# AGRICULTURAL COMPETITIVENESS: MARKET FORCES AND POLICY CHOICE

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# *Maintaining the Edge: The Case of Cassava Technology Transfer in Thailand*

## INTRODUCTION

While during the 1950s Thailand was only a minor player in global cassava production, by the mid-1980s the country had developed a large and sophisticated cassava sector, making it the second largest producer in the world and the leading exporter of cassava processed products (FAO, 1993), valued at over US$ 800 million (Chainuvat *et al.*, 1993). This rapid development, in the main, has been policy-induced.

After rice and kenaf, cassava has experienced one of the most recent of the commodity (export) booms. Up to the 1960s, the Thai cassava industry was based on a small Southeast Asian export market. During the late 1950s, Germany started to import small quantities of cassava (starch) waste from Thailand as a substitute for expensive domestic feedgrains in pig concentrates (Lynam and Titapiwatanakun, 1987). The EC Common Agriculture Policy (CAP) and further GATT negotiations in 1968 created favourable tariff conditions for imported Thai cassava and hence the boom commenced. Thai cassava exports grew from 1.2 million tonnes in 1970, reaching a peak in 1989 at 9.8 million tonnes, averaging an annual growth of 10.5 per cent. During the latter year, 80–85 per cent was destined for European ports (TTTA, 1992) although a voluntary export restraint (VER) was already in place. The Thai–EC trade agreement was first negotiated in 1982 and was further renewed in 1986 and 1990, specifying reduced total export volumes for four year periods (Miller, 1988).

The reduced export potential to the EC caused the Thai government to implement new policies based on three approaches including area reduction, product and market diversification, and raw material cost reduction. First, with financial support from the EC, a cassava substitution programme was introduced in the main growing areas of the northeast. Within this scheme, farmers received subsidies for every hectare of cassava removed from production and planted with alternative crops such as maize or rubber. Second, market development was emphasized by initiating a cassava export quota system, whereby Thai cassava exporters received an EC cassava quota of 1 tonne for every 1.2–

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1.4 tonnes exported to non-EC export markets. This has produced an incentive to penetrate non-traditional export markets in Eastern Europe, the Middle East, and North and South America (TTTA, various years), which were opened at dumping prices (US$ 40–50 per tonne fob Bangkok) that were made possible because of the relative high EC prices (US$ 150–160 per tonne, reduced to fob values). In addition, the government encouraged the search for new cassava products. This has involved increasing emphasis on the manufacturing of modified cassava starches, away from traditional pellets and chips, aiming at Asian export markets such as Taiwan, Korea and Japan.

Third, during the past two decades the Thai industry has invested heavily in state-of-the-art processing, export facilities and infrastructure, emphasizing pellet exports. Relative to other Asian pellet exporters, this has created a cost 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. Hence, at the end of the 1980s, the government made an initial attempt to speed up cassava varietal technology transfer (TT) by directing increased efforts towards the multiplication and dissemination of improved cassava varieties. The private cassava sector assisted significantly in this effort with complementary funding.

The aim of this paper is to consider whether the efforts of the government and private sector in reducing cassava costs have been successful. This is done by analysing the adoption of cassava variety RAYONG-3 (R3) and estimating the importance of different factors influencing adoption. The next section of this paper summarizes the historical background of R3. This is followed by a discussion on the adoption data and analytic methods. Next, the results from a 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 (CM 407–7)[1] and named it RAYONG-3 (R3). This variety has a significantly higher starch content (33.2 per cent), compared to the local variety, R1 (28.8 per cent). A further advantage was that the drying time of chips could be reduced from three to two days (Henry, 1991). The subsequent cost 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 for 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 gave 80 per cent of the subsequently harvested stakes to their neighbours. With complementary financial help (for additional stake multiplication) from the Cassava Development Fund (a cassava producer and processor organization) in 1989, by 1991 R3 adoption was estimated at 70–80 000 ha (Henry, 1991). However, during this time doubts were expressed by farmers about certain, less favourable characteristics of R3. These included poor architecture, less adaptation to poor soils than other traditional varieties, and sub-optimal stake storage ability. Hence an adoption study was conducted by DOAE and CIAT during 1991–2 to analyse the different factors influencing R3 adoption (Chainuvat *et al.*, 1993). For this adoption study a representative sample of 700 cassava farmer households was surveyed in nine provinces of east and northeastern Thailand. Table 1 shows that the major reasons for R3 adoption are higher yields (46 per cent), and better starch content/prices (34 per cent). These features are much in line with *ex ante* research assessments. It was also shown that adoption was higher on relatively large farms and in more fertile areas. This is in line with conclusions from the comparative adoption analysis by Feder *et al.* (1985).

