Cost-Benefit Model in Decision Making for Smallholder Farmers in Contract Farming Adoption

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Abstract

Smallholder farmers have a small area of land and have very limited access to capital. Contract farming is an alternative to liberate them from their limitations. This research applies net present value breakeven analysis and an optimization model in a cost-benefit approach to calculate the minimum land size for investment in contract farming. This analysis is based on land size, loan interest rate, and the timing of investment in no-contract farming and contract farming adoption. Numerical results which are obtained from baby corn farming in Thailand suggest that the model could provide essential information for smallholder farmers in deciding whether or not to adopt contract farming. It could be useful for smallholder farmers, policymakers, and financial institutions for decision on contract farming.

Keywords: *Smallholder Farmers, Contract Farming, Minimum Land-use, Net Present Value, Applied Optimization*

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แบบจำลองช่วยการตัดสินใจสำหรับเกษตรกรรายย่อย ในการทำเกษตรพันธสัญญา

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บทคัดย่อ

เกษตรกรรายย่อยมีพื้นที่การเกษตรขนาดเล็กและมีข้อจำกัดในการเข้าถึงแหล่งทุน เกษตรพันธสัญญาเป็นอีกทางเลือกหนึ่งที่ช่วยให้เกษตรกรเป็นอิสระจากข้อจำกัดดังกล่าว งานวิจัยนี้นำวิธีการหาสมดุลของมูลค่าปัจจุบันสุทธิและการประยุกต์การสร้างประโยชน์ให้มากที่สุด เพื่อคำนวณหาขนาดพื้นที่น้อยที่สุดในการลงทุนทำเกษตรพันธสัญญา การวิเคราะห์เพื่อการตัดสินใจนี้เกี่ยวข้องกับขนาดพื้นที่การเกษตร อัตราดอกเบี้ยเงินกู้และระยะเวลาในการลงทุนทั้งในแบบเกษตรพันธสัญญาและในแบบอิสระ แบบจำลองช่วยการตัดสินใจถูกนำไปประยุกต์ใช้กับข้อมูลผลผลิตข้าวโพดอ่อนในประเทศไทย ผลการคำนวณสรุปได้ว่า แบบจำลองนี้สามารถประมวลข้อมูลการผลิตและข้อมูลการเงินเพื่อช่วยในการตัดสินใจของเกษตรกรรายย่อยว่าจะลงทุนในเกษตรพันธสัญญาหรือไม่ นอกจากมีประโยชน์ต่อเกษตรกรรายย่อยแล้ว แบบจำลองนี้จะเป็นประโยชน์ต่อผู้วางนโยบายและสถาบันการเงินเพื่อช่วยประกอบการตัดสินใจว่า ควรจะส่งเสริมเกษตรพันธสัญญาในกลุ่มเกษตรกรเป้าหมายหรือไม่

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Introduction

According to World Bank (2012) statistics in 2012, the agricultural sector contributes between 10 and 30 percent to GDP in developing countries. This study shows that in these countries, farmers or small farms (henceforth in this article, we will use the term smallholder farmers (SF)) with a farm size of 1 ha (Reardon et al., 2009) or less constitute a large fraction of the national population and mostly live in rural areas. They play an important role for food security as producers, upstream of the agricultural supply chain. Their small farm size leads to high unit transaction costs, mostly non-labor transactions, in accessing capital, market and technical information, input and output markets, and in providing product traceability and quality assurance (Poulton et al., 2010). The high transaction costs affect their inefficient production and their poverty, with large needs for external sources of capital, but limited assets for collateral. This study suggests that if we empower the communities of SF to better utilize the land, they will improve the personal economics of the rural farmers and improve agricultural supply chains to ensure food security at the same time.

As mentioned before, SF have small plots of land and limited access to capital. With these constraints in mind, many policies and programs have been introduced to increase and stabilize farmer income, thereby reducing the degree of poverty and simultaneously increasing food security. One of these programs is contract farming (CF), in which production and supply of agricultural products are produced under forward contracts. CF has been employed with several benefits, to gain access to a larger market, gain a higher income, which is more stable through time, and gain access to better channels of financial support (Goodhue, 1999; Minten et al., 2009; Miyata et al., 2009). It is argued that CF benefits not only farmers and traders, but also consumers. CF is attractive for farmers who would like to expand their production as well as seek additional sources of capital and a more certain price by shifting a part of crop price variation to traders with future agreed prices (Hill and Ingersent, 1982). They also get access to new technology and inputs such as high quality seed, fertilizer, and chemical applications, which otherwise may be beyond their reach (Goldsmith, 1985). Many contracts provide fertilizer, pesticide, equipment, and other agricultural inputs; some even monitor the growing processes for the farmers. This kind of support is offered most frequently in developing countries since farmers there mostly do not have the established quality and safety standards as many countries in Europe and in the U.S. (Marcoul and Veyssiere, 2010).

CF seems beneficial especially to SF; however, CF requires higher investment than conventional farming in order to meet the quality and quantity requirements stated in the contract, so the match is not perfect. Even though some supermarkets directly assist farmers in the contract on their production or market channel, they are limited to the degree they are willing to help. When SF have limited resources, they seek credit and financial support to overcome input supply problems (Janvry et al., 1991; Grosh, 1994; Dorward et al., 1998; Delgado, 1999; Key and Runsten, 1999; Key et al., 2000; Govereh and Jayne, 2003). Without financial support, SF mostly often face financial problems when acquiring necessary equipment and other resources to satisfy the critical requirements of the client, guaranteed quantity, and minimum quality. Sriboonchitta and Wiboonpoongse (2008) present a list of lessons learned from CF in Thailand. One of the important issues is, farmers need information on risk management, so they can decide between contract and no-contract cultivation. Even though CF leads to better coordination of local production activities and can reduce transaction costs (Grosh, 1994; Key and Runsten, 1999), a question remains of how much arable land should be brought into CF schemes? Two questions from the farmer's perspective are: Should money be borrowed to enter into CF? and how long should they adopt CF for the benefits?

