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Contract Farming and Poverty Reduction: the Case of Organic Rice Contract Farming in Thailand

Sununtar Setboonsarng, PingSun Leung, and Junning Cai

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Sununtar Setboonsarng is Senior Research Fellow at the Asian Development Bank Institute. PingSun Leung is Professor, Department of Molecular Biosciences and Bioengineering at University of Hawaii. Junning Cai is Post Doctoral Research Fellow, Department of Molecular Biosciences and Bioengineering at University of Hawaii.

Introduction

Among the poor in Asia a very high proportion are subsistence farmers living on low-value traditional crops. Traditionally, development in the agricultural sector put emphasis on increasing productivity using external inputs with insufficient attention other aspects, in particular to market linkages. This strategy has resulted in mixed poverty outcomes. In countries such as Lao PDR and Cambodia where poverty is a pervasive problem governments and donors are in search of an alternative strategy to develop the rural sector.

With globalization, market liberalization, and the development of rural infrastructure, new market opportunities for high-value crops and livestock production are opening up. However, for the rural poor to take advantage of new market opportunities, backward and forward market linkages must be put in place. These linkages include provision of information on what to grow, rural credit, farming inputs, agricultural extension advice, and help in product accreditation. Putting in place the necessary agri-services for a massive number of small farms and un-organized farmers will require considerable resources from governments. Successes in the provision of public sector agri-services are rare and failures have been numerous. In recent years, a strategy involving private sector has been looked upon as an alternative.

In the provinces of Cambodia and Lao PDR, bordering Thailand and the People's Republic of China, contract farming has emerged in response to lack of markets in an environment of high risk and high costs. Under contract farming, the purchaser (agri-business firm or trader) provides farmers with inputs, credit, technical advice and market services. In return, farmers produce a certain quantity and quality of crop or livestock, and sell them exclusively to the purchaser. Such arrangements allow farmers to have access to an array of agricultural services, which they would otherwise not have access to.

The emergence of contract farming as an institution for facilitating market exchange is not a recent phenomenon. For decades, contract farming has been used as a supply chain governance strategy in response to market and institutional failures that characterize the agricultural sector in different stages of development. While contract farming itself has been around for a long time, its importance as a tool for transforming subsistence to commercial farmers and thus contributing to poverty reduction has only been reviewed in recent years.

Internationally, in response to changes in consumer preference within developed countries, multinational food corporations are engaging in contract farming in developing countries, mainly to ensure year-round supply of particular product ranges to specific markets and to take advantage of lower production costs It appears that through globalization, this type of contract farming could possibly transfer a production base to developing countries such as Lao PDR and Cambodia where conditions are conducive for growing non-traditional export crops, and where labor and land costs are lower. If managed well, this trend offers promising opportunities for the rural poor in these countries to gain from globalization. Contract farming would provide the rural poor in these areas with access to a vastly growing export market and hence opportunities to improve their income.

In the neighboring country of Thailand where the stage of agriculture development is more advanced and where contract farming has been widely adopted, there may be important lessons to be learnt for Lao, PDR and Cambodia. Due to the growing demand of organic rice in developed countries, in 2003, the Ministry of Agriculture and Agriculture Cooperatives of Thailand commissioned a study to investigate the potential of developing organic rice in Thailand for export. The study included a farm household survey covering 445 contract and non-contract rice farming in five provinces in the North and Northeastern regions of Thailand. The farms covered in the dataset share many characteristics with the rural sector in Lao PDR and Cambodia, where the vast majority are smallholder farms in marginal areas, with excess labor and little or almost no access to agricultural extension services. This data is examined here using econometric analysis to evaluate the profitability and profit efficiency of rice contract farming, as compared with rice non-contract farming, in Thailand.

We first examine the benefits of contract farming, particularly when it is promoted for organic agriculture. We then briefly discuss our methodology in measuring efficiency and also review relevant profit frontier studies on farming in developing countries. We next describe the survey data used in this study, before presenting our results from the profitability and efficiency analysis. A concluding section summarizes our main findings.

Potential benefits of contract farming and organic agriculture

The existing literature on contract farming identifies several major areas where contract farming can provide benefits. From the point of view of farmers, contract farming can provide access to markets, credit, technology and inputs that they would otherwise be excluded from. Moreover, contract farming can lead to improvements in income while reducing some of the risks they face from production and price fluctuations. From the point of view of purchasers, contract farming provides greater control over volume and quality consistency; to a certain extent, it can also lower certain transaction and production costs that purchasers face. Table 1 summarizes the main potential benefits.

Table 1. Potential benefits of contract farming

Parameter	Potential benefits
Farmers	
Access to markets	Contract farming arrangements serve to link farmers to distant markets where the demand and price of crops are more favorable.
Access to credit	Purchasers extend credit to farmers either in cash or in kind by providing inputs such as seeds. In cases where purchasers do not extend loans to farmers, banks may accept the contracts as collateral.
Access to technology/ skills development	Contract farming arrangements may facilitate the introduction of new production techniques, and further measures that upgrade agricultural commodities. These include training and assistance in crop production, soil and water management, and bookkeeping of inputs and outputs.
Access to inputs	Purchasers may undertake measures to ensure that contracted producers have timely access to inputs including seeds and fertilizers, in addition to training support and monitoring proper crop husbandry practices.
Increased income	Contract farming can lead to improved income, especially in cases where contract farming is adopted for non-traditional crops that are sold at a premium.
Reduced price risk	In contract farming a predetermined price for the crop is generally established during contract negotiations at the onset of the growing season. This may protect farmers from incurring losses in sales due to downward price fluctuations.
Reduced production risk	Contract farming arrangements facilitate risk sharing from production failures due to uncontrollable circumstances including weather or disease. Purchasers may absorb losses associated with reduced or non-existent throughput for the processing facility. Where production problems are widespread as a result of uncontrollable events, purchasers may defer the repayment of production advances until the following season.
Purchasers	
Control over volume and consistency	Contract farming assures suppliers that the required crops can be produced consistently. Contract farming may result in increased yields and improved quality with regard to certain types of crops.
Improved cost efficiency	Contract farming allows firms to minimize costs by not purchasing land or directly hiring labor. Contract farming can help firms minimize supervision costs, usually incurred due to classic principal-agent problems.

Contract farming likewise affords potential benefits to governments. While the development of market linkages for farmers is traditionally viewed as a public sector responsibility, the establishment of the necessary agro-services for a large number of small, unorganized farmers requires a considerable amount of public sector resources. On the other hand, contract farming provides market linkages in ways, which do not burden the public sector.

Contract farming and organic agriculture

In recent years, consumer concerns surrounding food safety have led to an increase in demand for organic products. The global market for organic products has been growing steadily not only in Europe and North America but in Asian countries such as Japan and it is estimated that it will continue to be the fastest growing sector in agriculture. Not surprisingly, organic food production has increased all over the globe, with much of the increase occurring in developing countries where farmers are being attracted by export benefits and substantial price premiums.

This increase in demand has come with a greater insistence on verifiable evidence of food product quality. This in turn has led to more stringent certification requirements and an influx of food traceability systems. Since chemical residues on food are not generally visible and conducting bio-chemical tests are costly and impractical, in order to guarantee the quality of products while minimizing transaction costs, certification systems and traceability systems have developed to provide information on products for consumers, notably in developed countries.

For export agents in developing countries, the ability to fulfill the traceability or certification requirements will determine their success in the export market for agricultural products, in particular, high value products such as organic products. Since such products have to meet strict quality requirements that are typically difficult to meet in spot markets, firms are utilizing contract farming to gain better control of inputs, achieve more uniform product attributes, and to reduce the cost of measuring quality, grading, and sorting of products.

Due to higher management costs of a food traceability system and the requirement for organic farming to be grown in areas free from chemicals, export firms are likely to engage farmers in marginal areas, where the cost of labor is lower and where use of agrochemicals is minimal. For farmers, contract farming provides access to information and markets. For purchasers, contract farming provides control over inputs throughout all stages of production and processing, making it easier to implement traceability systems. For the government, contract farming facilitates the production of high value agro-products that are consistent with international standards for food safety and traceability.

