MAINTAINING THE EDGE: THE CASE OF CASSAVA TECHNOLOGY TRANSFER[1] IN THAILAND

by

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ABSTRACT

For more than two decades Thailand has built up an intensive and highly profitable cassava processing and export industry, mainly due to favorable price and quota policy regimes with the European Community (EC). During the 1980's however, internal EC political pressure has attempted to reduce Thai pellet imports through various measures. Moreover, in 1993 internal EC grain prices were lowered substantially, thereby reducing the relative price advantages of Thai cassava as energy substitute.

The subsequent pressure on the Thai cassava sector has resulted in several Thai governmental policy measures: (a) reduce cassava area using EC subsidies, (b) diversify cassava products and markets, and (c) reduce cassava production cost through increased varietal technology transfer. To stimulate the latter, significant private (processors) and government funds have been directed to cassava varietal technology transfer.

The paper examines adoption characteristics of cassava variety RAYONG 3 (R3) and analyzes with a logistic regression model the different factors that influence (non) adoption based on survey data of 700 cassava farm households in 9 provinces of NE and E Thailand. Results show that both the government and the private cassava sector have played a key role in the technology diffusion process. Hence, this will help to maintain the competitiveness of cassava for export markets.

INTRODUCTION

While during the 1950's Thailand was only a minor player in global cassava production, by the mid 1980's, the country had developed a large and sophisticated cassava sector placing itself as the second largest cassava producer in the world and the number one exporter of cassava processed products (FAO, 1993), valued at over US$800 million (Chainuvat et al., 1993). This rapid development for the major part has been policy induced.

After rice and kenaf, cassava has been the youngest of the commodity (export) booms. Up to the 1960's the Thai cassava industry was based on a small SE-Asian export market (Lynam & Titapiwatanakun, 1987). During the late 1950's Germany started to import small quantities of cassava (starch) waste from Thailand to substitute for expensive domestic feed grains in pig concentrates (Lynam & Titapiwatanakun, 1987). The EC Common Agriculture Policy (CAP) and further GATT negotiations in 1968 created favorable tariff conditions for imported Thai cassava and hence the cassava boom commenced.

Thai cassava exports grew from 1.2 million ton in 1970 peaking in 1989 at 9.8 million ton, averaging an annual growth of 10.5%. During the latter year 80-85% was destined for European ports (TTTA, 1992), although a Voluntary Export Restraint (VER) was already in place. This

Thai-EC trade agreement was first negotiated in 1982 and was further renewed in 1986 and 1990, specifying reduced total export volumes for 4-year periods (Miller, 1988).

The reduced future export potential to the EC caused the Thai government to implement various policies. For this a scheme based on three approaches was developed including acreage reduction, product and market diversification and raw material cost reduction. First, with financial support from the EC, a cassava substitution program was initiated in the main cassava growing areas of the Northeast. Within this scheme, farmers received subsidies for every hectare of cassava pulled out of production and planted with alternative crops like maize or rubber. Secondly, market development was emphasized by initiating a cassava export quota system, whereby Thai cassava exporters received an EC cassava quota of 1 ton for every 1.2-1.4 ton exported to non-EC export markets. This has caused a run at non-traditional export markets i.e. Eastern Europe, Middle East, and North and South America (TTTA, various years), which were opened at dumping prices (US$40-50 fob BKK) that were made possible because of the relative high EC prices (US$150-160 fob BKK). In addition, the government started to incentivate the cassava industry to look for new cassava products. This has initiated an increasing emphasis on the manufacturing of modified cassava starches, away from traditional pellets and chips, targeting Asian export markets like Taiwan, Korea and Japan.

Thirdly, during the last two decades the Thai cassava industry has heavily invested in state of the art processing and export facilities and infrastructure emphasizing pellet exports. Relative to other Asian pellet exporters this infrastructure has created a comparative cost efficiency advantage. In addition, the seasonally dry northeastern cassava production areas have few viable crop alternatives. These were two strong arguments for the Thai government and private sector to look for ways to maintain the edge of pellets on world markets by reducing per unit cassava root costs. As such, at the end of the 1980's, the government made an initial attempt to speed up cassava varietal technology transfer by directing increased efforts towards the multiplication and dissemination of improved cassava varieties. The private cassava sector assisted significantly in this effort with complimentary funding.

The aim of this paper is to verify if the efforts of the government and private sector in reducing cassava costs have been successful. This is done by analyzing the (non) adoption of cassava variety RAYONG 3 and estimating the importance of different factors influencing adoption. The next section of this paper summarizes some historical background of R3. This is followed by a discussion on the adoption data and methodology for the analyzes. Next, the results from the logistic regression model are presented. The paper ends with a short discussion on conclusions and their implications.