There are clearly advantages and disadvantages of CF. This research focuses on assisting SF who likely do not have the background or access to people with the background to effectively evaluate different options, and select the best alternative for them. The decision support tool described in this article will assist SF in evaluating some of the key decisions surrounding CF: Should they put their land into CF and, if so, how much should be reserved for this purpose? To comply with the contract, how many years are required for adoption? Should CF be an option only if the SF can finance an enterprise internally or should a loan be acquired? If sought, what is the maximum interest rate for the proposition to be financially beneficial?

There are several fundamental methods employed in investment analysis, including net present value (NPV), benefit-cost ratios (BCR), internal rate of return (IRR), and the payback period. Most decision-making in capital budgeting follows the NPV method (Lin, 2009). Research using NPV for determining arable land size to dedicate to CF typically maximizes NPV when the land size is fixed (see Khanna et al., 2000, for example). An econometric analysis framework that determines differences in the characteristics of contract and independent farmers is found in Miyata et al. (2009). They noted that in determining the degree of small-scale farming, including the amount of arable land which should be brought into CF, it deserves more study, and this is the focus of our research.

We implement breakeven NPV analysis and an optimization model to develop a decision support tool for SF. This will help determine the minimum land size that can be brought into CF with full consideration of other critical decisions like self-financing or borrowing money, interest rates on loans, whether it is the preferred decision, and the length of the contract. A numerical study is performed using data from baby corn farming in Thailand collected by Thongthammachat (2007).

Literature Review

Definition of Smallholder Farming and Criteria

For farms that report farming as their major occupation, different regions use different definitions and criteria to define smallholder farming. The USA and EU-27 countries use economic size. In the U.S., USDA defines a farm as a small farm when its sales are less than 250,000 dollars per year (Hoppe et al., 2010). Likewise, the European Network for Rural Development defines a farm as a small farm when the Standard Gross Margin (SGM) is less than eight European size units (ESU) or 9,600 Euros per year; one ESU equals 1,200 Euros (European Network for Rural Development, 2010). There are widely used farm sizes for SF that vary in each country if we focus on arable land requirements (Otsuka, 2007). According to Reardon et al. (2009), the average land owned by SF is 1 ha. In Thailand, an average land size is 3.4 ha (Fan and Chan-Kang, 2005). In our study, we use land size criteria following Reardon et al. (2009) for generic SF.

Contract Farming

Contract farming, also known as an outgrower scheme, is broadly defined as binding arrangements through firms such as the Passicol Company of Colombia, Nestle Corporation of Malaysia, and C.P. Group of Thailand, which ensure the supply of agricultural products by individuals or groups of farmers (OECD, 2008). In this strategy, the production and supply of agricultural products are produced under forward contracts. This requires that a specific agricultural commodity type shall be delivered at a specified time, for a predefined price, and in the quantity required by the known buyer. "Since the 1970's, CF had become a topic of interest and the source of a long debate regarding the role of CF because SF had entered into domestic or export supply chains and have an essential role in rural development and assistance in poverty alleviation in developing countries" (Morrissy, 1974; Glover, 1984; Minot, 1986; Glover, 1990).

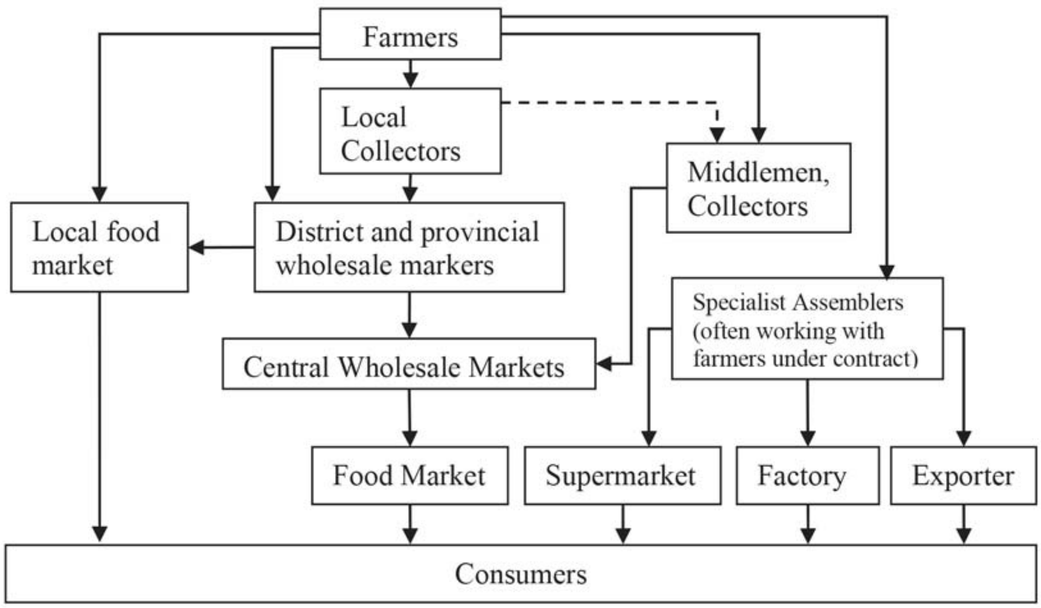

Figure 1: Vegetable Distribution Channels in Thailand. Middle: Traditional Multi-step Chain Through Local Collectors and Middlemen. Right: Contract Farming with Fewer Steps to End-markets (Johnson et al., 2008)