Beyond issues of establishing the requisite certification standards and traceability systems to promote exports, there are broader benefits from promoting contract farming for organic agriculture for poverty reduction. Over the years, it has become increasingly clear to farmers, non-governmental organizations (NGOs), governments and international development agencies alike that the conventional practice of farming under the banner of the ‘Green Revolution’ has by-passed the poor in marginal areas while benefited the richer farmers in fertile areas. There is also increasing evidence that high-external-input agriculture is unsustainable. The unsustainable nature of conventional agriculture is manifesting itself in terms of stagnant or declining yields, increasing ecological degradation, and worsening rural socio-economic conditions. Increasingly, countries have started to look at organic agriculture as a means of reversing these negative effects.

The foregoing discussion illustrates the potential for contract farming to provide benefits that meet multiple policy objectives. But while the benefits of implementing contract farming may be diverse, and while different stakeholders stand to gain from these benefits, persuading farmers to take part in such an arrangement is still largely a matter of financial incentives. In contract farming, one of the principal motives for smallholders consent is the promise of a steady and increased income incurred from the sale of their crops. To establish the benefits of contract farming providing empirical evidence is crucial. We address this below using data from small farms in Thailand.

Methodology

The chapter employs the profit frontier methodology to assess the profitability and profit efficiency of the sampled Thai rice farmers. Profit efficiency is defined here as the ratio of the observed profit to the potential maximum attainable profit. While profit provides a direct measure of relative competitiveness of one type of farm (that is a contract farm) in relation to others (that is a non-contract farm), the concept of profit efficiency can also be useful as an indicator of relative competitiveness. We also attempt to account for selection bias using a two-stage switching regression model. The estimated models are used for subsequent 'counterfactual' simulations of profit and profit efficiency.

The analysis aims to test the following hypotheses:

1. Contract rice farmers are more profitable than non-contract rice farmers for comparable scales of operation; and
2. Contract rice farmers are more (profit) efficient than non-contract rice farmers for comparable scales of operation.
3. Contract farming is biased against small farmers.

Since all contract rice farmers in the sample are certified organic or in transition to becoming organic farmers and all the non-contract farmers are conventional rice farmers, the analysis also throws some light on the debate concerning organic versus conventional agriculture. However the evidence on this must be interpreted with care and it is difficult to draw firm conclusions. This is partly because we cannot separate the effects of an institutional arrangement (a contract) from a technology (organic farming practices) as the contract farming group is influenced by both. Further not all contract farmers are certified organic farmers who have completed the required three year transition period, although we can distinguish between the pure (or certified) organic farmers from those who are either in transition or just starting out to adopt organic practices.

Efficiency and profit frontiers

Efficiency and inefficiency can generally be measured by its components - technical, cost, revenue and profit. Technical efficiency refers to a farm's ability to produce the maximum outputs for a given set of inputs and technology. Or conversely, it can be measured as the farm's ability to utilize the minimum amount of inputs to produce a desirable set of outputs for a given technology. Cost efficiency refers to the ability of the farm to minimize the expenditures required to produce a desirable set of outputs, given their respective input prices and production technology. Misallocation of inputs contributes to cost inefficiency and is sometimes refers to as input allocative inefficiency. Revenue efficiency refers to the farmer's ability in allocating their outputs in a revenue-maximizing manner for a given set of output prices. Finally, profit efficiency refers to a farm's ability to obtain maximum profit for a given set of input prices, output prices, and technology. While technical, cost, and revenue efficiency are necessary for the achievement of profit efficiency, they are collectively not sufficient for profit efficiency. Profit efficiency further requires that technical, cost and revenue efficiency be achieved at the proper scale, that is it requires some kind of scale efficiency (Kumbhakar and Lovell, 2000).

Here we utilize a dual variable profit frontier, which portrays the maximum variable profit (defined as gross revenue less variable cost) obtainable by a farm given the prices of inputs and outputs, the production technology, and the presence of fixed inputs such as land and capital. The variable profit frontier is more appropriate when farms do not have the flexibility to adjust all inputs. Farms operating on the profit frontier are profit efficient while farms operating under the profit frontier are profit inefficient.[1]

Other studies using profit frontier analysis

In terms of the wider literature, while rice is perhaps the most studied agricultural commodity by researchers, very few have used profit frontiers, which could be due to lack of appropriate data. In a review article by Bravo-Ureta and Pinheiro (1993) on efficiency analysis of developing country agriculture, 13 out of 20 studies were on rice farming. However, only two studies used the dual profit frontier approach and only one was on rice farming. Ali and Flinn (1989) used a single equation dual profit frontier to examine the efficiency of 120 rice producers from the Punjab in Pakistan. They found that the average inefficiency was 31%. Education was found to have a significant role in reducing profit inefficiency, while off-farm employment and difficulties in securing credit to purchase fertilizer tended to increase profit inefficiency. The other study by Bailey et al. (1989) is on dairy farms.

Since 1993 a few more studies have employed profit frontiers. Abdulai and Huffman (2000) used a stochastic translog profit frontier to examine the efficiency of 256 farmers in the Northern region of Ghana. They found that the average inefficiency was 27.4%. Their inefficiency analysis suggested that the education of the household head, access to credit, greater specialization, and location in districts with better access to extension services and better infrastructure were significant variables for increasing profit efficiency. On the other hand, increasing participation in nonfarm activities by farmers and being older tended to lower profit efficiency. Rahman (2003) also used a dual profit translog frontier to investigate the efficiency of 380 farms, which produced a modern variety of rice in three agro-ecological regions of Bangladesh. He found that the average inefficiency was about 23%. Farmers with more experience in growing modern varieties of rice, better access to input markets and extension services, located in fertile regions, as well as those with less off-farm work and who owned their land were found to be more efficient.

To our knowledge, there are no other efficiency studies on rice farming which employ the stochastic profit frontier approach. However, there are several efficiency studies of other agricultural products using the stochastic frontier approach since the 1993 review article by Bravo-Ureta and Pinheiro. Arajuo and Bonjean (1999) used a stochastic profit frontier to study the efficiency of different land tenure patterns in Brazilian farms. Bhattacharyya and Glover (1993) also employed a stochastic profit frontier to examine the efficiency of small versus large farms in India. Wang et al (1996) developed a shadow-price profit frontier model to examine the efficiency of Chinese rural households in farming operations. Delgado et al (2003) employed the profit frontier approach to investigate the efficiency of large versus small and contract versus independent livestock farms in the Philippines, India, Thailand, and Brazil.

Thai data

In 2003, the Ministry of Agriculture and Agriculture Cooperatives of Thailand commissioned a survey to investigate the potential of developing organic rice in Thailand for export. The survey covers 5 provinces, 2 of which are in the Northern region namely Phayao and Chiang rai, while the other 3 are in the Northeastern region, covering Ubon Ratchathani, Surin, and Yasothon.

The sampled farms in Northeast Thailand are ones, which practiced conventional agriculture using high level of agro-chemicals until the early 1980s. In the mid-1980s, in Surin and Yasothon Provinces, the movement of natural agricultural practices and environmental conservation promoted by religious groups and several Non-Government Organizations (NGOs) initiated contract farming of organic rice as a solution to the problems faced by farmers. This development was then supported by European NGOs, who wished to produce organic rice for export to their own Fair Trade Networks. In Ubon Ratchathani, contract farming of organic rice was supported by a semi-NGO as part of its strategy for community development and poverty reduction. It was also an income earning opportunity for the NGO. In contrast organic rice farming in the Northern region was a private sector-led initiative, prompted by demand growth in European countries. In search for land where chemicals has not been applied for organic production, the firms searched for marginal forest areas and introduced rice contract farming to farmers.

