Growers' participation in maize seed production contracts in Thailand

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Abstract

Thailand is the 2nd largest seed exporter in Asia after China, and maize contributes to the largest export revenue of all seed exports from Thailand. Leading multinational seed companies have invested in research facilities and breeding programs in Thailand since the late 1970s, and this makes Thailand one of important bases of maize seed production. Currently there are five multinational companies integrated in maize seed production in Thailand while many small local companies operate at national or provincial scale. This paper addresses different contract models operated by seed companies, and analyze the factors contributing to the participation of growers in maize seed production contracts.

Keywords

Seed production, contract model, contract farming, maize, Thailand

Introduction

Thailand is the 31st largest field crop seed exporter in the world and the 2nd largest in Asia after China (International Seed Federation, 2016). In 2012, the export value of maize seed from Thailand was about USD 43.8 million, beating out seed for all other crops. Given this success, the Thai Government intends to become the region's premier "Seed Hub." The government and Thai Seed Trade Association are central to this effort, and are aiming at strengthening Thailand's leadership in the regional seed market. Maize was chosen as the prototype crop for seed production, export, and value addition under this initiative. Previous studies have found that there are a limited number of large multinational companies and several small local companies competing in Thailand's maize seed market (Napasintuwong, 2014). Large multinational companies have access to proprietary breeding lines and advanced technologies; whereas, several small and medium enterprises (SME) rely primarily on improved germplasm from public research programs. Seed production technology and seed procurement process through contract farming differ significantly between these companies. There are three main types of maize seed companies in Thailand: large multinational companies, small national companies, and small local companies. Large multinational companies (MNCs) generally engage in R&D, seed multiplication and processing, and marketing and sales at international level. Large MNCs include foreign subsidiaries such as Monsanto (Thailand), Pacific Seeds, Pioneer Hi-Bred, Seed Asia, and Syngenta Seeds. Seed Asia was formally Thai national company that was taken over by Limagrain in early 2014. Large MNCs also includes Thai-parent, namely Charoen Pokphand Produce, the largest agro-industry in Thailand. Small national companies are those that may or may not employ R&D activities, but generally engage in multiplication of F1 hybrids seeds and parental seeds, and processing at the national level while their markets cover national level, and regional level such as neighbouring countries. The small national companies also include agricultural

cooperatives, but these cooperatives do not multiply parental seeds as they rely purely on public germplasm. Small local companies are those that have neither R&D activities nor parental seed multiplications. The small local companies only multiply and sell F1 hybrid seeds, and predominantly limited to provincial areas.

In order to understand the participation in contracts, this paper aims at 1) reviewing contract farming models used by different types of seed companies, and 2) identify factors influencing the participation of seed growers in the maize seed production.

Methods

By reviewing actual seed production contracts between seed companies (sponsors) and seed growers during the 2014/2015 cropping seasons, the contractual arrangements of the maize seed production in Thailand hold three aspects of provision categorized by Eaton and Shepherd (2001) and Will (2013). Those are 1) *market provision* where seed growers and seed companies agree to terms and conditions for future delivery, sale and purchase of seed, 2) *resource provision* where seed companies usually provide inputs as in-kind credits with costs being recovered upon product delivery. The resources provided by seed companies are parental seeds of F1 hybrid seeds which in most cases are the property rights of the seed companies, other inputs, and also technical supports for agronomic management, and 3) *production specification and management* where seed growers delegate a substantial part if not all of decision rights over production and harvesting practices to seed companies by agreeing to follow contractor's farm management requirements. Prowse (2012) and Eaton and Shepard (2001) describe that there are five types of contract models: centralized, nucleus estate, tripartite, informal and intermediary. Interviews with seed companies and samples of actual contracts obtained from the companies or contracted growers were analysed based on this contract model.

