PRESENT SITUATION AND FUTURE POTENTIAL OF CASSAVA IN THAILAND

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ABSTRACT

In Thailand cassava (*Manihot esculenta* Crantz) is considered one of the most important economic crops. Thailand has demonstrated the importance of cassava as more than a subsistence crop, and has developed a large and complex industrial system for processing and marketing of the crop. Production of cassava has steadily increased during the 1970s and 80s through expansion of the planted area, but has decreased again since the early 1990s. The national average yield has remained rather constant at about 14.5 t/ha. Major production problems are declining soil productivity, soil erosion and farmers' poverty. Since 1959, products obtained from cassava have been a major export commodity for Thailand, assisted by relatively easy market access to the EU. In a bid to meet the increasing demand, rapid growth in the industry also led to certain weaknesses.

Cassava roots are utilized for making dry chips, pellets, native starch, modified starch, MSG (monosodium glutamate), glucose, fructose, sorbitol, sago, citric acid, while starch is used in the paper, textile, and plywood industries. Of the products made from cassava, cassava starch and pellets are the only ones exported. Export companies are allocated export quotas of pellets to the EU market, but must seek new markets outside the EU to get a larger incentive quota for the EU. This helps to increase the farmers' income and reduce poverty.

CASSAVA PRODUCTION AND MARKETING

1. Cassava production

Cassava (*Manihot esculenta* Crantz.) is the third most important crop in Thailand. The root crop is known by many names in Thailand, but "cassava" and "tapioca" are the most widely used terms. Cassava was introduced into the southern part of Thailand from Malaysia during 1786-1840 (Cenpukdee *et al*., 1992) and was gradually distributed throughout the country within a few years. The main concentration of the crop is now found in the northeast of Thailand, especially in Nakhon Ratchasima province (**Figure 1**). Cassava has excellent drought tolerance properties and can be planted in almost all types of soil. Therefore, the planted area has rapidly increased. Cassava is grown by a large number of farmers, who own small plots of land (about 0.5-2 ha). No organized large-scale plantations have been established in Thailand, as this is prohibited by the land reform act. The total acreage of cassava, which peaked at about 1.6 million ha in 1988/89 is now reduced to 1.2 million ha (1998/99) (**Figure 2**). This trend is driven by a national agricultural policy promoting the reduction in planting area and increases in yields. Despite government promotion to improve yield, total production in 1998/99 was only 17 million tonnes or less than 70% of the peak of 24 million tonnes in 1988/89 (**Table 1**).