The farm survey was conducted during 2002 and 2003 with an updated interview with key informants during early 2005. Hence the monetary data are in prices of 2002-3. Within each province approximately the same number of contract and non-contract farmers were surveyed in the same locality. All of the contract rice farmers are organic or low-chemical farmers while all the non-contract farmers are conventional rice farmers. This resulted in 83 contract-organic and 85 conventional farmers surveyed in the Northern region, and 140 contract-organic and 137 conventional farmers in the Northeastern region. Thus, there are a total of 445 farms surveyed, 168 in the Northern region and 277 in the Northeast (Table 2).

The contract-organic farms in the survey are categorized into three groups according to the length of their organic farming experience and the restrictions on their farming practices. Farmers in the 'certified' organic group include those certified to avoid totally the use of chemical fertilizer, pesticides or herbicides. They are mostly more than four years into organic farming. The 'transitional' organic farming group represents farms, which were under transition (mostly two-four years into organic farming), while the 'initial' organic farming group represents farms, which had just gone organic (mostly one to two years into organic farming). Those in the 'transitional' organic or 'initial organic groups in principle should be committed to stop using chemical fertilizers, pesticides and herbicides. The fact that some still do is likely to be due to an ineffective inspection and certification system. In this sample all organic farmers are contract farmers, while all conventional farmers are non-contract farmers. All certified and transitional organic farmers received a premium price based on their years of organic practice. However not all contract farmers are pure organic farmers making it impossible to completely merge the organic and contract groups.

Table 2 gives the division between different categories of farmers within regions and provinces.

Table 2 Distribution of the sampled rice farms by region, province and special groups

Region	Province	Group	Type of rice produced by group	No. of sample
North	Phayao	Certified organic	Certified organic rice	20
		Conventional	Conventional (using chemical inputs)	23
	ChiangRai	Certified organic	Certified organic rice	21
		Transitional organic	Transitional organic rice	21
		Initial organic	Initial organic rice	21
		Conventional	Conventional (using chemical inputs)	62
		Total sample of contract rice farmers		83
		Total sample of non-contract rice farmers		85
Northeast	Ubon Ratchathani	Certified organic	Certified organic rice	52
		Conventional	Conventional (using chemical inputs)	47
	Surin	Certified	Certified organic rice	14
		Transitional	Transitional organic rice	17
		Initial	Chemical safe (no chemical fertilizer)	11
		Conventional	Conventional (using chemical inputs)	45
	Yasothon	Certified organic	Growing organic rice more than 5 yrs.	15
		Transitional organic	Growing organic for rice 2-4 yrs.	15
		Initial organic	First year transitional organic rice	16
		Conventional	Conventional (using chemical inputs)	45
		Total sample of contract rice farmers		140
		Total sample of non-contract rice farmers		137
Total sample		Total sample of contract rice farmers		223
		Total sample of non-contract rice farmers		222

Source: Survey conducted January-February 2003.

Information on quantity and value of rice output and major inputs were gathered in the farm survey. The major inputs include seed, hired and family labor, chemical fertilizer, organic fertilizer, pesticides and herbicides, fuel, machinery rental, land, and capital assets. In addition, data were collected on the characteristics of farmers and farms.

Table 3 provides a summary of the characteristics of the sampled farms by contract and non-contract farmers and by region. Overall, household heads for contract farms were significantly[2] younger (age of 49 versus 51 years) and better educated (2.86 versus 2.36 years of formal education) than for non-contract farms. These differences were also true for the two regions except that there was no significant difference between the age of the household heads between contract and non-contract farms in the Northern region. With respect to experience in organic rice farming, contract farmers in the North had a significantly higher level than in the Northeast (5.83 versus 3.23 years).

Table 3. Characteristics of sampled farms

	Total Sample Means	Non-Contract Farmers Means	Contract Farmers Means	p-value*
NORTH (No. of farms)	**168**	**85**	**83**	
Age of household head (years)	47.90	47.56	48.24	0.6660
Education of household head (years)	2.52	2.32	2.72	0.0229
Number of household members engaged in rice farming	2.14	2.15	2.13	0.8625
Female members engaged in rice farming (%)	0.48	0.50	0.46	0.5890
Land allocated to rice (rai/farm)	11.98	10.23	13.77	0.0044
Land ownership (%)	85%	76%	94%	0.0013
Years in rice farming	35.47	32.21	38.81	0.0858
Years in fragrant (Hom Mali) rice farming	10.45	8.65	12.29	0.0164
Years in organic rice farming	2.88	0.00	5.83	0.0000
% of saline soil	5%	6%	4%	0.4931
% of income from non-agricultural activities	8%	7%	9%	0.7390
% of agricultural income from rice faming	58%	56%	60%	0.5650
% of labor from family	66%	67%	65%	0.6900
% of seed from own supply	42%	38%	47%	0.2229
% of organic fertilizer from own supply	15%	4%	26%	0.0000
NORTHEAST (No. of farms)	**277**	**137**	**140**	
Age of household head (years)	50.72	52.81	48.68	0.0019
Education of household head (years)	2.67	2.39	2.94	0.0004
Number of household members engaged in rice farming	2.53	2.54	2.51	0.8482
Female members engaged in rice farming (%)	0.54	0.54	0.53	0.9690
Land allocated to rice (rai/farm)	12.17	11.01	13.31	0.0169
Land ownership (%)	93%	92%	94%	0.4478
Years in rice farming	43.00	42.45	43.54	0.6747
Years in fragrant (Hom Mali) rice farming	13.97	16.50	11.49	0.0001
Years in organic rice farming	1.63	0.00	3.23	0.0000

	Total Sample Means	Non-Contract Farmers Means	Contract Farmers Means	p-value*
% of saline soil	8%	9%	7%	0.6204
% of income from non-agricultural activities	14%	16%	12%	0.2790
% of agricultural income from rice faming	62%	61%	64%	0.5320
% of labor from family	76%	76%	76%	0.8783
% of seed from own supply	65%	70%	59%	0.0588
% of organic fertilizer from own supply	56%	53%	60%	0.1223
TOTAL (No. of farms)	**445**	**222**	**223**	
Age of household head (years)	49.66	50.80	48.52	0.0261
Education of household head (years)	2.61	2.36	2.86	0.0000
Number of household members engaged in rice farming	2.38	2.39	2.37	0.8384
Female members engaged in rice farming (%)	0.51	0.52	0.51	0.7310
Land allocated to rice (rai/farm)	12.10	10.71	13.48	0.0003
Land ownership (%)	90%	86%	94%	0.0040
Years in rice farming	40.16	38.53	41.78	0.1378
Years in fragrant (Hom Mali) rice farming	12.64	13.50	11.79	0.0093
Years in organic rice farming	2.10	0.00	4.20	0.0000
% of saline soil	7%	8%	6%	0.4430
% of income from non-agricultural activities	12%	13%	11%	0.4650
% of agricultural income from rice faming	61%	59%	63%	0.3920
% of labor from family	72%	73%	72%	0.7475
% of seed from own supply	56%	58%	55%	0.5299
% of organic fertilizer from own supply	41%	34%	48%	0.0005

* p-value is the smallest level of significance for which we can reject the respective hypothesis test of difference in means between contract and non-contract farmers using the appropriate t-test.

The average number of household members engaged in rice farming was very similar for contract and non-contract farmers (2.37 versus 2.39 persons) overall and in both regions. The percentage of female members engaged in rice farming was also very similar for contract and non-contract farmers (51% versus 52%) overall and in both regions. Overall, contract farmers allocated an average of 13.48 rai of land to rice farming, which was significantly higher than the non-contract farmers who allocated only 10.71 rai. Similar patterns were also exhibited in both regions. With respect to land ownership, while there was no significant difference between contract and non-contract farmers in the Northeast, contract farmers in the North had a higher percentage of ownership than the non-contract farmers (94% vs. 76%). While the percentage of income derived from non-agricultural activities was significantly lower for the farms in the North (8%) than in the Northeast (14%), there were no significant differences between the two contracting groups within each region. As to the percentage of agricultural income derived from rice farming, there were no significant differences between regions and within the two contracting groups.