For growers' participation in the contracts, a multi-stage stratified sampling method was used for seed grower's survey between January and March 2016 for 2014/2015 cropping seasons. In the first stage, maize seed companies were selected and interviewed to identify areas of seed production in 2014/2015 cropping seasons. All major field maize seed companies in Thailand were included in the samples. Those are Charoen Pokphand Produce (Thai-parent MNC), Monsanto (Thailand), Pacific Seeds, Pioneer Hi-Bred, Seed Asia, and Syngenta Seeds. For national maize seed companies, the list was obtained from registered seeds (Thai Seed Trade Association, 2015), and companies were randomly selected. Three cooperatives, namely Mae-Chaem Agricultural Cooperative, Mae-Sot Estate Cooperatives, and Mae-Ramat Estate Cooperatives that produce hybrid maize seeds of public varieties are included in the samples. For small local seed companies that operate at provincial or regional level, the seed growers were identified in the same areas as small national companies that are generally known for local seed production. Because the locations of seed production areas are confidential information, the identification of areas has to be carefully checked across companies. After identifying seed production companies and their seed production areas, the provinces and districts were randomly selected. In the second stage, seed growers were purposively selected by the assistance from seed companies, and the number of seed growers in each district of provinces was allocated based on the size of companies. There were 365 seed growers in the samples.

A multinomial logit model is adopted by assuming that seed growers, *n*, will maximize expected utility (or profit) subject to constraints such as household labor availability, suitability of soil, and investment requirement for water and other inputs. A seed grower

would obtain a certain level of utility (or profit) from participating in seed production for each type of sponsor, j, and will end up engage in seed production for the one that provides the greatest utility. Sponsors (Y) are classified as large MNCs, small national companies, and small local companies. The true utility that farmer n obtains from producing seed for sponsor j is U_{nj}, $j = 1, 2, 3$, and he will choose to produce maize seed for sponsor i if and only if $U_{ni} > U_{nj} \ \forall j \neq i$. Although the true utility of seed growers is unknown, but their farm and farmers characteristics, $x_{nj} \ \forall j$. can be observed. The representative utility, denoted $V_{nj} = V(x_{nj}) \ \forall j$, depends on these observed variables. The true utility is decomposed as $U_{nj} = V_{nj} + \varepsilon_{nj}$, where ε_{nj} is assumed to be random. The probability that seed grower n produces maize seeds for sponsor i (Train, 2009) can be written as

$$P_{ni} = Prob(U_{ni} > U_{nj} \ \forall j \neq i)$$

$$= Prob(V_{ni} + \varepsilon_{nj} > V_{nj} + \varepsilon_{nj} \ \forall j \neq i)$$

$$= Prob(\varepsilon_{nj} - \varepsilon_{ni} < V_{ni} - V_{nj} \ \forall j \neq i). \quad (1)$$

Given the joint density of random vector $\varepsilon_n = (\varepsilon_{n1}, \varepsilon_{n2}, \varepsilon_{n3})$, the cumulative probably in (1) can be written as

$$P_{ni} = \int_\varepsilon I(\varepsilon_{nj} - \varepsilon_{ni} < V_{ni} - V_{nj} \ \forall j \neq i) f(\varepsilon_n) \, d\varepsilon_n. \quad (2)$$

where $I(.)$ equal 1 when the expression in parentheses is true and 0 otherwise. In this study, ε_{nj} is assumed independently, identically distributed extreme value (iid), and the cumulative distribution of $\varepsilon_{nj} - \varepsilon_{ni}$ follows the logistic distribution

$$F(\varepsilon_{nj} - \varepsilon_{ni}) = \frac{e^{\varepsilon_{nj}-\varepsilon_{ni}}}{1+e^{\varepsilon_{nj}-\varepsilon_{ni}}} \quad (3).$$

The logit choice probabilities of (3) is given as (Train, 2009)

$$P_{ni} = \frac{e^{V_{ni}}}{\sum_j e^{V_{nj}}} \quad (4).$$

The representative utility is specified to be linear in parameters: $V_{nj} = \beta' x_{nj}$. Thus, logit choice probabilities in (4) is defined as

$$P_{ni} = \frac{e^{\beta' x_{ni}}}{\sum_j e^{\beta' x_{nj}}} \quad (5).$$

The change in probability that seed grower n produce maize seeds for sponsor i given a change in an observed variable x_{nk} is

$$\frac{\partial P_{ni}}{\partial x_{nk}} = \frac{\partial(\frac{e^{\beta' x_{ni}}}{\sum_j e^{\beta' x_{nj}}})}{\partial x_{nk}} \quad (6).$$

