
Inspection/Certification	-	5.2	-	5.2
Total	14.0	12.2	-	26.2

Notes:

1. Training of trainers is undertaken initially, followed by training of farmers for one day, repeated annually. There is also a one day meeting for all farmers. Lost wages are Baht 150 (US\$3.75) per day for farmers but Baht 555 (US\$13.9) for the trainers. There is a 50% attrition rate in the training and each session trains 25 farmers.
2. An interest-free loan of Baht 800 (US\$20) is given to each farmer. With prevailing market rates of 15%, this amounts to a subsidy of US\$3 per farmer.
3. Transition costs arise because of the decline in yields for 3 years (losses were 55kg/rai for the first two years followed by 25kg/rai for the third year). This is partly offset, however, by higher prices for the produce even in these three years. The net result is an amortized loss of US\$5 per farmer.
4. Inspection costs are Baht 12.5 per rai (US\$0.3), or Baht 208 (US\$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 of Baht 40 to US\$1 in 2005 and 2006 was used for this survey.

Source: Data Collected by the author from local sources.

**Figure 5: OA Costs in Thailand**



Source: Data Collected by the author from local sources.

At US\$26 per farmer, the costs of shifting to OA in Thailand are the lowest of the three countries; considerably less than in Sri Lanka (US\$170-172), or even in PRC (US\$77). The distribution of the costs is also different. In Sri Lanka, inspection costs dominated; in PRC input subsidies dominated; and in Thailand, the main component is training costs. The share of the costs borne by the farmers is 53%.

It is difficult to fully explain the differences in costs among the case studies but some things stand out. The first is the substantial variation in inspection costs and certification costs, with Sri Lanka standing out as exceptionally high. Differences in the costs of certification may be due to the crop system and how long it has been since the certification took place. In the case of Thailand, farmers who converted to organic much earlier than PRC or Sri Lanka have lower costs. Second, we note the large subsidies in Wanzai in PRC were largely borne by the private company. Third, we note the differences in the share of the cost borne by the

farmers—11% in PRC, 26% in Sri Lanka and 53% in Thailand. Fourth, we note that the training costs are quite similar in all three country case studies. In PRC, they are US\$6 per farmer, US\$14 per farmer in Sri Lanka and US\$13 per farmer in Thailand.

## 5. EVALUATING THE COST EFFECTIVENESS OF ADOPTING OA IN PRC, THAILAND, AND SRI LANKA

Ideally, we would like to compare the costs of adopting OA with the benefits. In other papers in the same series, we have estimated the gains from OA in terms of income, and the various MDGs. Here we bring the two sets of results together to see what we can say about the cost-effectiveness of the OA programs.

We start by looking at increases in income, resulting from adoption of OA. Other research has shown that households can expect increases in income if they adopt OA (Setboonsarng and Markandya 2009). The range of estimates varies, but approximate figures are given in Table 7 below under “Gain in Net Income per annum.

**Table 7: Costs of OA Compared to Gains**

Case Study (costs in US\$)	PRC		Sri Lanka	Thailand
	Wanzai	Wuyuan	Kandy	Ubon-R
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. in Each Household	15.2	12.3	-	31.8

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 the synthesis chapter as well as some supplementary analysis in the cases of PRC and Sri Lanka. For Thailand, the increase is the average for 2005 and 2006, taken from the synthesis chapter (Table 1).
3. Percentages of households in poverty (defined as less than one US dollar a day per person) are taken from the individual case study data.
4. Increases in income are taken from the synthesis chapter combined with basic data on incomes from the case studies. For the Thailand case study, we took the increases in income for farmers with less than 10 rai of land (Table 2 in that chapter) 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.

In order to estimate the cost per household taken out of poverty, we need to make some assumptions about the distribution of households below poverty line, and how the increase in incomes affects each of them. If we make the simplifying assumptions that (i) the distribution of households below the poverty line is rectangular,<sup>7</sup> and (ii) incomes of all households are increased by the same proportion, we can estimate the increase in the percentage brought out of poverty (given the percentage that are in poverty). The method is explained in the appendix of this paper. The table reveals some interesting findings:

<sup>7</sup> This approximation overestimates the number of very poor households, as almost certainly the underlying distribution will be closer to a log-normal. This cannot be estimated as we do not have data on the parameters of that distribution. Since the error in taking a rectangular distribution is to underestimate the numbers taken out of poverty, we can say that our figures were conservative estimates of the gains in poverty reduction.

1. In all four cases, the gains in income per household exceed the amortized cost of adoption of OA. The margin is greatest for PRC and smallest for Sri Lanka. In fact, at 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, we consider the costs of adoption of OA in Sri Lanka to be 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 US\$136 to US\$169. This translates into a cost of US\$32 to US\$38 per individual.