While farms in the Northeastern region used a significantly higher percentage of family labor (76%) when compared to the North (66%), there were no significant differences between contract and non-contract farmers within each region. While the contract and non-contract farmers in the North on the average showed no significant differences in using their own seeds, non-contract farmers in the Northeastern used significantly more seeds from their own supply than contract farmers (70% versus. 59%). In terms of utilization of organic fertilizers, contract and non-contract farmers in the North were similar in the percentage from their own production (slightly more than half). However, contract farmers in the Northeast used significantly more organic fertilizer derived from own supply than non-contract farmers (26% versus 4%).[3] Finally, both regions had a similar endowment of saline soil and there were no significant differences in soil distribution between contract and non-contract farmers.

Since contract and non-contract farming tend to have different production processes, we estimate their profit efficiency separately.[4] Tables A.1 and A.2 in the Appendix provide the summary statistics of variables used in estimating the profit frontiers for contract and non-contract farms, respectively.

Results: comparative profitability

Since our interest is in the estimation of profit inefficiency and its determinants, we do not focus on the estimates of the stochastic profit frontier except for the derived profit elasticities. Table 4 shows the profit elasticities with respect to the prices of the six variable inputs and the two fixed factors for both contract and non-contract farms. The profit elasticities of contract farms with respect to seed price, wage and energy are negative as expected yet not statistically significant, while the elasticities with respect to the prices of chemical fertilizer, organic fertilizer and machinery are positive yet insignificant.

As to the non-contract farms, the profit elasticities with respect to all the input prices are of the correct sign except for seed, which is also not statistically significant. For both contract and non-contract farms, profit elasticities with respect to the two fixed factors (land and capital) are also of the right sign but capital is not statistically significant. The estimated profit elasticities with respect to land are 0.87 for contract farms and 0.98 for non-contract farms, indicating that profit tends to increase by less than 1% with a 1% increase in land allocated to contract or non-contract rice farming.

Table 4 Estimated profit elasticities for farms

Profit elasticity with respect to	Contract farms		Non-contract farms	
	Elasticity	**p-value**	**Elasticity**	**p-value**
Variable inputs				
Seed price	-0.242	0.151	0.100	0.414
Wage	-0.076	0.277	-0.017	0.884
Chemical fertilizer price	0.106	0.653	-0.012	0.962
Organic fertilizer price	0.021	0.547	-0.171	0.002
Machinery	0.018	0.447	-0.047	0.108
Energy	-0.052	0.119	-0.001	0.985
Fixed inputs				
Land	0.868	0.000	0.975	0.000
Capital	0.006	0.784	0.027	0.385

We first test the hypothesis that 'contract rice farmers are more profitable than non-contract rice farmers for comparable scales of operation.' Full data on the calculations are given in the Appendix table A.3. Here we focus on two distinct measures of profit one deducting only direct cash costs from sales revenue ('profit over cash costs') and the other deducting both cash and imputed non-cash costs ('profit over total variable costs'). We place most emphasis on profit per unit of land (baht per rai).

The profit results are summarized in table 5, which shows that contract farmers had a significantly higher profit over total variable cost in the overall sample and in each region, but particularly in the Northeast. Contract farmers on the average generated a profit over total variable cost of 1,234 baht per rai in the North and 1,098 baht per rai in the Northeast. On the other hand, non-contract farmers produced a profit over total variable cost of 731 baht per rai in the North and only 273 baht per rai in the Northeast. Differences in profitability are less sharp (principally in the North) when costs include only cash costs excluding the imputed value of own inputs, like family labor and seeds ('profits over cash costs'). Differences in profitability can largely be explained by the significantly higher price of rice received by the contract farmers (6.5. versus 6.0 baht/kg in the North and 7.9 versus 5.9 baht/kg in the Northeast). The marked difference in price for organic rice between the two regions is explained by the different price formulae used in private sector-based contract farming in the North and an NGO-based system in the Northeast. In the North the contracting firms offered a fixed margin of 0.5 baht above the market price of conventional rice at harvesting. In the North east the price was fixed at the start of the season based on negotiations between the NGO and the farmers. On the other hand, it is interesting to note that yield in kg per rai or was very similar for the contract and non-contract farmers in both regions. Average yields are considerably lower in the Northeast, however, due to a higher level land degradation.

Table 5. Profitability of rice farming in sample farms

	Total sample	Contract/organic farms				Non-contract /conventional farms	p-value[1]
		Certified	Transitory	Initial	Total		
NORTH (number of farms)	**168**	**41**	**21**	**21**	**83**	**85**	
Profit over total variable costs:							
Profit per unit of land (baht/rai)	980	1,166[a]	1,309[a]	1,291[a]	1,234	731[b]	0.0000
Profit over cash costs:							
Profit per unit of land (baht/rai)	1,847	2,018[a]	2,042[a]	1,927[a]	2,001	1,697[a]	0.0047
Production/Yield (kg/rai)	464	472[a]	477[a]	461[a]	470	458[a]	0.3899
Price of rice (baht/kg)	6.26	6.59[a]	6.45[a]	6.38[a]	6.50	6.02[b]	0.0000

	Total sample	Contract/organic farms				Non-contract /conventional farms	p-value[1]
		Certified	Transitory	Initial	Total		
Farm capital assets (baht/rai)	16,378	18,853 [a,b]	17,956 [a,b]	25,956 [a]	20,423	12,427 [b]	0.0073
NORTHEAST	**275**	**40**	**88**	**11**	**139**	**136**	
Profit over variable costs:							
Profit per unit of land (baht/rai)	690	1,800[a]	833[a]	654[bc]	1,098	273[c]	0.0000
Profit over cash costs:							
Profit per unit of land (baht/rai)	1,644	2,849[a]	1,867[b]	1,416[c]	2,114	1,163[c]	0.0000
Production/Yield (kg/rai)	346	353 [a]	347 [a]	350 [a]	349	342 [a]	0.5881
Price of rice (baht/kg)	6.89	10 [a]	7.14 [b]	6.29 [c]	7.89	5.87 [d]	0.0000
Farm capital assets (baht/rai)	9,062	8,439 [a]	9,651 [a]	8,614 [a]	9,220	8,901 [a]	0.8257
TOTAL	**443**	**81**	**109**	**32**	**222**	**221**	
Profit over variable costs:							
Profit per unit of land (baht/rai)	800	1,479[a]	925[b]	1,072[b]	1,149	449[c]	0.0000
Profit over cash costs:							
Profit per unit of land (baht/rai)	1,721	2,428[a]	1,901[b]	1,752[b]	2,072	1,369[c]	0.0000
Production/Yield (kg/rai)	390	413 [a]	372 [a]	423 [a]	394	387 [a]	0.4828
Price of rice (baht/kg)	6.65	8.27 [a]	7.00 [b]	6.35 [c]	7.37	5.93 [d]	0.0000

	Total sample	Contract/organic farms				Non-contract /conventional farms	p-value[1]
		Certified	Transitory	Initial	Total		
Farm capital assets (baht/rai)	11,836	13,710 [b]	11,251 [b]	19,995 [a]	13,409	10,257 [b]	0.0338

1 p-values are for the respective tests of mean difference between contract farmers and non-contract farmers.
Similar superscript letters across groups denote homogeneous subsets using the Duncan's multiple range test at the 5 % level of significance.

Details of the cost structure of farms are given in Appendix table A.3. In terms of the role of organic farming practices it is important to note that while contract farmers in the Northeast, contracted to an NGO with broader social objectives, appeared wholly organic with zero expenditure on chemical fertilizer, pesticides and herbicides, the transition and initial organic groups in the North continued to use them, due to an ineffective monitoring system operated by the contracting firms, although at lower levels per rai than non-contract farms. For example expenditure on chemical fertilizer per rai in the initial organic group was roughly two-thirds of that for conventional farms. Furthermore, organic farmers in the Northeast used more on-farm organic fertilizer than the contract farmers in the North. Invested capital assets (valued at baht per rai) were significantly higher for contract farmers in the North, while there was no significant difference between contract and non-contract farmers in the Northeast. Farmers in the North were generally far more capitalized than the Northeast.