And the marginal effect of dummy variable x_k equals

$$Pr(Y_i = 1|x, x_k = 1) - Pr(Y_i = 1|x, x_k = 0). \quad (7)$$

The explanatory variables (Xs) are hypothesized to influence the participation of seed growers in different types of sponsors. Those include the age of head of the household (age_years), experience in maize seed production (seed exp_years), experience in producing seed for current sponsor (current sponsor_years), investment cost in irrigation (irrigation investment_USD/ha), size of maize seed farm (farm size_ha), land rent (land rent_USD/ha), labor and machinery service cost (labor and machinery service_USD/ha), number of full-time

household members engaging in seed production (full-time HH_persons), and land ownership (=1 if yes, =0 otherwise).

Results and discussion

The review of production contracts of maize seed companies in Thailand found that there are four possible models summarized in table 1.

Large MNCs operate in two models. The centralized scheme requires high fixed cost especially technical extension staff and field inspectors. MNCs contract with a large number of seed growers through several extension and technical staff who mostly are stationed in provincial areas. Quality requirements of seeds are high, and the contracts are monitored strictly and closely by MNC's extension and technical staff. Famers generally get a quota of seed production areas which are allocated within small sub-areas by the extension staff. The intermediary model is another possible contract model used by MNCs. Although it is less common than the centralized scheme, MNCs subcontracted to the intermediaries (brokers) such as traders or village leaders who have closer relationships with local farmers, and most of the time also monitor and provide technical assistance on the farm management recommended by extension staff. Under this model, the MNCs have two separate contracts: one with individual seed growers (buying/selling contract), and one with intermediaries (service contract). The intermediaries will receive a commission based on the quantity and quality of outgrowers' seed production. In several cases, the intermediary model decreases the degree of control that a company has over the production process and the product, and the company may lose the technical and input requirements as pointed out by Eaton and Shepard (2001) and Pawse (2012). However, because intermediaries generally understand local customs and are able to find their decent seed growers as well as manage agronomic practices and conflicts within local areas better, this model is used by some MNCs. One possible drawback of intermediary model is that the intermediary sometimes gets the payment after delivery the products, but does not give to seed growers instantly. This may affect seed growers' participation of contracts.

Small national companies use both the centralized and intermediary models, but the intermediary model is more common than the centralized model. However, the control of production requirements and quality is much less stringent than MNCs. Small national companies also get supports of their seed production knowledge from public sectors, or from their past experience of being seed outgrowers for large companies. With limited human capacity and capital, the terms and conditions of contracts by small national companies are relatively much more relaxed than MNCs.

Cooperatives use centralized scheme similar to MNCs but at much small scale in terms of scope of seed production area and number of farmers. Due to a growth in seed demand, there is one cooperative that recently initiated the tripartite model, a joint operation with a small national company that has relatively larger market, seed production volume and research capacity than other small national companies. The agricultural cooperative is the third party that select member farmers, provided input credits to its member farmers, allocated the seed production quota, and facilitated input distributions and output delivery. There are two separate contracts in this model: the first is an agreement between the national seed company and an agricultural cooperative to deliver a given quantity of quality seeds, and the second was an agreement between an agricultural cooperative and the seed growers. Because the

cooperatives do not provide in-kind input credits, the second agreement is generally the loan for inputs which will be deducted after the delivery of the product. The agricultural cooperative under this tripartite model is not responsible for processing and marketing of seeds.

Small local companies operate at a very small scale; thus, have much fewer contracted growers and production areas. Most of these small local companies use either intermediary or informal models in their operation. The informal contract is found to be a verbal agreement between the sponsor and seed growers. However, there is also a written agreement where requirements of seed quality and agronomic practices are not stringent. As the contracts are usually among the sponsors and seed growers who have had a long term relationship in contacted seed production, much of the seed production areas are close to the processing plants owned or rented by the seed companies. The agronomic practice requirements and quality standards of small local companies are also relatively low.