CASSAVA VARIETAL DEVELOPMENT AND TRANSFER

Traditional cassava variety RAYONG-1 (R1) has been planted throughout Thailand and predominates because of its excellent adaptation to existing harsh conditions. In collaboration with

CIAT scientists, Thai cassava breeders selected a CIAT-bred variety[2] (CM 407-7) and named it RAYONG-3 (R3). This variety has a significantly higher starch content (33.2%), compared to the local variety, RAYONG-1 (28.8%). Besides, the drying time of chips could be reduced from 3 to 2 days (Henry, 1991). The subsequent cost price reduction for the cassava processors was rewarded by paying farmers a price premium for the new variety. These advantages have been the main driving force to the initial positive response of cassava farmers to R3.

After several years of testing on experiment stations and farms, R3 was released in four provinces of northeastern Thailand in 1984. The Thai Agricultural Extension Service (DOAE) started the diffusion by supplying "innovative" farmers with 600 stakes each. These farmers then provided 80% of the subsequently harvested stakes to their neighbors. With the complementary financial help (for additional stake multiplication) from the Cassava Development Fund (a cassava producer and processor organization) in 1989, by 1991 the R3 adoption was estimated at 70 - 80,000 ha (Henry, 1991). However, during this time doubts were expressed by farmers about certain negative characteristics of R3. These included poor architecture, lesser adaptability to poor soils, and sub-optimal stake storageability. Hence, an adoption study was conducted by DOAE and CIAT during 1991-92 to analyze the different factors influencing R3 adoption (Chanuvat et al., 1993).

For this adoption study a representative sample of 700 cassava farmer households were surveyed in 9 provinces of east and northeastern Thailand. Table 1 shows that the major reasons for R3 adoption are *higher yields* (46%), and *better starch content/prices* (34%). These arguments are much in line with ex-ante research assessments. It is also shown that adoption is higher on relatively larger farms and in more fertile areas. This is in line with conclusions from the comparative adoption analysis by Feder et al.(1987).

What, in the context of this paper, is of further interest, are the reasons for non-adoption. As such, Table 1 shows the relative importance of the reasons for not adopting R3. The first 3 reasons, *soil fertility*, *harvesting* and *weeding problems* were to be expected. The other 4 reasons however, especially, *stake storage problems* was not anticipated. The last reason, *high production costs*, is basically the aggregated indirect effect from the reasons already mentioned.

The reason *unavailability of stakes*, was mentioned by 6% of non-adopters, which is surprisingly low for cassava varietal diffusion. What is relevant to this issue is analyzing the initial source of R3 stakes for the first planting. Survey results show that the majority of stakes (57%) originated from a government source (mainly DOAE and experiment stations); 21% from exchange between farmers; and 16% was bought commercially. The latter is made up for the greater part by cassava chip or starch factories, who have been actively involved in multiplying R3 planting material. The commercially availability of stakes is crucial for an optimal diffusion. This has been lacking for example in Colombia, which has been one of the reasons of low adoption levels of variety MP 12 (Henry et al., 1992).

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[2] A historical treatise on the development of this variety can be found in the CIAT Annual Report, 1991.

In the same adoption survey farmers were also asked to quantify yields and specify the different production costs between R1 and R3. Analysis of these data show that relative to R!, the per unit production cost of R3 increased by 8%, while due to the starch price premium for R3, net profits augmented by 41 % (Chainuvat et al., 1993). This may indicate that there was no unit cost reduction at the farm. However, a proportionally greater cost reduction was incorporated at the processing plants. While the adoption data shows that the R3 starch price premium for the farmer averaged 10%, cassava processing factories are estimated to be able to reduce pellet production costs by 10-20%.

METHODOLOGY

To further analyze the factors influencing the initial adoption decision and also the factors affecting the decision to continue using or abandoning the new cassava variety a logistic regression model[3], following the methodology of Hosmer and Lemeshow (1989), was fitted to data obtained from the 700 surveys. This methodology was selected to overcome the limitations of the traditional Ordinary Least Squares (OLS) regression model[4].