Table 5 also shows the differences in profit and cost structure among the three organic farmer groups – certified, transitory and initial – indicating their levels of sophistication in organic farming. While organic farmers in the North regardless of their stage of transition achieved similar levels of profit (in terms of profit over cash cost per rai), the certified organic farmers in the Northeast were considerably more profitable than the transitory and initial organic farmers. This is despite the fact that in the North, as we have just noted, there were considerable differences in terms of organic practices between the three different groups, with only the certified group being wholly organic. In the Northeast where profitability was generally lower than the North, the profitability of the initial organic farmers (defined as profit over cash expenditure), who continued to use chemical fertilizers, was roughly 25% above that of conventional farms. This profitability pattern can again be largely explained by the price of rice received by the farmers. While the price of rice was not significantly different among the three organic groups in the North, the price received by the certified organic farmers (10 baht per kg) in the Northeast was considerably higher than that received by the transitory and initial organic farmers (7.1 and 6.3 baht per kg respectively) and nearly double that received by non-contract farmers.

Table 6. Profitability by farm size (profit after cash costs per rai)

Land category	All farms	Non-contract farmers	Contract farmers	p-value*
0-5 rai	1,719[a]	1,374[a]	2,432[a]	0.0000
6-10 rai	1,744[a]	1,413[a]	2,076[ab]	0.0000
11-20 rai	1,723[a]	1,337[a]	2,021[b]	0.0000
>20 rai	1,646[a]	1,276[a]	1,866[b]	0.0057
Total	1,721	1,369	2,072	0.0000

2. p-values are for the respective tests of mean difference between contract farmers and non-contract farmers.

Similar superscript letters across farm size denote homogeneous subsets using the Duncan's multiple range test at the 5 % level of significance.

Table 6 relates profit to farm size. Profit after cash costs for contract farmers per unit of land decreases with the increase in farm size, while for non-contract farmers profit after cash cost is more stable. We find no support for our third hypothesis and conclude from this that contract farming as practiced in these areas of Thailand does not seem to be biased against smaller farms in terms of profitability, as is sometimes argued. Furthermore, for all farm sizes profits are significantly higher for contract farmers, as compared with non-contract farmers.

Selection bias and counterfactual simulation

The above profitability comparison reveals that contract farms in the sample generally have higher profits than non-contract farms. However, this profitability difference does not necessarily indicate that contracting has a positive impact on profits because it could be caused by selection bias. That is, the higher profitability in contract farming may merely reflect the fact that farms with the potential of securing higher profitability are more likely to become contract farms. In other words, these contract farmers might have relatively high profits whether engaging in contract or non-contract farming.

A counterfactual simulation can help sort out the impact of contracting on profitability. In brief, the key to this approach is to estimate farms' counterfactual profits and compare these to their actual profits. The counterfactual profit of a contract farm is defined as the hypothetical profit that it could have earned had it farmed like a (typical) non-contract farm. Similarly, the counterfactual profitability of a non-contract farm is defined as the hypothetical profit that it could have earned had it farmed like a (typical) *contract* farm. Non-contract farms in the sample generally sold their rice at lower prices than contract farms. We use the rice prices of contract (or non-contract) farms in the estimation of the counterfactual profits of non-contract (or contract) farms. Higher actual than counterfactual profits for contract farms would indicate that contract farms would have been less profitable had they operated like a non-contract farm. Similarly, lower actual than counterfactual profits for non-contract farms would indicate that non-contract farms would have been more profitable had they operated like a contract farms.[5]

The counterfactual results are given in table 7. Had contract farms operated like a non-contract farm, their counterfactual profits would (on average) have been 31% lower than their actual profits; the differences are 49% and 21% respectively for contract farms in the North and Northeast. Conversely, had non-contract farms operated like a contract farm, their counterfactual profits would have been 47% higher than their actual profits; the differences are 9.4% (significant at 10% level) in the North and 72% in the Northeast. These results clarify that the observed higher profitability in contract farming is not simply because of contract farming attracting the more profitable farms; rather, it is evidence supporting the hypothesis that contract farming tends to be more profitable than non-contract farming.

Table 7. Counterfactual versus actual profits

Profit	All		North		Northeast	
	Profit differences	p value	Profit differences	p value	Profit differences	p value
Contract counterfactual vs. Contract actual	-31.4%	0.0000	-48.8%	0.0000	-21.1%	0.0059
Non-contract counterfactual vs. Non-contract actual	47.4%	0.0000	9.4%	0.0957	71.8%	0.0000

Results: comparative profit efficiency

Here we test the second hypothesis that 'contract rice farmers are more profit efficient than non-contract rice farmers for comparable scales of operation.' Table 8 shows the profit efficiency, actual profit and profit loss per rai for contract and non-contract farms by region. Profits here are after deducting cash costs only from sales revenue. Profit loss is defined as the amount of unrealized profit due to inefficiency and can be calculated as the difference between maximum possible profit (that is, profit on the profit frontier) for each farm and its actual profit.[6]

The estimated mean profit efficiency score for the entire sample farms is 0.68. In other words, significant profit inefficiency occurred among the sample rice farms in Thailand and farms could increase their profit by 32% or 842 baht per rai by improving their efficiency.

Table 8 Profit efficiency of contract versus non-contract rice farmers

	N	Actual Profit (baht/rai)	Profit Loss (baht/rai)	Profit Efficiency index
All	443	1,721	842	0.68
Contract	222	2,072	906	0.72
Non-contract	221	1,369	778	0.64
p-value		0.0000	0.0388	0.0032
North	168	1,847	650	0.76
Contract	83	2,001	727	0.76
Non-contract	85	1,697	575	0.76
p-value		0.0047	0.0934	0.9916
Northeast	275	1,644	960	0.63
Contract	139	2,114	1,014	0.69
Non-contract	136	1,163	905	0.56
p-value		0.0000	0.1769	0.0002

As shown in Table 8 farmers in the North, where new land was brought into production, exhibited significantly higher profit efficiency than farmers working on the more degraded land of the Northeast, with a mean efficiency of 0.76 versus 0.63. Overall, contract farmers were significantly more profit efficient than non-contract farmers, with a mean profit efficiency of 0.72 versus 0.64. This is also true for farmers in the Northeast where contract farmers are found to be significantly more profit efficient than non-contract farmers (0.69 versus 0.56). However, the efficiency scores of contract and non-contract farmers in the North were virtually the same on average, although the scores were more diverse among the non-contract farmers.

Table 9 shows the profit efficiency across different farm sizes for contract and non-contract farmers. Similar to profitability, contract farmers had higher profit efficiency for all farm sizes except those greater than 20 rai. Contract farmers appear to show a slight tendency to decreasing profit efficiency for larger farm sizes, while non-contract farmers are more homogeneous across all farm sizes. Similar to the profitability, comparison by farm size, with respect to profit efficiency contract farming does not seem to be biased against smaller farms.

Table 9 Profit efficiency by farm size

Farm Size	0-5 rai	6-10 rai	11-20 rai	>20 rai
All Farms				
Actual profit (per rai)	1,719[a]	1,744[a]	1,723[a]	1,646[a]
Profit loss (per rai)	821[b]	774[b]	850[b]	1,067[a]
Profit Efficiency	0.69[a]	0.70[a]	0.67[a]	0.64[a]
Non-Contract Farms				
Actual profit (per rai)	1,374[a]	1,413[a]	1,337[a]	1,276[a]
Profit loss (per rai)	801[a]	762[a]	764[a]	818[a]
Profit Efficiency	0.64[a]	0.65[a]	0.62[a]	0.64[a]
Contract Farms				
Actual profit (per rai)	2,432[a]	2,076[ab]	2,021[b]	1,866[b]
Profit loss (per rai)	862[b]	786[b]	916[b]	1,215[a]
Profit Efficiency	0.78[a]	0.75[a]	0.70[ab]	0.64[b]
p-value of profit efficiency between contract and non-contract farmers	0.0276	0.0325	0.1351	0.9902

Note: Similar superscript letters across farm size denote homogeneous subsets using the Duncan's multiple range test at the 5 % level of significance.