Table 1 Maize seed production contract models in Thailand, 2014/2015 cropping season

Model	Sponsor characteristics	Type of sponsor	Seed quality requirements	Monitoring quality and yield
Centralized	Require high fixed cost especially technical extension staff, field inspectors	Large MNCs	High	Regularly by extension/technical staff
		Small national companies	Moderate	Fairly
		Cooperatives	Moderate	Fairly
Intermediary	Subcontracted to intermediaries (commissioners) with a paid commission	Large MNCs	High	Regularly by commissioners
	Separate contracts between seed companies and farmers and between seed companies and commissioners	Small national companies	Low	Fairly
		Small local companies	Low	Rarely/Never
Tripartite	Partnership between local seed company and agricultural cooperative who facilitates input distribution, input credits and output collection	Cooperatives and small local companies	Moderate	Fairly
Informal	Written or verbal agreement between small local companies and contracted farmers Commonly found in long term relationships	Small local companies	Low	Rarely/Never

Table 2 summarizes the specifications of maize seed production contracts in Thailand. All MNCs and small national companies specify the address and size of cultivation area (quota). Some cooperatives and none of the small sized companies specify the address of contract growers, but not farm size. For pricing arrangement, all contracts specify a predetermined fixed price (in most cases depending on the difficulty of agronomic management, and yield of seed production) which may vary across varieties of the same company. Most sponsors also indicate the prices based on the quality of delivered product. One of the MNCs specifies fixed prices based on the yield, the higher the yield, the higher is the price. Furthermore, this same company pays a bonus for complied agronomic management based on technical recommendations. The small sized local companies do not specify ranges of prices based on quality. The standards of quality are explicitly described in the contracts of MNCs. In practice, the quality of products is pre-determined by technical or quality assurance staff based on recommendations on agronomic management practices. If the field is questionable on genetic purity, a laboratory test will be required after product delivery and before the payment. Some small national companies also describe the classification of quality in the contract, but it is unclear how the quality is tested. Most of the small national companies do not have sufficient quality assurance and extension staff so the process of quality determination is rather vague.

The payment procedures vary vastly across sponsors. Most contracts agree to pay the whole in one single payment after product delivery within a specific time, or on a specific date. The period of payment after product delivery ranges from 15 days to 30 days. In practice, some companies, especially small national companies and small local companies pay later than what is specified in the contract. As small national companies via intermediary model do not pay their outgrowers directly, but through an intermediary who receives a lump sum payment and distribute to seed growers under their supervision, the payment to farmers can be delayed. For the centralized model, the payment is usually transferred directly to seed growers' bank or the cooperative account. As inputs are usually provided to seed growers as in kind advanced credit (except for small sized companies), the payment is the total revenue deduced by the cost of advanced inputs. Some MNCs split the payments into 2-3 payments.

The contracts of all MNCs clearly state that seed growers agree to comply with the specifications of farm practices or agronomic managements recommended by the companies. Some of the MNCs' contracts specify the details of agronomic managements while some others only specify that seed growers agree to comply with instructions of the companies. For the rest of sponsors, either the contract agreements state that seed growers agree to comply with the company's specifications or not at all mentioned. Only some MNCs specify that they agree to provide technical services in a written contract while other sponsors do not specifically state this service in the contract even if they still provide technical assistance to ensure the seed quality.

It is necessarily that seed growers produce specific hybrid varies determined by the sponsors. As a result, the sponsors must provide parental seeds as a mandatory input. Parental seeds for F1 hybrid seed production are considered the intellectual property of the companies or breeders who own the rights of the hybrid varieties. The contracts of these companies clearly state that farmers agree to use provided parental seeds exclusively for seed production of the company, and any unused parental seeds must be returned to the company. It is observed that some small national companies that bought licenses from private breeders also have the similar written agreement of prohibited use of parental seeds. For other input use, only some MNCs and small national companies specify types of inputs, and do not allow other sources of inputs. Others grant the right for seed growers to find inputs of equivalences. Because

inputs are generally provided as in kind credits to seed growers, the sponsors estimate and provide the quantity of each input based on recommended rates of use and the quota areas to avoid diverting them by selling or using inputs for other purposes.