Since using the "Score Test for the equal slopes assumption"[5] (SAS, 1990), the parallel lines assumption was rejected, two separate logistic functions were estimated: one for the "adopted and continued" and one for the "adopted and abandon" decision. A third regression equation was estimated for the sum of the first two in order to capture the total initial adoption decision. Thus the following logit functions were estimated:

$$S_1 = g_1(X) = \ln\left|\frac{P(Y=1 \mid X_i)}{P(Y=0 \mid X_i)}\right| = \alpha_{10} + \sum \beta_{1i} X_i$$

(1)

$$S_2 = g_2(X) = \ln\left|\frac{P(Y=0.5 \mid X_i)}{P(Y=0 \mid X_i)}\right| = \alpha_{20} + \sum \beta_{2i} X_i$$

(2)

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[3] For the sake of brevity, the majority of econometrics of this rather straightforward methodology has been left out and only the major steps are shown. For a detailed discussion on this, see Gotrett et al., 1993.

[4] For a detailed explanation of the limitations of OLS regression methods for the estimation of relationships which include dichotomous dependent variables (adoption vs. non-adoption) see Gujarati 1988 or Gottret et al., 1993).

[5] For a treatise of this specific assumption see Gottret et al., 1993).

where:

P_1 equals the probability that Y=1, that is, the farmer adopts the new variety and continues planting it,

P_2 equals the probability that Y=2, that is, the farmer adopts the new variety but latter on abandons it, and

$1-P_1-P_2$ equals the probability that Y=0, that is, the farmer does not adopt the new variety.

Therefore, the conditional probability for each outcome category (j) is given by:

$$P(Y=j|X) = \frac{e^{g_j(x)}}{\sum_{r=0}^{2} e^{g_r(x)}}$$

(3)

In order to assess the fit of the model the -1 log likelihood and the score tests (Hosmer and Lemeshow, 1989, and SAS, 1990) were used.

Once the model was estimated, the probability that a farmer with Xi characteristics will adopt the new variety--and continue or abandon it-- we estimated by solving equation (3).

Also, the elasticities of the probability of adoption with respect to changes in the factors that influence the adoption process (Eyji) were derived from equations (1) and (2). Therefore,

$$E_{yji} = \frac{\delta P_j X_i}{\delta X_i P_j} = \beta_i X_i (1 - P_j)$$

EMPIRICAL RESULTS

Table 2 shows the parameter estimates of the regression. These results show that of the total adoption of 19.2%, two-thirds continued planting R3, while one-third at some time abandoned the variety. The probability of R3 adoption *and continuing by the average farmer*[6] is 6%. The

6 The average farmer is defined as a male operator (72%), who makes the operation decisions (76%), has 11 years of experience growing cassava, heading a 5-member household of whom 3 collaborate with farm activities. The farm measures 4.8 ha, of which 2.7 ha is planted with cassava, representing 67% of the area under crops. The average farmer sells cassava to the processing factory (86%), interchanges varietal

other factors in the table show the additional probability of adoption relative to the average farmer. The highest and statistically significant probability of R3 adoption is scored by when *stakes are provided to farmers by the processing factory.* This is followed by *farmers who received stakes through DOAE.* This is 14% and 8% higher, respectively, than the average farmer, three-quarters of whom receive stakes from neighbors and/or friends. As such, TT government agents and processing factories have played the largest role in the diffusion of R3.

Two other farmer characteristics that are market related are *the starch content is formally tested at the factory* (11%) and the fact that *the farmer sells directly to the factory* or to its collectors (11%). Only a formal test, most often the "specific gravity method", will be able to specify the additional percentage points dry matter of R3, that will translate into a price premium. As such, intermediaries buying roots at the farm will in general not pay a price premium for R3.

What is of additional interest here is the relative difference in value between continuous adopters and adopters who abandoned. For the majority of characteristics, the absolute value for continuous adopters is higher, except for the factor *seed provided by the factory.* As such, the farmers that adopted but abandoned were at first highly influenced by the opportunity of purchasing stakes at the factory. After experimenting with R3, other factors influenced the decision to abandon the variety however at a later stage. The other adoption characteristics in the table do not show any statistical significance and as such are less relevant to the discussion.

Table 2 also shows results from the adoption regression model using continuous variables. However, the majority of the variables included here have traditionally been used in adoption models as concluded by Feder et al. (1987). In this table the effect of the factors (farm characteristics) is calculated as adoption elasticities. One factor that shows both a high value and significance is *cassava root price.* Again this is a market related adoption characteristic. Another characteristic of interest is *farmer experience with cassava.* The statistically significant estimate shows that there exists a strong inverse correlation between experience and adoption. In other words, the longer the farmer's experience of growing cassava i.e. the more traditional he is, the smaller the probability of R3 adoption. Again, this is much in line with the literature (Feder et al., 1987). Moreover, this effect is even stronger pronounced in the group that later on abandoned R3. Other traditional factors like *farm size* and *cassava area* show a lesser significant influence.