Table 10 shows profit efficiency among the different groups of organic farms we have identified. Farmers with a longer history and more experience in organic farming (the 'certified' group) appear to be more profit efficient, as well as more profitable. However, multiple range tests show that all three groups of organic farmers in the North exhibited similar profit efficiency as well as profitability. In fact, in terms of profit efficiency they were not different from the conventional non-contract farmers. In the Northeast profit efficiency was not statistically different between the certified and transitory groups, although it was higher for these than for the initial organic group, whose efficiency was statistically similar to that of conventional non-contract farmers.

Table 10 Profit efficiency by different stages of organic farming

	Certified Organic	Transitory Organic	Initial Organic	All Organic	Conventional
All Farms					
Actual profit (per rai)	2,428[a]	1,901[b]	1,752[b]	2,072	1,369[c]
Profit loss (per rai)	956[a]	904[a]	790[a]	906	778[a]
Profit Efficiency	0.75[a]	0.71[b]	0.70[ab]	0.72	0.64[b]
North					
Actual profit (per rai)	2,018 [a]	2,042 [a]	1,927 [a]	2,001	1,697 [a]
Profit loss (per rai)	745[a]	691[a]	727[a]	727	575[a]
Profit Efficiency	0.77[a]	0.77[a]	0.75[a]	0.76	0.76[a]
Northeast					
Actual profit (per rai)	2,849[a]	1,867[b]	1,416[c]	2,114	1,163[c]
Profit loss (per rai)	1,172[a]	955[a]	909[a]	1,014	905[a]
Profit Efficiency	0.73[a]	0.69[ab]	0.60[ab]	0.69	0.56[b]

Note: Similar superscript letters across groups denote homogeneous subsets using the Duncan's multiple range test at the 5 % level of significance.

Counterfactual simulation for profit efficiency

Similar to the case of the actual-counterfactual profitability comparison, the difference in profit efficiency between contract and non-contract farming can also be evaluated through comparing actual and counterfactual efficiency. The methodology is similar to that used in estimating the counterfactual profitability. To estimate the counterfactual efficiency of a contract farm (that is its profit efficiency when hypothetically operating like a non-contract farm), the first step is to use the estimated profit frontier of non-contract farming to estimate the maximum profit the contract farm would have obtained had it produced like a non-contract farm with 100 percent efficiency.[7] The second step is to use its hypothetical profit estimated from the counterfactual profit simulation to represent its counterfactual profit in non-contract farming. Then the difference between this counterfactual profit and the counterfactual frontier can be used to measure the farm's counterfactual efficiency. The counterfactual efficiency of a non-contract farm can be estimated similarly.

Table 11 shows that contract farms in the entire sample would not have had very different counterfactual efficiency from their actual efficiency (69% versus 70%) had they operated like a non-contract farm. This mainly reflects the situation in the Northeast, while contract farms in the North would have reduced their efficiency from 74% to 68% by counterfactually operating like a non-contract farm. With respect to the non-contract farms, generally for the entire sample, non-contract farms would have had a slightly higher counterfactual than actual efficiency (69% versus. 66%), and the difference is statistically significant at 10%. Again, this mainly reflects the situation in the Northeast (68% versus 59%), while surprisingly the non-contract farms in the North would have had lower counterfactual efficiency than their actual efficiency (69% versus. 77%).

In summary, the results from the counterfactual efficiency estimations are mixed and do not generally support the hypothesis that contract farming enhances profit efficiency. Indeed, the efficiency patterns appear to be different between the North and Northeast regions, perhaps due to different contract management systems and different land endowments.

Table 11 Counterfactual versus actual efficiency

Counterfactual versus actual[1]	Average profit efficiency[2]		
Contract farming	**Entire**	**North**	**Northeast**
Contract counterfactual	0.6879	0.6798	0.6928
Contract actual	0.6988	0.7409	0.6736
p-value	0.4965	0.0326	0.3096
Non-contract farming	**Entire**	**North**	**Northeast**
Non-contract counterfactual	0.6854	0.6873	0.6841
Non-contract actual	0.6596	0.7658	0.5913
p-value	0.1284	0.0009	0.0000

Notes:
1. 222 contract farms (83 in the North; 139 in the Northeast); 212 non-contract farms (83 North; 129 Northeast).
2. Efficiency scores are slightly different from those reported in the previous table that include the nine non-contract farms with negative profits (see footnote 6).

Conclusions

The results of the empirical analysis lend credence to the contention that contract farming can be an effective institutional mechanism to reduce transaction costs faced by small-scale, poor rice farmers and hence increase profitability and reduce rural poverty. Our results show that for the sample contract rice farmers are more profitable than non-contract farmers by a significant margin. This is also true for each of the two regions in the sample. This profitability gap holds for alternative definitions of profitability and for all scales of operation. In terms of scale of operation there is no evidence that contract farming is biased against small farmers and profits per unit of land decline with farm size, being highest for farms below 5 rai. Counterfactual simulations suggest this is not due to selection bias with the more profitable farms shifting to contracting arrangements.

There is significant profit inefficiency among the sample rice farmers in Thailand. Overall, rice farmers in Thailand could increase their profit by more than 30%. Again overall the efficiency losses are greater for non-contract farms, although there is only a significant difference in the Northeast region, where land is significantly more degraded than in the North. Counterfactual simulations indicate that only in the Northeast would shifting to contract farming raise efficiency amongst non-contract farms. Farm size seems to have little impact on profit efficiency, although contract farms below 5 rai show higher efficiency than larger farmers.

The major factor driving these results appears to be the higher prices received by contract farmers (rather than by higher yields for example). These higher prices are in turn due to the fact that contract farmers (particularly the NGO-based fair trade network operation in the Northeast) are growing high quality organic rice that commands a premium price. As noted above, the analysis does not allow us to disentangle the effects of contracting arrangements from the use of organic farming technology. However as a group the well-established ('certified') organic farmers show considerably higher profitability than other contract farmers in the Northeast. In the North, where organic practices are less strictly enforced in the sample farms, there seems no significant difference between the profitability of the permanent, transition and initial organic groups, even though the latter two continue to use some chemicals and pesticides. All organic groups in both regions show a significantly higher profitability than non-contract, conventional farmers when we measure profits by deducting non-cash costs ('profits over total variable costs').

With respect to the development of organic farming, the results from the present study show a distinctive development path in the different parts of the country. In Northeast Thailand where farmers have converted from conventional chemical to organic farming on degraded land, profitability initially is relatively low (although still higher than that in similar, non-contract conventional farms) and increases with the number of years of organic operation. In other words, during the transition years, profits are low and as ecosystems restore themselves, the farms become more profitable and profit efficient. In Northern Thailand, on the other hand, where new marginal land was brought into organic production, this pattern of increasing profit and profit efficiency over the years is not found, although profits are higher than on conventional farms. Since farms in the Northern region are on less degraded land than are farms in the Northeast, initial and transitional profitability from partial organic agriculture is much higher in the North than in the Northeast and conventional rice farming also generates considerably higher profitability there than in the Northeast. These profitability figures simply reflect the market price value of rice output and if the definition of benefits were widened to include the potential environmental (avoidance of pollution from agro-chemicals leaching) and health benefits (farmers not exposed to pesticides) of organic farming the economic returns to organic farming are likely to be even greater.

This analysis suggests that a combination of contract and organic farming has been effective in enhancing the profitability and to some extent the efficiency of small-scale rice farmers in Thailand. Particularly in the case of provinces in Northeast Thailand where a majority of the poor resides and where the green revolution has not been effective in addressing poverty, and has worsened ecosystems, contract farming of organic rice is shown to be effective means of raising incomes and by implication addressing rural poverty. There are lessons here for Lao PDR and Cambodia.