If we compare these costs with those presented in Section II of this chapter, we see 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 goals of halving the percentage of households in poverty comes out to around US\$554 to US\$880 per head. The costs of poverty reduction through the adoption of OA in these two countries are about one-twentieth of that amount. Of course, the investment and growth approaches to meeting the MDG also provide other benefits of growth (e.g., increases in incomes of non-poor), which should be taken into account. On the other hand, the OA program also provides non-income poverty benefits, which are not measured here.

The purpose of the comparison is to show how the two sets of costs match up against each other and to note that OA does in fact come out as cost-effective. We must, however, interpret these findings with some caution. The estimates in both the World Bank's study and our own are very rough, and we are certainly aware of the possible ranges for both the estimates of the costs of adoption, as well as the gains in net income.<sup>8</sup> Nevertheless, we believe the figures do indicate that OA can contribute to poverty reduction in a reasonably cost-effective way. In addition to the direct impact on poverty, we have also noted elsewhere in this report the gains in terms of other MDGs. In particular, 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 in improving education, health, and environmental sustainability. Table 8 summarizes the additional benefits as far as they are directly related to the other MDGs.

The table shows benefits from OA 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).

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<sup>8</sup> 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 of Setboonsarng and Markandya (2009), these are probably due to special conditions in the market in 2005, when conventional farmers were offered higher than market prices.

**Table 8: Gains from OA in Terms of Other MDGs**

<b>Case Study</b>	<b>PRC Wuyuan</b>	<b>PRC Wanzai</b>	<b>Sri Lanka Kandy</b>	<b>Thailand Ubon-R</b>
Universal Primary Education	In terms of education there is nothing to separate the two groups of households.	All the education-related data favors OA households: expenses for education, the number of members of the household who dropped out of school and the number of illiterates.	Both OA and conventional households spent about the same on education	OA households spent more in per capita terms on education than conventional households, but the differences are not statistically significant.
Gender Equality	In terms of gender equality there is also nothing to separate the two 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. Likewise, differences in who decides which children will go to school or what should be spent on health care are insignificant between OA and conventional 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 woman-headed households among the conventional farmers and OA farmers is statistically significant. On the other hand the income from the main job of women belonging to organic households is, on the average, 6,033 Baht higher than the income of women belonging to the conventional part of the sample. Women from OA households are more likely to attend training courses and be members of outside groups than women from conventional households.
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 three months of pregnancy and members of OA households have twice as many sick days than conventional households. Organic households spend about 30% more on health care but difference is not statistically significant	OA households experience less travel time to health centres and money spent on children's health is higher. They are also better trained to deal with pesticides.	Conventional 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.
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 conventional 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 environmentally friendly farming than conventional households.	There is much greater variability in expenditure on water, fuel and electricity among conventional households, suggesting some are using these resources inefficiently.
Global Partnership for Development	OA households spend more on house expansion than conventional 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 so than conventional 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.

While these benefits are almost impossible to quantify in terms of the MDGs and targets as outlined in Section I, they are nonetheless very real and important. Moreover, these benefits are in addition to the gains in net income and the reductions in poverty detailed above. The World Bank study described in Section II made the unsubstantiated assumption that an expenditure of US\$40–60 million, if used to finance income growth would also finance the achievement of the other MDGs; it also claimed that if a similar amount were used to finance 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. To be sure, we cannot say quantitatively in every case how much OA will lead to the attainment of those goals, but we can say that there will be some direct impact (as described in Table 8).

## 6. CONCLUSIONS

This paper has provided estimates of the costs of OA 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 OA programs in the four case studies of Wanzai, PRC; Wuyuan, PRC; Kandy, Sri Lanka; and Ubon Ratchathani, Thailand. A detailed analysis of the programs resulted in cost estimates per farmer per annum. These showed considerable variation across the case studies, suggesting that there is no clear structure to the costs of adopting OA. It also revealed that costs do depend on the efficiency with which the OA adoption programs are run. The lowest-cost programs were more than ten times less expensive than the highest-cost ones.