The prohibition of extra-contractual sales (side selling) is a very important specification of contract, especially in this case where the products contain intellectual property of the sponsors. All contracts of seed production, except for some small local companies (that presumably produce unlicensed hybrids), clearly state the prohibition of extra-contractual sales.

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Table 2 Maize seed production contract specifications in Thailand, 2014/2015 cropping season

Type of sponsors	Production quota (area)	Fixed price	Price based on quality standard	Quality standards	Payment procedure & period	Farm management agreement	Technical service	In kind input advanced credit	Prohibit extra-contractual sales
Large MNC	●	●	●[1]	●	● - Single payment within 15-30 days after product delivery or - 2-3 payments after start planting[2]	● - Written explicitly or - Written as to be complied with sponsor' instructions	Ө	●	●
Small national company	●	●	Ө	Ө	Ө - Single payment within 14-30 days after product delivery or - Single payment by a given date or - 2 payments after product delivery[3] - Not specified	Ө - Written as to be complied with sponsor' instructions or - Not specified	○	●	●
Cooperative	Ө	●	Ө	○	Ө - Single payment within 15 days after product delivery or - Not specified	Ө - Written as to be complied with sponsor' instructions or - Not specified	○	Ө	●
Small local company	○	●	○	○	Ө - Single payment within 2-3 weeks days after product delivery paid by intermediary	Ө - Written as to be complied with sponsor' instructions or Not specified	○	○	○

Note: ● always specified; Ө specified by some sponsors; ○ not specified
[1] Except for one sponsor that specifies price based on yield [2,3] Some companies split the payments into 2-3 payments.

The estimates of the multinomial logit model on seed growers' participation in contracts of seed companies and the marginal effects are presented in table 3 and table 4. It is found that older seed growers and those who have longer experience in seed production will have higher probability of being the outgrowers of small local and small national companies, but younger seed growers and those who have less experience in seed production will be more likely to be the outgrowers of large MNCs. On the contrary, seed growers who have been contracted by the current sponsor longer are more likely to be contracted by large MNCs, but the probability of being contracted by small local and small national companies decreases if farmers have more experiences in producing seeds for the same contracted sponsor. This might be because younger farmers are more flexible to follow rigorous farm management required by the large MNCs and even with less experience in seed production, they may be more skilful. Younger farmers who have less experienced in seed production may be preferred and selected by the MNCs. Thus, they have longer experience with the current MNCs. On the other hand, older farmers and those who have a long experience and tend to be attached to old farming practices maybe left with small local and small national companies if they could not get a quota from the large MNCs so the outgrowers of small companies have shorter experience with current sponsors.

Water is one important factor to ensure the expected yield and quality of seeds. However, many of the survey areas are rainfed even if it is produced in the dry season. Farmers who have high investment cost in irrigation system will be more likely to be contracted by large MNCs. Those who have little or no investment in irrigation system will be more likely to work for small local or small national companies. Furthermore, to ensure the outgrowers are able to follow the requirements for farm practices, the seed companies would prefer a household that have enough members responsible for seed production. Household that has more members working full-time on seed production will increase the probability of being contracted by small local and small national companies. The number of full-time members of household, however, decreases the probability of being contracted by large MNCs. Nevertheless, seed farms that have high labor (including family labor) and machinery service cost increase the probability of being contracted by large MNCs and small local companies, but decrease the probability of being contracted by small national companies. This might be because seed production for large MNCs is more labor-intensive, and seed farms that incurred high labor cost that will most likely be contracted by large MNCs. At the same time farms of less efficient use of labor (low labor productivity) also are contracted by local seed companies.

The size of farms or scale of production seems to affect for whom the growers produce maize seeds. Larger farms increase the probability of being contracted by small national companies, but decrease the probably of being contracted by the large MNCs or small local companies. Too large farm may not be preferred by large MNCs as maize seed production has strict requirements. Larger farms are more likely being contracted by the small national companies but less likely being contracted by large MNCs. It might also be because small national companies have much fewer extension staff, and may prefer larger farm size and fewer seed growers for their management. The small local companies generally operate at much smaller scale. As a result, their outgrowers will be allocated smaller farm area. Regarding the land ownership, it was found to significantly increase the probability of being used for small national companies, but decrease the probability of being contracted by MNCs and local companies perhaps due to the geographical area of designated seed production of different companies. Land rent (including opportunity   cost of using land) is found to increase the

probability of being used for small national different sponsors. Higher value of land increases the opportunity for being a seed production area for large MNCs and small national companies.