Appendix Table A. 1 Summary statistics of variables used in frontier estimation (contract farms)[1]

Variable	Unit	Mean	SD	Min	Maxi
Output, profit, prices and fixed inputs:					
Rice output	kg	5,134	3,444	400	22,500
Variable profit (Gross revenue less total cash cost)	baht/farm	26,692	18,207	2,495	90,881
Rice price	baht/kg	7.37	1.39	5	10
Seed price	baht/kg	9.88	1.48	6	15
Hired labor wage	baht/person /day	195	365	21	4,600
Chemical fertilizer price	baht/kg	7.04	0.18	6	8
Organic fertilizer price	baht/kg	2.08	3.17	0.15	28
Machinery power	baht/rai	213	211	5	1,010
Fuel price	baht/rai	5.76	5.09	0.10	33
Land	rai	14	8.58	1	60
Capital	bath	53,265	67,557	204	543,717
Farm-specific variables:					
Farm characteristics and endowments					
Regional dummy (North=1; Northeast=0)	0/1	0.37	0.48	0	1
Farm size	Rai	14	8.58	1	60
Land ownership (own=1; rent=0)[2]	0/1	0.94	0.24	0	1
Rice income in total agricultural income	%	63%	25%	8%	100%
Demographic and other characteristics of household head					
Experience in fragrant rice farming	years	12	9.82	1	50
Level of formal education	years	2.86	1.38	1	8
Age	years	49	11	30	76
Non-agricultural income in total household income	%	11%	20%	0%	92%
General production practices					
Amount of own labor	%	72%	26%	9%	100%
Amount of own organic fertilizer	%	47%	39%	0%	100%
Amount of own seed	%	55%	50%	0%	100%

Notes:

1 Among the 223 contract farms in the sample, only 222 are used in the regression, with one outlier excluded.

2 Farms with more than 50% of lands owned are considered an 'owner's farm'; those with less than 50% of lands owned are considered a 'rented farm'.

Table A. 2. Summary statistics of variables used in frontier estimation (non-contract farms)[1]

Variable	Unit	Mean	SD	Min	Max
Output, profit, prices and fixed inputs:					
Rice output	kg	4,106	3,050	360	25,000
Variable profit (Gross revenue less total cash cost)	baht/farm	15,114	13,182	180	107,350
Rice price	baht/kg	5.94	0.72	4	12
Seed price	baht/kg	9.66	2.45	5	20
Hired labor wage	baht/person /day	144	87	36	952
Chemical fertilizer price	baht/kg	7.02	0.47	5	9
Organic fertilizer price	baht/kg	1.29	1.88	0.13	25
Machinery power	baht/rai	237	209	5	1,159
Fuel price	baht/rai	6.12	4.46	0.21	32
Land	rai	11	7.36	1	50
Capital	bath	34,115	44,882	235	366,981
Farm-specific variables:					
Farm characteristics and endowments					
Regional dummy (North=1; Northeast=0)	0/1	0.39	0.49	0	1
Farm size	Rai	11	7.36	1	50
Land ownership (own=1; rent=0)[2]	0/1	0.86	0.35	0	1
Rice income in total agricultural income	%	59%	27%	7%	100%
Demographic and other characteristics of household head					
Experience in fragrant rice farming	years	13	9.34	1	50
Level of formal education	years	2.38	1.06	1	8
Age	years	51	11	29	85
Non-agricultural income in total household income	%	12%	23%	0%	89%
General production practices					
Amount of own labor	%	74%	27%	8%	100%
Amount of own organic fertilizer	%	35%	44%	0%	100%
Amount of own seed	%	57%	49%	0%	100%

Notes:
1 Only 212 among the 222 non-contract farms in the sample are used in the regression; one outlier is excluded and another 9 farms are excluded as they have negative profits.
2 Farms with more than 50% of lands owned considered an owners farm; those with less than 50% of lands owned considered a rented farm.

Table A. 3. Costs and returns of rice farming in Thailand

	Total sample	Contract/organic farms				Non-contract /conventional farms	p-value[1]
		Permanent	Transitory	Initial	Total		
NORTH (number of farms)	**168**	**41**	**21**	**21**	**83**	**85**	
Profit over total variable costs:							
Total profit (baht)	13,680	17,437 [a,b]	21,015[a]	15,754 [a,b]	17,916	9,543[b]	0.0009
Profit per unit of land (baht/rai)	980	1,166[a]	1,309 [a]	1,291[a]	1,234	731 [b]	0.0000
Profit per unit of production (baht/kg)	1.98	2.34 [a]	2.68 [a]	2.61 [a]	2.50	1.48 [b]	0.0000
Profit over cash costs:							
Total profit (baht)	21,800	27,377 [a]	30,731 [a]	22,371 [a,b]	26,959	16,762 [b]	0.0001
Profit per unit of land (baht/rai)	1,847	2,018 [a]	2,042 [a]	1,927 [a]	2,001	1,697 [a]	0.0047
Profit per unit of production (baht/kg)	3.90	4.23 [a]	4.23 [a]	4.07 [a]	4.19	3.62 [a]	0.0018
Production/Yield (kg/rai)	464	472 [a]	477 [a]	461 [a]	470	458 [a]	0.3899
Price of rice (baht/kg)	6.26	6.59 [a]	6.45 [a]	6.38 [a]	6.50	6.02 [b]	0.0000
Cash costs (baht/rai):[2]	1,061	1,095 [a]	1,034 [a]	1,022 [a]	1,061	1,060 [a]	0.9867
Labor	406	440 [a]	368 [a]	349 [a]	399	414 [a]	0.7706
Seed	57	44 [a]	43 [a]	76 [a]	51	62 [a]	0.3598
Chemical fertilizer	136	0 [d]	85 [c]	138 [b]	56	214 [a]	0.0000
Organic fertilizer	95	217 [a]	161 [a]	96 [b]	172	19 [c]	0.0000
Pesticides and herbicides	5.61	0[c]	3.51 [a,b]	2.38 [a,b]	1.49	9.63 [a]	0.0016
Fuel	93	98 [a]	79	115 [a]	98	88 [a]	0.4546
Machinery power	267	295 [a]	295 [a]	246 [a]	282	253 [a]	0.4328
Non-cash costs (baht/rai):	868	852 [a]	733 [a]	636 [a]	767	966 [a]	0.0375
Labor	774	645 [a,b]	620 [a,b]	574 [b]	621	923 [a]	0.0014
Seed	42	57 [a]	51 [a]	33 [a]	50	34 [a]	0.0972
Organic fertilizer	52	150 [a]	62 [b]	28 [b]	97	8.75 [b]	0.0011
Total variable costs (baht/rai)	1,928	1,946 [a,b]	1,768 [a,b]	1,658 [b]	1,828	2,026 [a]	0.0401
Farm capital assets (baht/farm)	57,322	75,494 [a]	79,081 [a]	63,113 [a]	73,269	41,751 [a]	0.0039
Farm capital assets (baht/rai)	16,378	18,853 [a,b]	17,956 [a,b]	25,956 [a]	20,423	12,427 [b]	0.0073