When compared to the traditional marketing chain, the modern trend of contract farming has simpler and fewer steps (Johnson et al., 2008), see Figure 1. In most cases, CF is designed to provide incentives for performance and/or to facilitate risk sharing for price, quantity, and/or quality (Goodhue, 1999; Key and McBride, 2003). A contract specifies the four following items in an agreement: 1) pre-agreed price, 2) quality of the product, 3) quantity of product or land size used in the contract, and 4) time to delivery. There are three types of contracts: 1) procurement contracts in which sale and purchase conditions are specified, 2) partial contracts – only some of the inputs are supplied by the contracting firm with selling at pre-agreed prices; and 3) total contracts under which the contracting firm supplies and manages all the inputs, and the farmer becomes only a supplier of land and labor (Hill and Ingersent, 1982; Key and Runsten, 1999). The third type of contract is increasingly dominating developing markets like Thailand because it can ensure quality and yield through proper leveraging of economies of scale. Stakeholders in agribusiness in CF schemes are vertically integrated. The purchasing firms provide credit, a guaranteed price at harvest, and inputs such as seed, fertilizer, and technical assistance that SF need to cultivate, and lucrative nontraditional crops (Morrissy, 1974; Glover, 1984; Goldsmith, 1985; Williams and Karen, 1985). This support from the purchasing firms alleviates uncertainty of prices and input costs for farmers; however, the firms demand that farmers strictly adhere to the contract terms regarding delivery time, quality, and quantity. Therefore, SF must be certain that they can deliver as promised before engaging in CF; otherwise they can acquire significant debt and even go bankrupt.

Why do farmers engage in CF? CF is often associated with export crops and high-value crops (Simmons, 2002). These crops have specific characteristics. They are more perishable and care sensitive. Their yields are more uncertain, so they are likely to be riskier than traditional crops when crop failure happens, and prices are more dynamic due to limited trading channels. CF has offered to farmers' protection against these production and market risks. Masakure and Henson (2005) surveyed SF in Zimbabwe in 2001-2002 and found four factors motivating them to contract non-traditional vegetables for export. These factors are market uncertainty, indirect benefits (e.g. knowledge acquisition), income benefits, and intangible benefits (e.g. status).

Are SF in developing countries included in or excluded from CF arrangements? If SF are not included in CF, then the objective to improve SF's income in rural area cannot be achieved. We found a discussion about this issue in Bijman (2008). There is evidence in Key and Runsten (1999, 396) showing that processing companies prefer a contract with large-scale farmers; however, a study in Pomareda (2006) shows no clear preference for middle to large farmers compared to SF in Costa Rica. There are also examples in Runsten and Key (1996) showing that contractors shift from large farms to SF. Birthal et al. (2005) presented several reasons that contractors in India find it is more convenient to contract with SF. Miyata et al. (2009) concludes that CF can be effective in raising the personal economics of SF, but it is only applicable in certain circumstances. Bijman (2008), for example, stated favorable conditions for SF and benefit from CF.

Making decisions whether to contract or not, is clearly rather complex, with great opportunities and dire consequences. SF typically do not have the quantitative background (or access to this knowledge) that is required to routinely make decisions that are in their best interest. This research is focused on bridging this gap and providing assistance in terms of a tool to support decision making. This tool is capable of providing a recommendation on the minimum land size to devote to CF, an acceptable loan interest rate if the farmer uses a loan, and length of contract adoption. The proposed model is presented in the next section.

Methodology

Net Present Value (NPV) Model for Agricultural Investment

We focus on financial aspects, and NPV has been selected as the basis for our model to help the SF because it is the standard benefit-cost analysis technique that proceeds systematically to deal with various measurement problems, and is relatively simple to calculate (Little and Mirrlees, 1974; Dasgupta et al., 1972) while other techniques are sometimes complex (Brigham and Ehrhardt, 2005), and because it provides a definitive answer that can be easily understood by the decision maker. The heart of NPV is the cash flow per period. The net profit for a single time period t (P_t) is the difference between income and costs in the same period. Thus, when $P_t > 0$, a profit is made; when $P_t < 0$, a loss has occurred, and $P_t = 0$

is the breakeven point. P_t is a cumulative measure that gives an integral measure of the project's financial potential. The annual net cash flow (B_t) is calculated as income (I_t) plus the project's released or residual value (R_t), minus cash expenses. The cash expenses include the incremental investment into fixed assets and working capital (X_t), variable cost (M_t), overhead cost (W_t), financial expenses (F_t), and taxes (V_t) (Brigham and Ehrhardt, 2005). Hence, the net cash flow is written as:

$$B_t = I_t + R_t - X_t - M_t - W_t - F_t - V_t \qquad where\ t = 1, 2, \dots, T \tag{1}$$

and T is the length of investment/contract. Since this NPV model is applied to assist a farmer, we adopted a structure that reflects the farmer's viewpoint. In this transaction, the farmer's decision is how much land (if any) will he/she commit to CF and, possibly, the length of the contract period. As such, the model seeks to determine the minimum arable land that satisfies breakeven NPV in agricultural investment, given interest rate, investment, and length of contract.

From the general NPV model, we have developed the NPV model in the form of net cash flow, specifically for agricultural investment. In our proposed model, land size and loan interest rate from cash borrowing for first investment are crucial in the decision making. These factors impact the following variables in the NPV model: income, variable cost, and financial expense for fixed cost. The income from producing agricultural products in period t (I_t) is the cash flow generated from selling the crops. This is computed as the product of the size of arable land (q), the yield per area unit (y), and the unit price (p) of harvested crops. Added to this is any other revenue, such as selling stubble, per area unit (o). Therefore, the income function written in terms of land size is:

$$I_t = q(y_t p_t + o_t). \tag{2}$$

Consider a variable cost in period t (M_t) that is also affected by land size. This cost in agriculture can be divided into two parts – material input cost (m_t) and labor cost (l_t), spending on a land size q. Thus, a variable cost function written in term of land size is:

$$M_t = q(m_t + l_t)\ . \tag{3}$$

The material input cost (m_t) consists of six costs: cost of seed/seeding, cost of fertilizer, cost of herbicides and pesticides, cost of other chemicals, cost of maintenance, and other expenses; the labor cost (l_t) is composed of five other costs: cost of culture, cost of growing, cost of maintenance, cost of harvest, and cost of irrigation.