Table 3 Coefficient estimates of multinomial logit model of participation in maize seed production in Thailand, 2014/2015 (Small local = base)

Variable	Small national		Large MNC	
	Coeff (β)	Std. Err.	Coeff (β)	Std. Err.
Const	-2.8787	1.8230	1.8745	1.3421
Age	0.0362**	0.0258	-0.0097**	0.0200
Seed Exp	0.1852*	0.0546	-0.0608**	0.0472
Currrent sponsor	-0.2422*	0.0670	0.0953**	0.0495
Irrigation investment	0.00008***	0.0002	0.00008***	0.0001
Farm size	0.0035***	0.0063	0.0012**	0.0053
Land rent	0.0011***	0.0009	0.0011***	0.0009
Labor and machinery service cost	-0.0002***	0.0001	0.000007***	0.0000
Full-time HH	0.3164	0.3264	-0.0901	0.2598
Land ownership	1.3991	0.5368	0.4166	0.4093
Log likelihood	-221.11076			
Number of seed farms	365			

*** = significance at 1% level, ** = significance at 5% level, * = significance at 10% level

Table 4 Marginal effects of multinomial logit model of participation in maize seed production in Thailand, 2014/2015

Variable	Small local		Small national		Large MNC	
	dy/dx	Std. Err.	dy/dx	Std. Err.	dy/dx	Std. Err.
Age	0.0005***	0.0017	0.0035***	0.0015	-0.0039***	0.0022
Seed Exp	0.0032***	0.0040	0.0184***	0.0037	-0.0217***	0.0055
Current sponsor	-0.0054***	0.0043	-0.0252***	0.0043	0.0307***	0.0059
Irrigation investment	-0.000007***	1.00E-05	0.0000003***	1.00E-05	0.000007***	1.00E-05
Farm size	-0.0001***	0.0005	0.0002***	0.0003	-0.00006***	0.0005
Land rent	-0.0001***	0.0001	0.000004***	0.0000	0.00009***	0.0001
Labor and machinery service cost	0.000001***	0.00E+00	-0.00002***	1.00E-05	0.00002***	1.00E-05
Full-time HH	0.0045**	0.0220	0.0305**	0.0186	-0.0350**	0.0282
Land ownership	-0.0444**	0.0355	0.0746**	0.0289	-0.0303**	0.0449

*** = significance at 1% level, ** = significance at 5% level, * = significance at 10% level

Conclusions

There are three types of seed companies or sponsors engaging in maize seed production in Thailand. The MNCs generally have strict requirements of farm management, and quality of seeds, but have good technical assistance to farmers and offer relatively higher guaranteed price based on the quality. Because of explicit written agreements such as agreed price, terms of payment and input advanced credit, seed growers have high confident on the contract agreement, and MNCs are generally preferred   by seed growers. Small national companies

including agricultural cooperatives are less stringent on the requirement of seeds so the production is more flexible, but they may not be preferred by seed growers due to lower price and delay in payment depending on the contract model. Farmers will be more likely to be contracted by the large MNCs if they can follow the farm management requirements, specifically able to invest in appropriate irrigation, find sufficient and available labor, have not too large size, and being flexible (e.g. being younger) to adjust to the production requirements. This suggests that small seed companies may have to develop into similar contract requirements to the large MNCs and offer seed growers with similar benefits. As good seed products start from seed farming, it is important that Thailand produces high quality seeds that meet the market demand. For small seed companies to be able to offer high price, they should secure markets that farmers' proposition for high seed quality with desired characteristics of maize varieties. This implies that continuous R&D investment in seed technology and breeding is one of the main factors that could promote "Seed Hub" policy in Thailand.

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