	Total sample	Contract/organic farms				Non-contract /conventional farms	p-value[1]
		Permanent	Transitory	Initial	Total		
NORTHEAST	**275**	**40**	**88**	**11**	**139**	**136**	
Profit over variable costs:							
Total profit (baht)	9,983	22,606[a]	13,071[b]	5,531[c]	15,218	4,633[c]	0.0000
Profit per unit of land (baht/rai)	690	1,800[a]	833[a]	654[bc]	1,098	273[c]	0.0000
Profit per unit of production (baht/kg)	1.66	4.97[a]	2.21[b]	1.60[b]	2.96	0.34[c]	0.0000
Profit over cash costs:							
Total profit (baht)	19,726	35,203[a]	24,320[b]	12,693[c]	26,532	12,771[c]	0.0000
Profit per unit of land (baht/rai)	1,644	2,849[a]	1,867[b]	1,416[c]	2,114	1,163[c]	0.0000
Profit per unit of production (baht/kg)	4.66	8.07[a]	5.34[b]	3.85[c]	6.01	3.29[c]	0.0000
Production/Yield (kg/rai)	346	353[a]	347[a]	350[a]	349	342[a]	0.5881
Price of rice (baht/kg)	6.89	10[a]	7.14[b]	6.29[c]	7.89	5.87[d]	0.0000
Cash costs (baht/rai):[2]	725	631[a]	592[a]	810[a]	621	831[a]	0.0006
Labor	281	239[a]	274[a]	369[a]	272	290[a]	0.6599
Seed	16	2.40[a]	17[a]	14[a]	13	18[a]	0.1388
Chemical fertilizer	95	0[b]	0[b]	0[b]	0	192[a]	0.0000
Organic fertilizer	101	174[a]	114[a,b]	191[a]	137	65[b]	0.0000
Pesticides and herbicides	1.33	0.00[a]	0.00[a]	0.00[a]	0	2.69[a]	0.0001
Fuel	37	49[a,b]	33[b]	69[a]	40	34[b]	0.2596
Machinery power	193	166[a]	154[a]	167[a]	158	228[a]	0.0079
Non-cash costs (baht/rai):	954	1,049[a]	1,033[a]	761[a]	1,016	890[a]	0.0585
Labor	697	677[a]	726[a]	512[a]	695	699[a]	0.9387
Seed	58	69[b]	39[b]	107[a]	53	63[b]	0.1981
Organic fertilizer	199	303[a]	269[a]	142[b]	269	127[b]	0.0000
Total variable costs (baht/rai)	1,679	1,680[a]	1,625[a]	1,572[a]	1,637	1,721[a]	0.2746
Farm capital assets (baht/farm)	36,191	34,618[a]	45,367[a]	33,311[a]	41,320	30,950[a]	0.0628
Farm capital assets (baht/rai)	9,062	8,439[a]	9,651[a]	8,614[a]	9,220	8,901[a]	0.8257
TOTAL	**443**	**81**	**109**	**32**	**222**	**221**	
Profit over variable costs:							
Total profit (baht)	11,385	19,989[a]	14,601[b]	12,240[b]	16,227	6,522[c]	0.0000
Profit per unit of land (baht/rai)	800	1,479[a]	925[b]	1,072[b]	1,149	449[c]	0.0000

	Total sample	Contract/organic farms				Non-contract /conventional farms	p-value[1]
		Permanent	Transitory	Initial	Total		
Profit per unit of production (baht/kg)	1.78	3.64[a]	2.30[b]	2.26[b]	2.78	0.78[c]	0.0000
Profit over cash costs:							
Total profit (baht)	20,513	31,242[a]	25,555[b]	19,044[c]	26,692	14,306[c]	0.0000
Profit per unit of land (baht/rai)	1,721	2,428[a]	1,901[b]	1,752[b]	2,072	1,369[c]	0.0000
Profit per unit of production (baht/kg)	4.37	6.13[a]	5.13[b]	4.00[c]	5.33	3.41[c]	0.0000
Production/Yield (kg/rai)	390	413[a]	372[a]	423[a]	394	387[a]	0.4828
Price of rice (baht/kg)	6.65	8.27[a]	7.00[b]	6.35[c]	7.37	5.93[d]	0.0000
Cash costs (baht/rai):[2]	852	866[a]	677[b]	949[a]	785	919[a]	0.0053
Labor	328	341[a]	292[a]	356[a]	319	338[a]	0.5746
Seed	31	24[b]	22[b]	54[a]	27	35[b]	0.1303
Chemical fertilizer	111	0[c]	16[c]	91[b]	21	201[a]	0.0000
Organic fertilizer	99	196[a]	123[b]	128[b]	150	47[c]	0.0000
Pesticides and herbicides	2.95	0[b]	0.68[b]	1.56[b]	0.56	5.36[a]	0.0000
Fuel	59	74[a,b]	42[c]	99[a]	62	55[b,c]	0.2916
Machinery power	221	231[a]	181[a]	219[a]	205	238[a]	0.1334
Non-cash costs (baht/rai):	921	949[a]	975[a]	679[b]	923	919[a]	0.9461
Labor	726	661[a,b]	705[a,b]	553[c]	667	785[a]	0.0199
Seed	52	63[a]	41[a]	59[a]	52	52[a]	0.9319
Organic fertilizer	143	225[a]	229[a]	68[b]	204	82[b]	0.0000
Total variable costs (baht/rai)	1,773	1,815[a]	1,653[a]	1,628[a]	1,708	1,838[a]	0.0336
Farm capital assets (baht/farm)	44,205	55,309[a]	51,863[a]	52,869[a]	53,265	35,104[a]	0.0009
Farm capital assets (baht/rai)	11,836	13,710[b]	11,251[b]	19,995[a]	13,409	10,257[b]	0.0338

Notes:
1 p-values are for the respective tests of mean difference between contract farmers and non-contract farmers.
Similar superscript letters across organic groups denote homogeneous subsets using the Duncan's multiple range test at the 5 % level of significance.
2. Besides those listed in the table, cash costs also include certification fees for organic farms.

[1] Our analysis follows Battese and Coelli (1988, 1995); for further details see Coelli et al (1998).
[2] Significance herein refers to statistical significance.
[3] It should be noted that there is a high cash cost associated with organic fertilizers, which is interesting as we would normally assume that organic fertilizers are derived from farm wastes (such as compost) and therefore is appropriate for farmers who do not have access to credit. In the case of Thailand, it appears from the survey that there are commercial forms of organic fertilizers and farmers in the North do have cash to purchase these.
[4] An alternative is to include contract and non-contract farms in a single estimation and use a dummy variable to distinguish them. However, as pointed out by Delgado et al. (2003), Warnings and Key (2002), and Larsen and Foster (2005), such specifications may lead to self-selection or simultaneity bias since the decision to be a contract or organic farmer may not be independent from other production decisions.
[5] Methodologically, our counterfactual simulations are based on a switching regression model (Maddala 1983, Chapter 8 and 9) and follow the two-stage estimation process suggested by Heckman (1976).

Let $p_i = 1$ if farm *i* is a contract farm; and $p_i = 0$ otherwise. Then we first use the profit model to estimate a selection model specified as $I_i^* = \delta Z_i + \varepsilon_i$, where I_i^* is a latent index capturing how farms choose between contract and non-contract farming; specifically farm *i* would choose contract farming (*i.e.* $p_i = 1$) if $I_i^* > 0$ and non-contract farming (*i.e.* $p_i = 0$) if otherwise. Z_i is farms' characteristics that affect the probability of their choices between contract and non-contract farming.

[6] Profit efficiency reported is an index adjusted by including nine negative profit observations that were dropped from the estimation The profit efficiency measure PE_i which measures the ratio of a farm's actual profit to its maximum attainable profit, is not well defined when actual profits are negative. Since all the cases of negative profits are non-contract farms, excluding them would lead to biased results. Therefore, we apply the following measure of the profit efficiency of farms with negative actual profits. We first calculate the absolute value of profit loss of each of the nine negative profit farms compared to its estimated maximum attainable profit; let us denote such profit losses as $\Delta\pi_i$. Then, the profit efficiency of say farm *i* among these 9 negative-profited farms is measured by $-\Delta\pi_i / \max(\Delta\pi_j)$, where $\max(\Delta\pi_j)$ represents the greatest profit loss among these 9 farms. Under this profit efficiency measure, the profit efficiency score of a farm with negative profits would be negative and at the range of [-1, 0). The one with the largest profit loss would have profit efficiency score of -1; and the closer a farm's negative profit efficiency to zero, the greater its profit efficiency score would be compared to other farms with negative actual profits. That farms with positive (or negative) actual profits have positive (or negative) profit efficiency scores implies that farms with negative actual profits must be less efficient than those with positive profits. This makes sense because farms with negative profits have lost more than whatever attainable profits they may have. Considering that we have used the least efficient farm as a benchmark to index the profit efficiency of farms with negative profits, we adjust the efficiency measure for positive profit farms accordingly by using $PE_i / \max(PE_j)$ to measure farm *i*'s efficiency. In sum, the adjusted profit efficiency scores are in the range of [-1, 1]. Farms with positive actual profits have positive profit efficiency scores, while farms with negative profits with negative scores. The greater a farm's score is, the more profit efficient it is.

[7] Similar to the estimation of counterfactual profits, we use the rice prices of non-contract farms to simulate contract farms' counterfactual rice prices.

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