Next, consider fixed cost in agriculture. The fixed cost is the summation of depreciation, amortization, overhead cost, financial expenses, and taxes. The depreciation (D_t) is the value of machines and other farm assets that are divided by an asset's useful economic life time, used as non-cash charge for cost of goods produced by the asset. The depreciation value in each period t (D_t) is:

$$D_t = \sum_{i=1}^{n} \frac{C_i - S_i}{k_i} \tag{4}$$

where i indexes each asset; C_i is an asset purchase price, and S_i is the salvage value at the end of depreciation period (k) (Lindeburg, 1992). The amortization (A_t) is another non-cash charge against intangible assets such as patents, copyrights, trademarks, and goodwill that usually are not found in agricultural investments in developing countries. Thus, this value is omitted in the model ($A_t = 0$). The overhead cost (W_t) is composed of land rent, land taxes, and other overhead, if there is any.

Unlike the other costs, the financial expense (F_t) is affected by the loan interest rate (r). If a farmer receives financial support and is obligated to pay back the loan (L), F_t is formulated as an amortization periodic repayment in T periods (Brigham and Ehrhardt, 2005) and is written as follows.

$$F_t = \begin{cases} L\dfrac{r}{1-(1+r)^{-T}} & where \;\; r > 0 \\ \dfrac{L}{T} & where \;\; r = 0 \end{cases} \tag{5}$$

The last component in the fixed cost is revenue tax (V_t). Brigham and Ehrhardt (2005) defined V_t as the income (I_t) subtracted by costs ($M_t + D_t + A_t + W_t + F_t$), and multiplied by the tax rate v. Farmers in Thailand have tax exemption, thus, $V_t = 0$.

$$V_t = v(I_t - M_t - D_t - A_t - W_t - F_t) \tag{6}$$

In the NPV model, future costs and returns are known with certainty and it is possible to recover the initial costs of the investment, i.e., certainty and reversibility are implicit in the NPV analysis (Copeland and Antikarov, 2003; Tozer, 2009). The present value of cash flow or discount cash flow of year t into the future is defined as follows.

$$\text{Discount cash flow of year } t = \frac{B_t}{(1+\rho)^t} \quad \text{where } t = 1, 2 \ldots, T. \tag{7}$$

where ρ is the risk adjusted discount rate or the interest rate earned elsewhere when a farmer does not invest in this agricultural project, and brings the fund to invest in another project. Values of ρ can be different for different investments. But when ρ is set for a specific investment, its value is assumed to be unchanged over the life of that investment.

The NPV model for agricultural investment is defined as the difference between the initial investment cost of farm investment (K) and the summation of discounted annual net cash flow in all investment periods (T). That is,

$$NPV = -K + \sum_{t=1}^{T} \frac{B_t}{(1+\rho)^t} \qquad \text{where } t = 1, 2 \ldots, T \tag{8}$$

where K is an initial fixed cost invested in machines (such as a plowing machine and a lawn mower) and other equipment like wheelbarrows, weeding tools, etc.

NPV Breakeven in the Form of Land Size

The NPV formulation obtained above is then set to satisfy the breakeven criterion: NPV = 0. That is,

$$-K + \sum_{t=1}^{T} \frac{B_t}{(1+\rho)^t} = 0$$

This model with $A_t = 0$ for all t is:

$$q = \frac{K - \sum_{t=1}^{T} \frac{R_t - X_t - (1-v)W_t - (1-v)F_t - vD_t}{(1+\rho)^t}}{\sum_{t=1}^{T} \frac{(1-v)(y_t p_t + o_t - m_t - l_t)}{(1+\rho)^t}} \tag{9}$$

The amount of land (q) in Equation (9), satisfying the breakeven criterion, is obtained by subtracting the sum of fixed cost's present value, exceeding residual value, from the initial investment, and divided by the present value of marginal profit. Here, the value of residual (R_t) is the value of cash flow in the previous year (B_{t-1}) depending on unknown land size q. The amount of minimum land size q that farmers should bring into CF is still unknown. Hence, we propose an optimization model to minimize the land size q.

Land-use Optimization Model for Agricultural Investment

The proposed optimization model has the following assumptions: 1) farmers produce in a mono-cropping system, 2) farmers have skill and knowledge to produce crops meeting minimum yield and quality standards throughout the length of investment, 3) farmers use a Type-3 contract (contracts under which the contracting firm supplies and manages all the inputs and the farmer becomes only a supplier of land and labor), 4) farmers only invest in capital assets like machines and farm equipment, in year 0; no additional investment is made afterwards ($X_t = 0$ for $t = 1,2, ..., T$); 5) cash flow in each year (B_t) is positive in order to prevent extra loans in the period of investment. A loan is allowed one time at the beginning of investment, 6) net cash flow from each year will be carried forward to the next year as residual money ($R_t = B_{t-1}$ for $t = 1,2, ..., T$) to guarantee that the outcome of investment in the following year will not be negative, and 7) any impacts of CF, positive or negative, on society or the environment are not included in the model.