A further analysis of the gains resulting from adoption of OA revealed that the costs per person taken out of poverty was much lower than the World Bank's estimates, based on income growth in general or, based on the detailed costs of meeting some of the more quantifiable MDGs (education, health, and environment). The World Bank estimates that the cost of achieving the MDG goal of halving the percentage of households in poverty totals around US\$554 to US\$880 per head. Our study, using a different estimation method, found that the cost of moving a household out of poverty through engaging farmers in organic agriculture could be only US\$32 to US\$38 per head. Although the estimates are not directly comparable, the results do suggest that there is a role for targeted programs such as OA in providing a cost-effective solution to meeting the poverty alleviation MDG (MDG 1). As for the other MDGs, this study shows that OA makes some contribution to them, although it is not possible to quantify the exact magnitude. While one can draw the conclusion that OA programs can contribute cost-effectively to poverty reduction in the countries studied, there are still some open questions that need to be addressed. One of the most important is whether the costs of OA conversion borne by farmers effectively impede OA adoption. If so, what measures need to be taken to make the change more affordable? Many developing countries in Eastern Europe have programs to subsidize farmers during the conversion period. Such systems could be investigated to draw lessons for developing countries in other regions of the world.

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 cost 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 are among the activities to be supported.

Given the fact that private sector firms that engage farmers to produce OA are effectively providing public services, i.e., reducing poverty while providing environmental services,

scaling up such private sector participation by providing public supports 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 OA and the other non-income 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 OA practices (e.g., OA benefits health by reducing exposure to pesticides and promotes re-use of agricultural waste which can improve sanitation). But the relative importance of these two pathways, and how they interact with each other has yet to be established.

## APPENDIX 1: MILLENNIUM DEVELOPMENT GOAL 8

Goal	Targets	Indicators
<p><b>Develop a Global Partnership for Development</b></p>	<p>Address the special needs of the least developed countries.                      Address the special needs of landlocked countries and small island developing States.                      Develop further an open, rule-based, predictable, non-discriminatory trading and financial system                      Deal comprehensively with the debt problems of developing countries through national and international measures in order to make debt sustainable in the long term.</p>	<ul style="list-style-type: none"> <li>• Net Official Development Assistance (ODA) as percentage of Organization for Economic Cooperation and Development (OECD) and Development Assistance Committee (DAC) donors' gross national product (targets of 0.7% in total and 0.15 % for LDCs)</li> <li>• Proportion of ODA to basic social services (basic education, primary health care, nutrition, safe water and sanitation)</li> <li>• Proportion of ODA that is untied</li> <li>• Proportion of ODA for environment in small island developing states</li> <li>• Proportion of ODA for transport sector in landlocked countries</li> </ul> <p><i>Market access</i></p> <ul style="list-style-type: none"> <li>• Proportion of exports (by value and excluding arms) admitted free of duties and quotas</li> <li>• Average tariffs and quotas on agricultural products, and textiles and clothing</li> <li>• Domestic and export agricultural subsidies in OECD countries</li> <li>• Proportion of ODA to help build trade capacity</li> </ul> <p><i>Debt sustainability</i></p> <ul style="list-style-type: none"> <li>• Proportion of official bilateral debt cancelled of heavily indebted poor countries (HIPC)</li> <li>• Debt service as a percentage of exports of goods and services</li> <li>• Proportion of ODA provided as debt relief</li> <li>• Number of countries reaching HIPC decision and completion points</li> </ul>
	<p>In cooperation with developing countries, develop and implement strategies for decent and productive work for youth</p>	<ul style="list-style-type: none"> <li>• Unemployment rate of 15 to 24 year olds</li> </ul>
	<p>In cooperation with pharmaceutical companies, provide access to affordable essential drugs in developing countries</p>	<ul style="list-style-type: none"> <li>• Proportion of population with access to affordable essential drugs on a sustainable bases</li> </ul>
	<p>In cooperation with the private sector, make available the benefits of new technologies, especially information and communications</p>	<ul style="list-style-type: none"> <li>• Telephone lines per 1,000 people</li> <li>• Personal computers per 1,000 people</li> </ul>