CONCLUSIONS AND IMPLICATIONS

From a methodological point of view it can be concluded that first, a logistical regression model as used here is more appropriate for analyzing both dichotomous and continuous variables in an adoption analysis than the frequently used OLS regression methods as reported by Feder et al, (1987). Secondly, the adaptation of the model to allow for the intensity or extension of adoption of a certain technology can shed more light on adoption and adopter behavior. Thirdly, the

information with neighbors (68%), receives new planting material from neighbors (73%). The average root price received (at factory gate) is US$ 33/ton, and the starch content is not measured formally (64%).

introduction of market related variables has proven to be important in explaining factors influencing adoption.

In addition, as has been shown in this paper, increased emphasis on the diffusion of improved varietal technologies can have a positive effect on reducing per-unit production cost of raw materials (cassava root) and its processed products (chips, pellets and starch) leading towards maintaining a comparative price advantage in international markets. Secondly, it has been shown that both the direct involvement and the interaction of the private sector with government extension activities has been crucial in boosting varietal adoption. Not only was the financial help for stake multiplication important, but maybe even more the introduction of price differentiation for higher starch contents in cassava roots at the factory gate. The latter was "imposed" by the cassava processors association on all its members.

The knowledge of the above facts and the further erosion of the Thai pellet EC market position due to the 1993 decrease of internal EC grain prices as a result of GATT negotiations[7], has been the principal arguments for the Thai government to further increase extension resources. While before 1993 the annual budget of the DOAE was US$40-80,000 for cassava technology transfer (and a much more significant sum to cassava research), in 1993 a government resolution stipulated that a total budget of US$11.2 million was to be divided between cassava research (40%) and cassava technology transfer (60%) for the 1993-98 period (Chainuvat et al., 1993). With this financial injection the government aims to increase the area with improved varieties (R3, R60, R90, KU50 and Sriracha 1) to 20% of total Thai cassava acreage, by 1998 (Chainuvat et al., 1993).

Three lessons can be derived from this analysis. First, government assistance can be used effectively and in a long term sustainable manner to help maintain an export market position. Secondly, the private sector must be involved , made co-responsible and integrated in such an effort. And third, it proves to be possible to use Monitoring & Evaluation (adoption studies) to feed back pertinent information to policy makers that can influence decision making.

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[7] For an in-depth discussion of the cause, the extent of the EC grain price decrease and its potential implications for Thai pellet exports to the EC and for domestic cassava prices, see Titapiwatanakun (1994).

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Table 1. Relative importance of the most important reasons for adoption and non-adoption of Rayong-3.

Reasons for adoption	% of adopter's responses	Reasons for non-adoption	% of non-adopter's responses[a]
Higher yields	46	Unsuitable soils	32
Higher root prices	21	Difficult harvesting	24
Higher starch content	13	Difficult weeding	16
Willingness for experiment	16	Stake storage	12
Other	4	problems	8
		Slow plant growth	6
		No stakes available	6
		High production costs	

[a] Farmers were able to give more than one answer for not adopting Rayong 3 and therefore the precentages do not add to 100%.

Source: Henry and Gottret, 1993.

Table 2. Influencing characteristics of Rayong-3 adoption dynamics in NE. and E. Thailand, 1991.

	Extent of Adoptions		
	Adopted and Continued	Adopted and Abandoned	All Adopters
% farmers	12.9	6.3	19.2
	Probability of Adoption		
Average farmer	0.06	0.03	0.09
Women farmer	0.06	0.03	0.09
Women and/or children take decision to grow crop	0.08	0.03	0.12
Sell cassava root to collector	0.11**	0.04	0.15**
Starch content tested	0.11***	0.06***	0.18
Variety recommended by Agricultural Farm Officer	0.07	0.02	0.08
Variety recommended by factory	0.06	0.03	0.07
Seed provided by Agricultural Farm Officer	0.14***	0.08***	0.22***
Seed provided by factory	0.20	0.27***	0.48***
Plants only Cassava	0.03	0.02	0.05
	Adoption elasticity (% change in probability of adoption for a 10% increase in the factor)		
Total family member	-0.41	-0.20	-0.34
Total family labour	-0.02	-0.08	-0.05
Percentage of land owned by the farmer	-0.23	-0.35	-0.24
Farm size	0.01	0.20	0.06*
Cassava area	0.21	0.13	0.21
Percentage of crop area with cassava	0.96*	0.47	0.67
Experience	-0.40*	-0.95***	-0.53***
Cassava root price	0.78**	-0.51	0.47

Source: Henry and Gottret, 1993.

*** Significance level < 0.05.
** Significance level 0.10-0.05.
* Significance level 0.15-0.10.