The proposed optimization model to assist SF and decision makers in determining the minimum arable land size to achieve breakeven NPV for a CF is as follows. If the minimum land size does not exceed SF's land size criteria (1 ha for generic SF), farmers can adopt the practice and gain the financial benefits. If we consider the institutional factors, SF either manage their farms individually or cooperate to manage their farms as a group, the prices of buying agricultural inputs from suppliers and selling products to the middlemen or customers can be different. The proposed model is still applicable to determine the amount of minimum land size q when expenditure and revenue are varied.

$$Minimize\ q = \frac{K - \sum_{t=1}^{T} \frac{R_t - X_t - (1-v)W_t - (1-v)F_t - vD_t}{(1+\rho)^t}}{\sum_{t=1}^{T} \frac{(1-v)(y_t p_t + o_t - m_t - l_t)}{(1+\rho)^t}} \tag{10}$$

$$Subject\ to: \quad -K + \sum_{t=1}^{T} \frac{B_t}{(1+\rho)^t} = 0,$$

$$B_t \geq 0,$$
$$q \geq 0.$$

Model Application and Land Use Analysis in Contract Farming Adoption

The model is employed to conduct a numerical study focused on baby corn cultivation in Thailand. Baby corn is one of the major crops in the Thai vegetable industry. Its production area is 8.1% of the total area of industrial crops (chili, sweet corn, baby corn, yard-long bean, Chinese kale, watermelon, cucumber, water spinach, and pumpkin) (DOAE, 2007). Baby corn in Thailand is a small- to medium-size industry concentrated in western provinces (Kanchana Buri, Nakorn Pathom, Suphan Buri, and Ratcha Buri). The market is orientated in three sectors: 1) 70-80% of all baby corn production goes directly from farmers or collectors to the canning and processing industry, 2) 10-20% to domestic consumption market, and 3) about 5% to the frozen baby corn market (Thongthammachat, 2007). While the majority of fresh baby corn is exported to Japan; a large part of processed baby corn is sent to the UK and US. In 2005, fresh baby corn and processed baby corn earned US$ 9.1 million and US$ 50.5 million, for the UK and US markets, respectively. “In 2003, the industry involved 9,300 farms covering 26,500 ha (production area is 0.8-1.6 ha per farm), with total production averaging 200,000 tons/year. Crop yields ranged from 190 to 290 kg/ha (of de-husked cobs), with farm-gate values of US$ 0.33/kg” (GTZ-CMU, 2006 in Johnson et al. (2008)). Later in 2011, the value of processed baby corn exports altogether was US$ 50.44 million (or 1,513.08 million baht). This value was 17.5% or US$ 8.83 million (264.87 million baht) for frozen baby corn and 82.5% or US$ 41.61 (1,248.21 million baht) for canned baby corn (OAE, 2011). More details about the baby corn sub-sector in Thailand are in Johnson et al. (2008, 36).

The empirical data used in our model was collected from 60 farmers with the sampling method of Thongthammachat (2007) during the crop year 2005/2006. A group of 30 farmers was selected from Kanchana Buri and the other 30 farmers were from Nakhon Pathom in Thailand. While the greater number of SF in the first province complies with CF, the majority of the SF in the latter group did not join CF. These two provinces have a high potential to grow baby corn; they can produce throughout the year, contributing almost 80% of Thailand's baby corn production. The cultivation areas were located near a processing plant. Both groups were not different in socio-economic situation. They faced the same problems: high input price, flooding, and unstable and low selling price. The average cultivation area is 6.46 rai or 1.03 ha, which satisfies the SF land size criteria. The inputs in the cultivation are a water pump, sprayer, seed dropper, rubber tube, wheelbarrow, and motor. The growing process is labor intensive so farmers hire workers and pay wages. Half of these farmers invested in the cultivation by themselves while the others borrowed from the Bank for Agriculture and Agricultural Cooperatives (BAAC) of Thailand, village fund, or farm contractors. Some farm contractors provide cash without interest.

While independent farmers sold products through local middlemen, farmers under CF sold through collectors with whom they contracted. The products from collectors and middlemen were distributed to the domestic market and to processing plants for export. The average costs, revenues, and yields of contact and no-contract farmers are provided in Table 1. From this data, contract farmers have costs, initial investment, and selling price at farm-gate higher than no-contract farmers. The money unit shown in this article is in baht; 30 Thai baht is approximately equal to one US dollar.

Table 1: Average Expenditure of Baby Corn Production under Contract and No-contract Farming

Costs structure	Variables	Contract	No-contract
1. Variable cost (Baht/ha)			
1.1 Labors cost	l		
1) Planting & Cultivating		5,162.50	5,775.00
2) Growing		1,061.00	1,139.13
3) Maintenance		798.56	522.94
4) Harvesting		5,241.69	5,284.06
5) Spraying		355.19	343.75
1.2 Input cost	m		
1) Seeds/Seedlings		2,797.88	3,068.75
2) Fertilizer		7,280.25	5,312.94
3) Herbicides & Pesticides		707.00	561.38
4) Maintenance		2,151.63	2,170.56
5) Other expenses		3,142.63	2,488.00
6) Other chemicals		0.00	0.00
2. Fixed cost (Baht)			
1) Depreciation	D	118.59	80.78
2) Other overhead	W	204.63	309.70
3) Land rent		0.00	0.00
4) Land tax		0.00	0.00
3. Investment cost (Baht)	K		
1) Machinery		36,640.00	30,640.00
2) Other investment		1,000.00	1,000.00

Source: adapted from Thongthammachat (2007)

Table 2: Yield and Revenue of Baby Corn under Contract and No-contract Farming

Yield & Revenue	Variables	Contract	No-contract
Price at farm-gate (Baht/Kg.)	p	3.13	2.54
Yield (Kg/ha)	y	11,437.50	10,855.69
Revenue from stubble (Baht/ha)	o	3,843.75	4,212.50

Source: adapted from Thongthammachat (2007)

The optimization model with breakeven NPV constraint in Equation (10) is employed to assist decision making. An analysis of land minimization is conducted under two scenarios. Scenario 1 is an analysis before investing in cultivation either under CF or no-CF when farmers do not borrow money for initial investments; they use their money to invest in farm assets. Scenario 2 is an analysis before investing in cultivation when SF do not have sufficient money; they have to use loans or borrow money to invest in either CF or no-CF. Farmers have to repay principal and loan interest if they borrow. The effect of the loan interest for three different rates on the minimum land size for breakeven NPV is investigated. These three rates represent no interest (0% interest rate), interest equal to the saving account rate at local banks in Thailand (3% interest rate), and the minimum retail rate (MRR) (7% interest rate) offered by the BAAC of Thailand. The timing of adoption is varied from one to five years to study the effect that the time horizon has on the required minimum land size. With three different interest rates and five time horizons, the model provides a minimum land size that guarantees positive cash flow in each period with the breakeven NPV analysis for the cultivation investment under CF or no-CF. The numerical experiment is conducted by coding the model in IBM ILOG CPLEX. Results are presented in the next section.