In the context of this paper, there is further interest in the reasons for non-adoption of R3 shown in Table 1. The first three, unsuitability of soils, harvesting and weeding problems were to be expected. The other four, however, especially stake storage problems, were not anticipated. The last reason, high production costs, is basically the aggregated indirect effect from the reasons already mentioned. The unavailability of stakes was mentioned by 6 per cent of non-adopters, which is surprisingly low for cassava varietal diffusion. What is relevant to this issue is analysing the initial source of R3 stakes for the first planting. Survey results show that the majority of stakes (57 per cent) originated from a government source (mainly DOAE and experiment stations); 21 per cent from exchange between farmers; and 16 per cent bought commercially. The latter is made up for the greater part by cassava chip or starch factories, which have been actively involved in multiplying R3 planting mate-

**TABLE 1** *Relative importance of the most important reasons for adoption and non-adoption of RAYONG-3*

| Reasons for adoption | % of adopters' responses | Reasons for non-adoption | % of non-adopters' responses[1] |
|---|---|---|---|
| Higher yields | 46 | Unsuitable soils | 32 |
| Higher root prices | 21 | Difficult harvesting | 24 |
| Higher starch content | 13 | Difficult weeding | 16 |
| Willingness to experiment | 16 | Stake storage problems | 12 |
| Other | 4 | Slow plant growth | 8 |
| | | No stake available | 6 |
| | | High production costs | 6 |

*Notes*: [1]Farmers were able to give more than one answer for not adopting RAYONG-3 and therefore the percentages do not add to 100.

*Source*: Henry and Gottret (1993).

rial. The commercial availability of stakes is crucial for an optimal diffusion. This has been lacking, for example, in Colombia, which has been one of the reasons for low adoption levels of variety MP 12 (Henry *et al.*, 1993).

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 shows that, relative to R1, the per unit production cost of R3 increased by 8 per cent, while, as a result of the starch price premium for R3, net profit was increased by 41 per cent (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 show that the R3 starch price premium for the farmer averaged 10 per cent, cassava processing factories are estimated to be able to reduce pellet production costs by 10–20 per cent.

## METHODS

To further analyse the factors influencing the initial adoption decision and also those affecting the decision to continue using or to abandon the new cassava variety, a logistic regression model,[2] following the methods of Hosmer and Lemeshow (1989), was fitted to data obtained from the 700 surveys. This method was selected to overcome the limitations of the traditional ordinary least squares (OLS) regression model.[3]

Since under the 'score test for the equal slopes assumption'[4] (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 abandoned' 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:

$$L_1 = g_1(x) = \ln\left[\frac{P(Y=1 \mid X_i)}{P(Y=0 \mid X_i)}\right] = \alpha_{10} + \sum \beta_{1i} X_i \quad (1)$$

$$L_2 = g_2(x) = \ln\left[\frac{P(Y=0.5 \mid X_i)}{P(Y=0 \mid X_i)}\right] = \alpha_{20} + \sum \beta_{2i} X_i \quad (2)$$

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 later 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:

$$P(Y = j \mid X_i) = \frac{e^{g_j(x)}}{\sum_{r=0}^{2} e^{g_r(x)}} \quad (3)$$

In order to assess the fit of the model, the log likelihood and score tests (Hosmer and Lemeshow, 1989; SAS, 1990) were used. Once the model was estimated, the probability that a farmer with $X_i$ characteristics will adopt the new variety – and continue or abandon it – was 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 ($\varepsilon_{yji}$) were derived from equations (1) and (2). Therefore

$$\varepsilon_{yji} = \frac{\delta P_j X_i}{\delta X_i P_j} = \beta_i X_i \,(1 - P_j) \qquad (4)$$

## EMPIRICAL RESULTS

Table 2 shows the parameter estimates of the regression. These results indicate that of the total adoption of 19.2 per cent, two-thirds continued planting R3, while one-third at some time abandoned the variety. The probability of sustained adoption of R3 by the average farmer[5] is 6 per cent. The 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 when stakes are provided to farmers by the processing factory. This is followed by farmers who received stakes through DOAE (14 and 8 per cent higher, respectively, than the average farmer, three-quarters of whom receive stakes from neighbours and/or friends). TT government agents and processing factories have thus played an important role in R3 stake multiplication and diffusion.

Two other farmer characteristics that are market-related are that the starch content is formally tested at the factory (11 per cent) and the fact that the farmer sells directly to the factory or to its collectors (11 per cent). Only a formal test, most often the 'specific gravity method', will be able to specify the additional dry matter of R3 that will translate into a price premium. 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 who 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 at a later stage. The other adoption characteristics in the table do not show any statistical significance and consequently 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 summarized by Feder *et al.* (1985). In this table the effect of the factors (farm characteristics) are calculated as adoption elasticities. One factor that shows both a high value and significance is the cassava root price. Again this is a market-related adoption characteristic. Another characteristic of interest is farmer experience with cas-

**TABLE 2** *Influencing characteristics of RAYONG–3 adoption dynamics in NE and E Thailand, 1991*

| | Extent of adoptions (% farmers) | | |
|---|---|---|---|
| | Adopted and continued 12.9 | Adopted and abandoned 6.3 | All adopters 19.2 |
| | Probability of adoption | | |
| Average farmer | 0.06 | 0.03 | 0.09 |
| Women farmers | 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 members | –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 |

*Notes*: *** Significance level < 0.05.
** Significance level 0.10–0.05.
* Significance level 0.15–0.10.