## APPENDIX 2: TARGETS AND INDICATORS FOR THE MILLENNIUM DEVELOPMENT GOALS

Goal	Targets	Indicators
<b>Eradicate extreme poverty and hunger</b>	Halve between 1990 and 2015 proportion of people whose income is less than US\$1/day	<ul style="list-style-type: none"> <li>• Proportion of population below US\$1 per day</li> <li>• Poverty gap ratio (incidence x depth of poverty)</li> <li>• Share of poorest quintile in national consumption</li> </ul>
	Halve between 1990 and 2015 proportion of people who suffer from hunger	<ul style="list-style-type: none"> <li>• Prevalence of underweight children (under 5 years of age)</li> <li>• Proportion of population below minimum level of dietary energy consumption</li> </ul>
<b>Universal Primary Education</b>	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"> <li>• Net enrollment ratio in primary education</li> <li>• Proportion of pupils starting grade 1 who reach grade 5</li> <li>• Illiteracy rate of 15–24 year olds</li> </ul>
<b>Gender Equality and Empower Women</b>	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"> <li>• Ratio of girls to boys in primary, secondary, and tertiary education</li> <li>• Ratio of literate females to males of 15–24 –year olds</li> <li>• Ratio of women to men in wage employment in the non-agricultural sector</li> <li>• Proportion of seats held by women in national parliament</li> </ul>
<b>Reduce Child Mortality</b>	Reduce by two-thirds, between 1990 and 2015, the under 5 child mortality rate	<ul style="list-style-type: none"> <li>• Under-5 mortality rate</li> <li>• Infant mortality rate</li> <li>• Proportion of 1 –year old children immunized against measles</li> </ul>
<b>Improve Maternal Health</b>	Reduce by three-quarters, between 1990 and 2015, the maternal mortality ratio.	<ul style="list-style-type: none"> <li>• Maternal mortality ratio</li> <li>• Proportion of births attended by skilled health personnel</li> </ul>
<b>Combat HIV/AIDS, malaria and other diseases</b>	Have halted by 2015 and begun to reverse the spread of HIV/AIDS	<ul style="list-style-type: none"> <li>• HIV prevalence among 15–24 –year old pregnant women</li> <li>• Contraceptive prevalence rate</li> <li>• Number of children orphaned by HIV/AIDS</li> </ul>
	Have halted by 2015 and begun to reverse the incidence of malaria and other major diseases.	<ul style="list-style-type: none"> <li>• Prevalence and death rates associated with malaria</li> <li>• Proportion of population in malaria risk areas using effective malaria prevention and treatment measures</li> <li>• Incidence of tuberculosis (per 100,000 people)</li> <li>• Proportion of tuberculosis cases detected and cured under directly observed treatment short course</li> </ul>
<b>Environmental Sustainability</b>	Integrate the principles of sustainable development into country policies and programs and reverse losses of environmental resources.	<ul style="list-style-type: none"> <li>• Proportion of land area covered by forest</li> <li>• Land area protected to maintain biological diversity</li> <li>• GDP per unit of energy use (as proxy for energy efficiency)</li> <li>• Carbon dioxide emissions (per capita)</li> </ul>
	Halve by 2015 the proportion of people without sustainable access to safe drinking water	<ul style="list-style-type: none"> <li>• Proportion of population with sustainable access to an improved water source</li> </ul>
	By 2020 to have achieved a significant improvement in the lives of at least 100 million slum dwellers	<ul style="list-style-type: none"> <li>• Proportion of people with access to improved sanitation</li> <li>• Proportion of people with access to secure tenure (urban/rural)</li> </ul>



### APPENDIX 3: ESTIMATING THE COST PER HOUSEHOLD TAKEN OUT OF POVERTY BY OA

This is an estimate of the increase in income per household as a result of the 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
$\pi$	Percentage of adopting households who are poor
$\lambda$	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 as 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 the Figure 6 below. The share of households taken out of poverty can be written as:

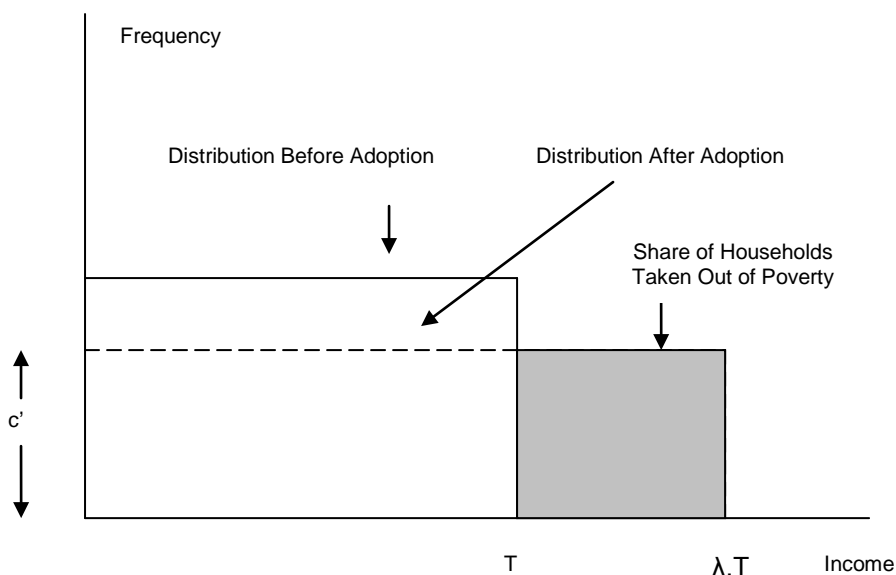
$$\left[ \frac{(\lambda T - T).c'}{\lambda T.c'} \right] = 1 - \frac{1}{\lambda}$$

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 above equation.

**Figure 6: Frequency Distribution of Poor Households by Income**



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