Results and Discussion

Scenario 1: Farmers Do Not Use a Loan to Finance Their Investment

Scenario 1 focuses on farmers that do not use a loan to finance their investment. Table 3 and Figure 2 show the minimum amount of arable land which should be brought into CF and no-CF in different time lengths of investment. The result shows that 1) the longer the farmers grow the baby corn, the smaller the minimum land size (from Equations (8) and (9), the longer the farmers grow the baby corn, the smaller the discounted annual net cash flow in all periods, i.e. the smaller the revenue; therefore, the smaller the minimum land size required to generate such revenue) and 2) the arable land sizes in CF are approximately half the land used in no-CF (according to the input data, CF has higher yields, presumably due to better technical assistance).

Table 3: Minimum Land Size Required in Contract and No-contract Scheme in Scenario1 – Farmers Do Not Use Loans

Scheme	Minimum land size (ha) under different lengths of investment				
	1-year	2-year	3-year	4-year	5-year
Contract	3.699	1.301	0.689	0.439	0.311
No-Contract	6.673	2.365	1.265	0.816	0.587

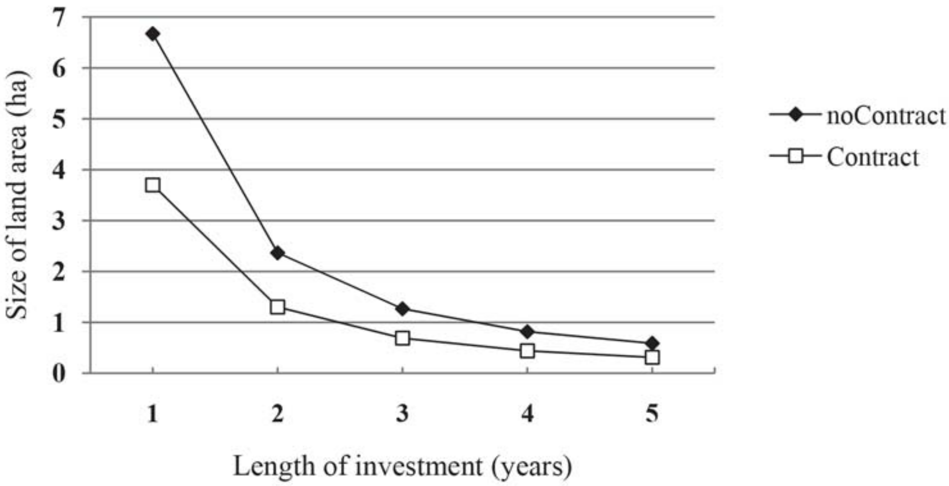

Figure 2: Minimum Land Size Required Under Different Time Lengths of Investment in Scenario 1 – Farmers Do Not Use Loans

Scenario 2: Farmers Use a Loan to Finance Their Investment

In Scenario 2, farmers do not have sufficient money, and use loans in CF and no-CF. They must repay the principal and interest. Table 4 and Figure 3 display minimum amount of arable land which should be brought into CF and no-CF for different time lengths of investment and different interest rates. The result reveals that the minimum land size in the investment depends on the length of investment and loan interest. That is, the minimum land size decreases when the time length of investment becomes longer or when the loan interest rate decreases. Similar to the result in Scenario 1, when the length of time for growing baby corn becomes longer, the smaller the revenue required; therefore, the smaller the minimum land size. Furthermore, when the loan interest rate decreases, the financial cost (or cash outflow) decreases; as a result, the minimum land size generating revenue in the annual net cash flow decreases.

To see the result in Figure 3 better, the 1-year investment is omitted. The new figure is illustrated in Figure 4.

Table 4: Minimum Land Required Under Contract Farming in Scenario 2 – When Farmers Use Loans with Different Loan Interest Rates under Different Time Lengths of Investment

Loan interest rate	Minimum land size (ha) under different lengths of investment				
	1-year	2-year	3-year	4-year	5-year
Contact 0%	7.138	3.021	1.835	1.299	0.999
Contact 3%	7.241	3.099	1.905	1.364	1.062
Contact 7%	7.378	3.203	1.999	1.454	1.150
No-Contact 0%	12.854	5.456	3.325	2.361	1.823
No-Contact 3%	13.039	5.595	3.450	2.479	1.936
No-Contact 7%	13.286	5.784	3.620	2.640	2.094