*Source*: Henry and Gottret (1993).

sava. The statistically significant estimate shows that there exists a strong inverse correlation between length of experience and adoption. In other words, the longer the farmer's experience of growing cassava, the smaller the probability of R3 adoption. Again, this is much in line with the literature (Feder *et al.*, 1985). Moreover, this effect is even more strongly pronounced in the group that later on abandoned R3. Other 'traditional' factors such as 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 analysing both dichotomous and continuous variables in an adoption analysis than the frequently used OLS regression methods as reported by Feder *et al.* (1985). Second, the adaptation of the model to allow for the analysis of not only the decision to adopt (or not adopt) the technology but to continue (or abandon) using it can shed more light on adoption and adopter behaviour. Third, the introduction of market-related variables has proved to be important in explaining factors influencing adoption.

In addition, as shown, 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 their processed products (chips, pellets and starch) leading towards maintaining a price advantage in international markets. Also 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 so was 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.

Knowledge of the above facts, and the further erosion of the Thai pellet EC market position as a result of the 1993 decrease of internal EC grain prices owing to GATT negotiations,[6] have 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 TT (and a much more significant sum for 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 per cent) and cassava TT (60 per cent) for the 1993–8 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 per cent 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. Second, the private sector must be involved, made coresponsible and integrated in such an effort. And third, it proves to be possible to use monitoring and evaluation (adoption studies) to feed back pertinent information to policy makers that can influence decision making.

## NOTES

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

[2]For the sake of brevity, the econometrics of this rather straightforward methodology is not described in detail and only the major steps are shown. For a detailed discussion, see Gottret *et al.* (1993).

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

[4]For a discussion of this specific assumption, see Gottret *et al.*, 1993.

[5]The average farmer is defined as a male (72 per cent), who makes the operation decisions (76 per cent), has 11 years of experience growing cassava, heading a five-member household of whom three collaborate with farm activities. The farm measures 4.8 ha, of which 2.7 ha are planted with cassava, representing 67 per cent of the area under crops. The average farmer sells cassava to the processing factory (86 per cent), interchanges varietal information with neighbours (68 per cent) and receives new planting material from neighbours (73 per cent). The average root price received (at factory gate) is US$ 33/tonne, and the starch content is not measured formally (64 per cent).

[6]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).

## REFERENCES

Centro Internacional de Agricultura Tropical (1992), *CIAT Annual Report 1991*, Cali, Colombia: CIAT.

Chainuvat, C., Boonmark, C. and K. Klakhaeng (1993), 'Cassava, Extension Organization and Activities in Thailand', paper presented to the IV Asian Cassava Workshop, Trivandrum, India, November.

Feder, G., Just R.E. and Zilberman D. (1985), 'Adoption of Agricultural Innovations in Developing Countries: A Survey', *Economic Development and Cultural Change*, 33 (2).

Food and Agricultural Organization of the United Nations (FAO) (1993), *AGROSTAT*, Rome: FAO.

Gottret, M.V., Henry G. and Duque M.C. (1993), 'Going beyond Dichotomous Adoption: The Case of Cassava Technology on the Atlantic Coast of Colombia', in G. Henry (ed.), *Trends in CIAT Commodities 1993*, CIAT Working Document No. 128, Cali, Colombia: CIAT.

Gujarati, D.N. (1988), *Basic Econometrics*, 2nd edn, New York: McGraw-Hill.

Henry, G. (1991), 'Adoption of Cassava Technologies: Constraints, Strategies and Impact', in G. Henry (ed.), *Trends in CIAT Commodities 1991*, CIAT Working Document No. 93, Cali, Colombia: CIAT.

Henry, G. and Gottret, M.V. (1993), 'Cassava Technology Transfer: Constraints and Opportunities', paper presented to the IV Asian Cassava Workshop, Trivandrum, India, November.

Henry, G., Izquierdo, D.A. and Gottret, M.V. (1993), *Adopción de Tecnología de Producción de Yuca y el Proyecto Integrado de Yuca en la Costa Atlántica de Colombia*, CIAT Working Document, Cali, Colombia: CIAT.

Hosmer, D.W. and Lemeshow, S. (1989), *Applied Logistic Regression*, New York: Wiley.

Lynam, J.K. and Titapiwatanakun, B. (1989), *The Cassava Economy of Asia: Adapting to Economic Change*, Internal CIAT Document, Cali, Colombia: CIAT.

Miller, P.J. (1988), 'Voluntary Export Restraint Assessment: A Case Study of the Implications for the Thai Dried Cassava Industry of the 1982 Cassava Agreement', unpublished paper of a special study, Wye College, University of London.

SAS Institute Inc. (1990), 'The Logistic Procedure', in *SAS/STAT User's Guide*, vol. 2, London: SAS/STAT.

Thai Tapioca Trade Association (TTTA) (1989–94), *Tapioca Products Market Review*, various issues, Bangkok: TTTA.

Thai Tapioca Trade Association (TTTA) (1992), *Yearbook 1992*, Bangkok: TTTA.

Titapiwatanakun, B. (1994), 'The Thai Cassava Starch Industry: Current and Future Utilization', paper presented at the International Meeting on Cassava Flour and Starch, CIAT, Cali, Colombia, 11–15 January.