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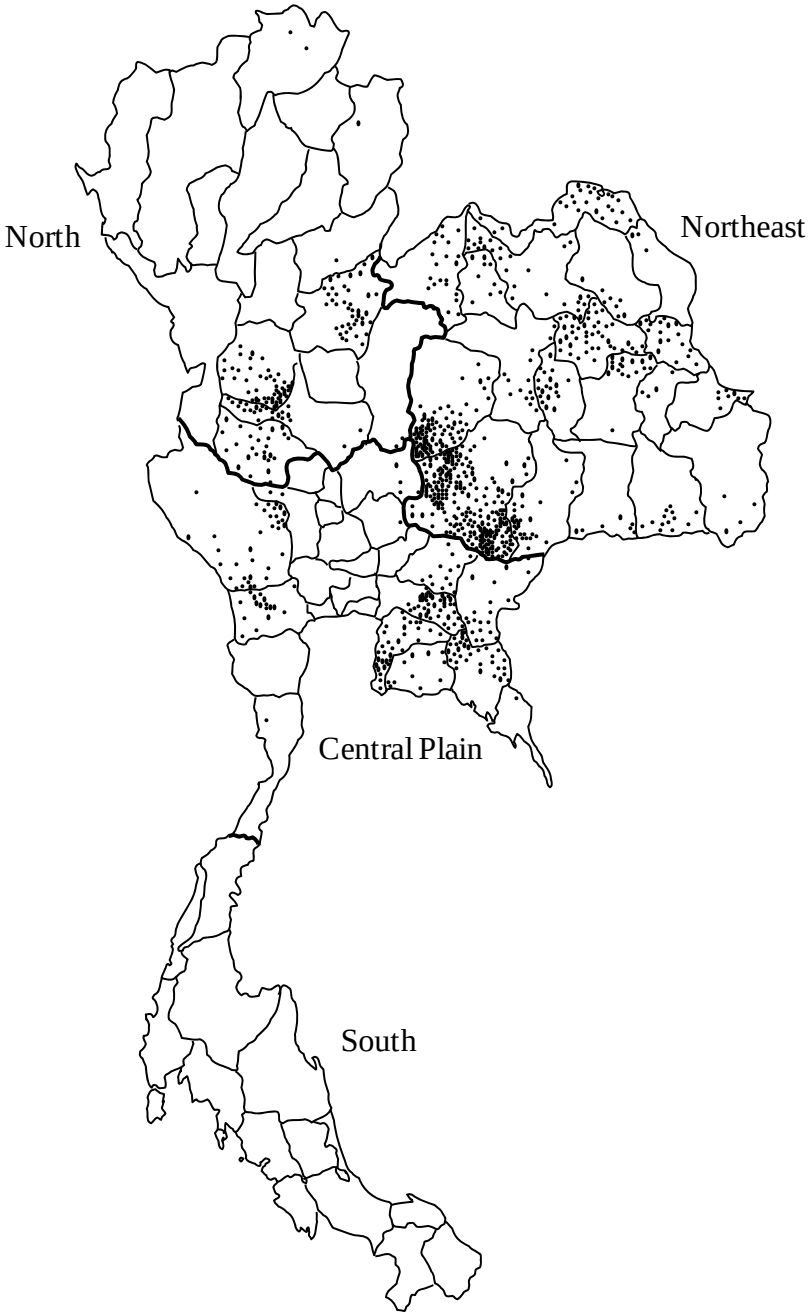

Figure 1. Distribution of cassava planted area in Thailand in 1995/96.
Each dot represents 1000 ha.
***Source:** DOAE, 1998.*