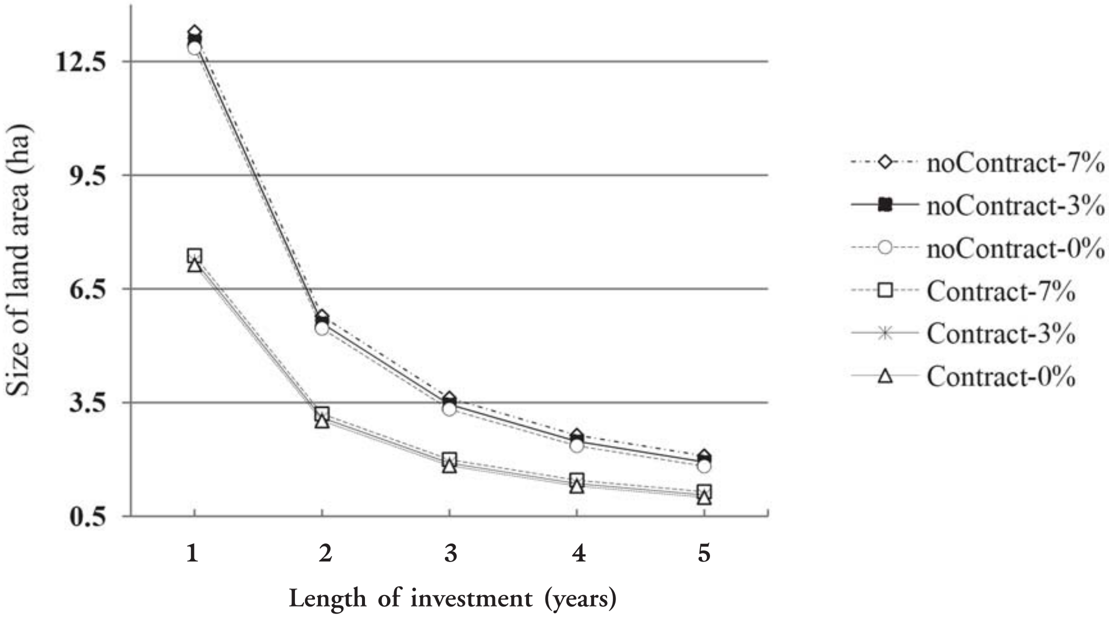

Figure 3: Minimum Land Size Required in Contract Farming Under Different Time Lengths of Investment in Scenario 2 – Farmers Use Loans

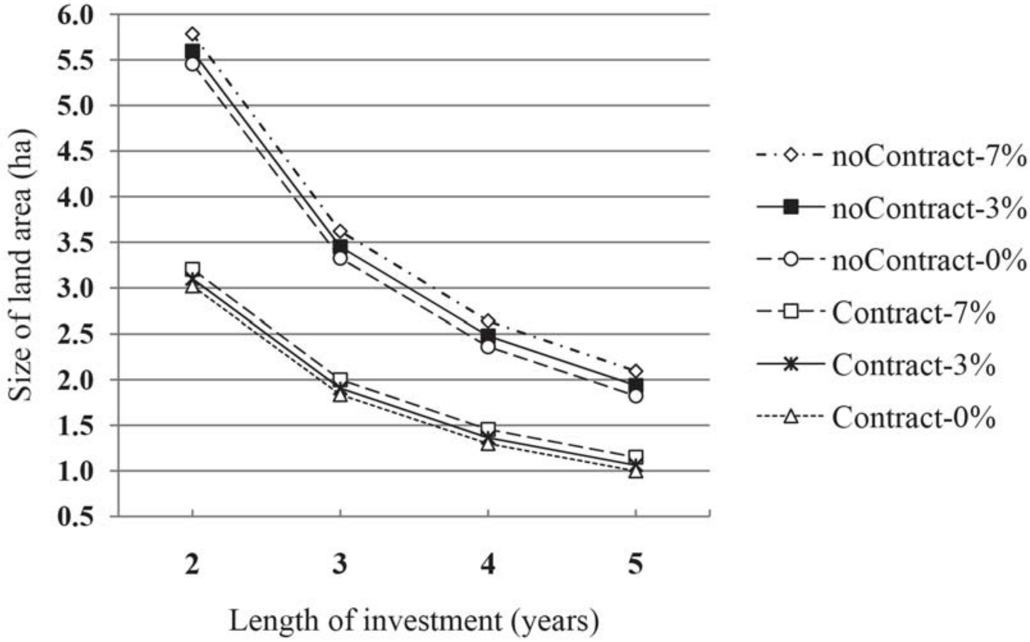

Figure 4: Minimum Land Size Required in Contract Farming Under Different Time Length of Investment in Scenario 2 – Farmers Use Loans (enlarged)

Decision Making: Whether to Adopt Contract Farming

The minimum land sized obtained from the proposed model that guarantees financial benefits is compared with SF's criteria (1 ha). If the minimum land size does not exceed the size in the criteria, the land size and the profile of other associated critical decisions are the preferred decision. To make a decision whether to adopt CF, the minimum land sizes in Scenarios 1 and 2 are displayed together in the same figure (Figure 5). To see the result better, the 1-year period is omitted and re-plotted (see Figure 6). Following Reardon et al. (2009), an average land size for generic SF is 1 ha. Therefore, to decide whether or not each investment is financially beneficial and acceptable for SF, a 1-ha line is horizontally marked. We only consider investments that require a land size equal or below the line. Thus, from the input data, if farmers in this scheme want to invest in baby corn cultivation, there are three possibilities to gain positive cash flow: 1) invest without a loan for four or five years in no-CF, 2) invest without a loan for three to five years in CF, or 3) invest with a 0% interest loan for five years in CF.

Additionally, there are three observations from the result. First, when farmers do not use a loan, the minimum land size is smaller. A higher interest rate requires a bigger land size. Second, when farmers invest in CF without a loan, the minimum land size is smaller than the land size in no-CF, in all five different time lengths of investment. This is because baby corn in CF in our study has higher yields. Third, when farmers use a loan to invest in CF, the optimal land size is larger than the area needed in no-CF in all five different time lengths of investment. The land size is smaller when farmers receive a loan at 0% interest for a 5-year investment due to a lower obligation to repay the principal and loan interest.

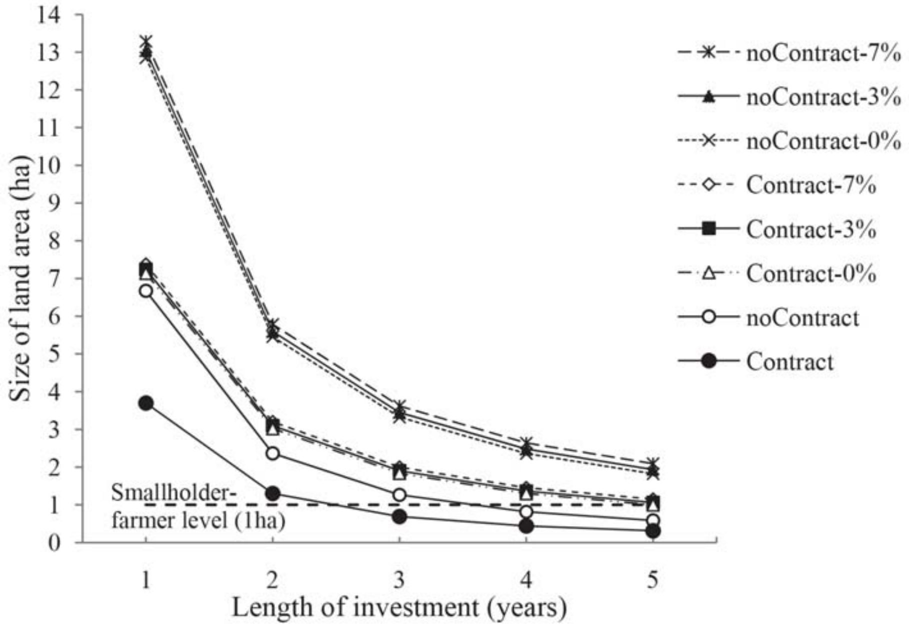

Figure 5: Minimum Land Required Under Different Time Lengths of Investment from Both Scenarios (The Numbers in the Description Mean Loan Interest Rate; No Number Means Farmers Do Not Use Loans to Finance Their Investment)

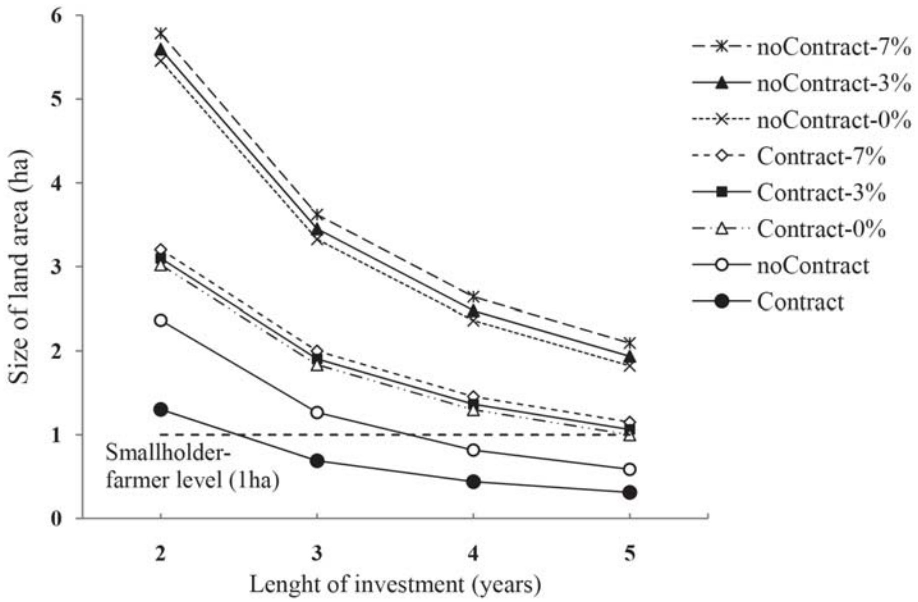

Figure 6: Minimum Land Required Under Different Time Lengths of Investment from Both Scenarios (The Numbers in the Description Mean Loan Interest Rate; No Number Means Farmers Do Not Use Loans to Finance Their Investment) (enlarged)

Conclusions

Analyzing the behavior and decision making process of SF is not a trivial task. Miyata et al. (2009) have studied CF in Shandong Province, China, and found that "CF farmers earn significantly more than independent farmers after controlling for household labor availability, education, farm size, and other characteristics." Our study contributes to the literature on the decision making for the land size in the CF adoption of SF, using the case of baby corn producers in Thailand to illustrate the proposed model. The focus of our research is to determine the amount of arable land which should be brought into CF. We apply NPV breakeven analysis and an optimization model to develop a tool to determine the minimum land size with other critical decisions like self-financing or borrowing money, interest rate on loan if that is the preferred decision, and the length of the investment/contract. The minimum land size obtained from the proposed model guarantees financial benefits with SF's criteria (1 ha). If the minimum land size does not exceed the size in the criteria, the land size and the characteristics of other associated critical decisions may be better. This tool is useful not only for SF, but also for policy makers, contractors, and financial firms. It can assist them when making decisions, whether it is appropriate to promote CF to target farmers.

While farm size is important in decision making, other favorable conditions should not be ignored. Contractors can benefit SF. A contractor must understand the needs of farmers so he/she can provide appropriate technical assistance and transfer suitable technology. There are other favorable conditions for SF to benefit from CF (see Bijman (2008)). We name a few here: 1) there must be strong demand for the crop output and competition among traders, 2) government policies should support the market. Such policies should play two roles: first, they should regulate contractors from abusing their market power, for example, they can provide low cost arbitration options. Second, policies should facilitate contracting to encourage agribusiness firms to prepare SF to become good candidates in contract selection, and 3) the power relationship between SF and contractors should be balanced. CF can bring higher income to contract farmers, higher yields via technical assistance, higher prices via better quality, or better markets via contract channels. However, this is applicable in certain circumstances as discussed above. Hence, SF should acquire information on risk management and use the tool provided here to decide between contract and no-contract cultivation.

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