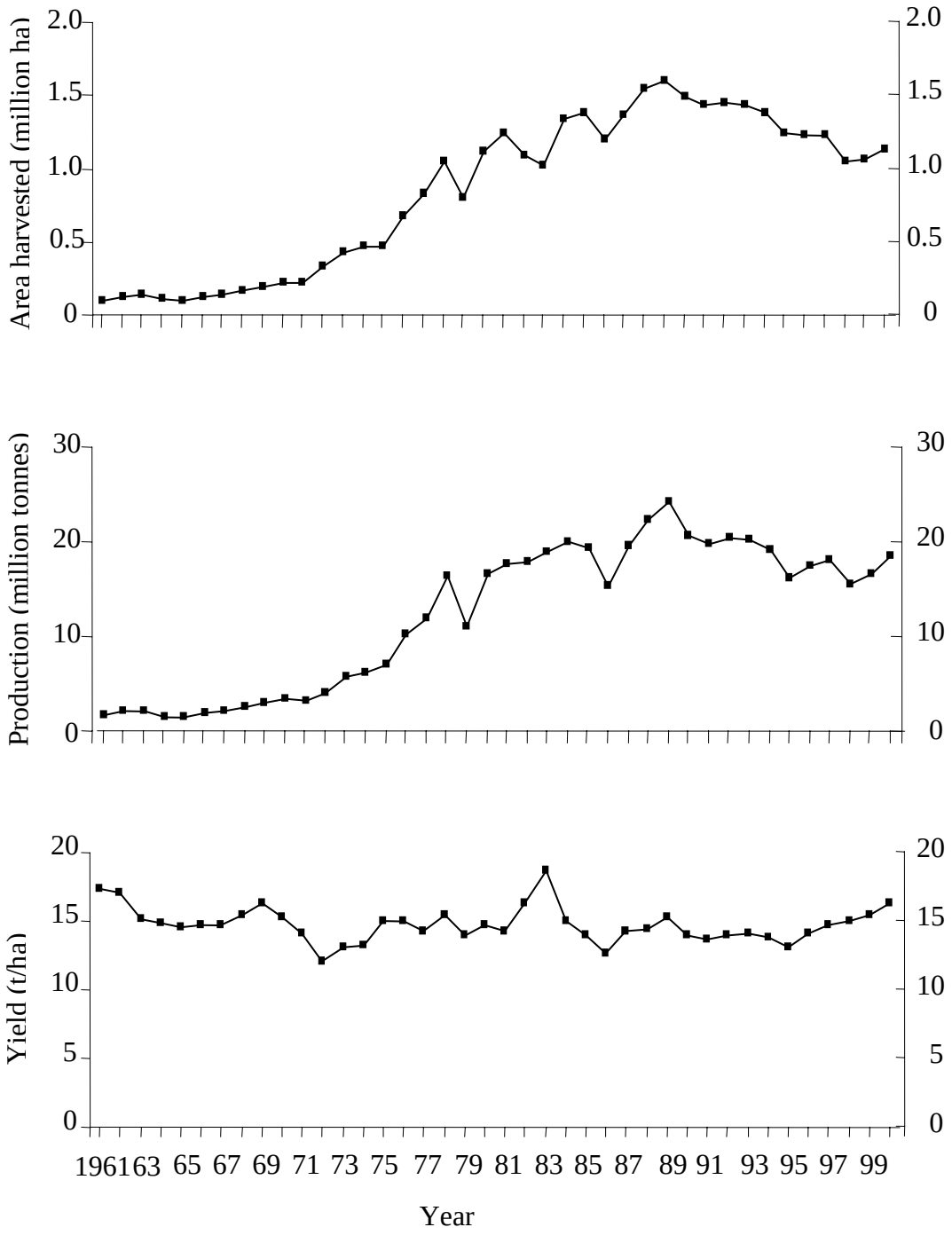

Figure 2. Cassava harvested area, production and yield in Thailand from 1961 to 2000.
Source: *FAOSTAT, 2001.*

Table 1. Planting area, production and yield of cassava in Thailand from 1988/89 to 1999/2000.

Year	Planting area (ha)	Total production (tonnes)	Yield (t/ha)
1988/89	1,593,164	24,264,026	15.23
1989/90	1,487,540	20,700,511	13.92
1990/91	1,433,579	19,705,040	13.75
1991/92	1,450,539	20,355,723	14.03
1992/93	1,438,017	20,202,897	14.05
1993/94	1,382,695	19,091,347	13.81
1994/95	1,245,157	16,217,378	13.02
1995/96	1,228,114	17,387,780	14.16
1996/97	1,230,381	18,083,579	14.70
1997/98	1,119,096	15,968,474	14.27
1998/99	1,172,374	17,315,554	14.77
1999/00	1,095,631	16,930,190	15.45

Source : *Office of Agricultural Economics, 1991-2000.*

2. Varieties

Until the early 1990s the most popular cassava variety was the local variety. A selection of this local variety was named Rayong 1, and was the first variety used as a source of industrial raw material. The cassava breeding program has continued progressively at:

- Rayong Field Crops Research Center (RAY-FCR), Department of Agricultural (DOA), Ministry of Agriculture
- Sriracha Research Center of Kasetsart University (KU), Ministry of University Affairs, and
- Research and Training Center of the Thai Tapioca Development Institute (TTDI) Foundation.

The goal of cassava breeding in Thailand is to increase yields and root starch content, as well as the crop's adaptability to a wide range of growing conditions. Starch yield is a function of starch content and root dry matter yield. There has been no systematic institutional breeding of cassava for improved cooking quality in Thailand. Of the many varieties developed and released only a few are now widely adopted, mainly Kasetsart 50, Rayong 5 and Rayong 90 (**Table 2**).

Table 2. Recommended cassava cultivars in Thailand.

Cultivar	Year released	Parents	Main features
Rayong 1	1975	From local cultivars	High yield
			Good adaptability
Rayong 3	1983	MMex 55 x MVen 307	High root DM
			Low cyanide
Rayong 60	1987	MCol 1684 x Rayong 1	Early harvest
			High yield
Rayong 90	1991	CMC 76 x V43	High root DM
			High yield
Kasetsart 50	1992	Rayong 1 x Rayong 90	High root DM
			High yield
			Good adaptability
Rayong 5	1994	CMR 27-77-10 x Rayong 3	High yield
			High root DM
			Good adaptability
Rayong 72	1999	Rayong 1 x Rayong 5	High yield
			Relatively high DM
			Adapted to Northeast Thailand

Source : *Limsila et al., 1996; Sarakarn et al., 2001.*

3. Production Costs and Net Income

Production costs (**Table 3**) are mainly dependent on the time of planting and environmental conditions during growth. For example, the first planting period (Feb-Apr) and the second planting period (Nov-Jan), known as early and late rainy season plantings, respectively, need different levels of weed control and inputs. Variable costs account for about 85% of the total costs. Major components of production costs (in descending order) are labor, materials and land rent (**Table 3**). Net income per rai varied from 355 to 1,794 baht during 1995/96 to 1999/00. In 1997 there was an oversupply of roots, which depressed the root price to 0.69 baht per tonne (TTTA, 1998). The Ministry of Commerce, in an attempt to protect the farmers, intervened in the purchasing cycle by providing soft loans to starch factories to encourage them to purchase roots at 1,000 baht/tonne. This situation was short term, as a few months later environmental conditions, mainly drought due to El Niño, led to a sharp reduction in cassava yields. Indonesia was particularly affected and the country had to import cassava products from Thailand to supplement this

shortfall. The root price in Thailand increased to 2.22 baht per kg resulting in an average root price for 1998 of 1766 baht per tonne (TTTA, 1999) (**Figure 3**).

The low root price in early 1997 also led to a reduction in the area planted to cassava that year, which in turn resulted in a high price of roots in 1998 (up to 2500 baht). Aggravating the situation of cassava was the new exchange rate in July 1997 (from 25 to 42 baht/dollar). The crop harvested in late 1999, was not effected by a high price as in the previous year. The cassava root price in Dec 1999, was about 0.92 baht/kg.

The current world economic crisis is reflected by a reduction in meat consumption and surplus of cereals, especially of maize, driven by reduced demand from the feed sector. This has depressed the current maize and maize starch prices, and as cassava products (pellets, starch) have to compete directly with maize, this has substantially reduced the price of these cassava products (**Figure 4**).

Table 3. Variable and fixed costs of cassava planting in Thailand, 1995/96 to 1999/00.

	1995/96	1997/98	1999/00
Variable costs (baht/rai)	**1,229**	**1,535**	**1,743**
1. Labor costs	*918*	*1,082*	*1,238*
Land preparation	203	236	270
Planting	119	135	176
Weed control	292	353	387
Harvesting	284	331	372
Transportation	20	27	33
2. Material costs	*214*	*347*	*363*
Planting material	95	137	158
Fertilizers	52	120	120
Herbicides	36	58	51
Others	31	32	34
3. Miscellaneous costs	*97*	*106*	*142*
Reparation	0	0	0
Interest	97	106	142
Fixed costs (baht/rai)	**208**	**281**	**281**
Land rent	188	261	261
Depreciation	20	20	20
Production costs (baht/rai)	**1,437**	**1,816**	**2,024**
Production cost (baht/kg)	0.65	0.78	0.77
Yield (kg/rai)	2,205	2,329	2,643
Price (baht/kg)	1.38	1.55	0.90
Gross income (baht/rai)	3,043	3,609	2,379
Net income (baht/rai)	1,606	1,794	355

[1)] 1 rai = 0.16 hectare

[2)] 1 US$ = 25 baht until July 1997 and about 40 baht thereafter
fresh root price in Jan of year of harvest (TTTA, 1999; 2000).

Source: *Office of Agric. Economics (OAE), 2001.*

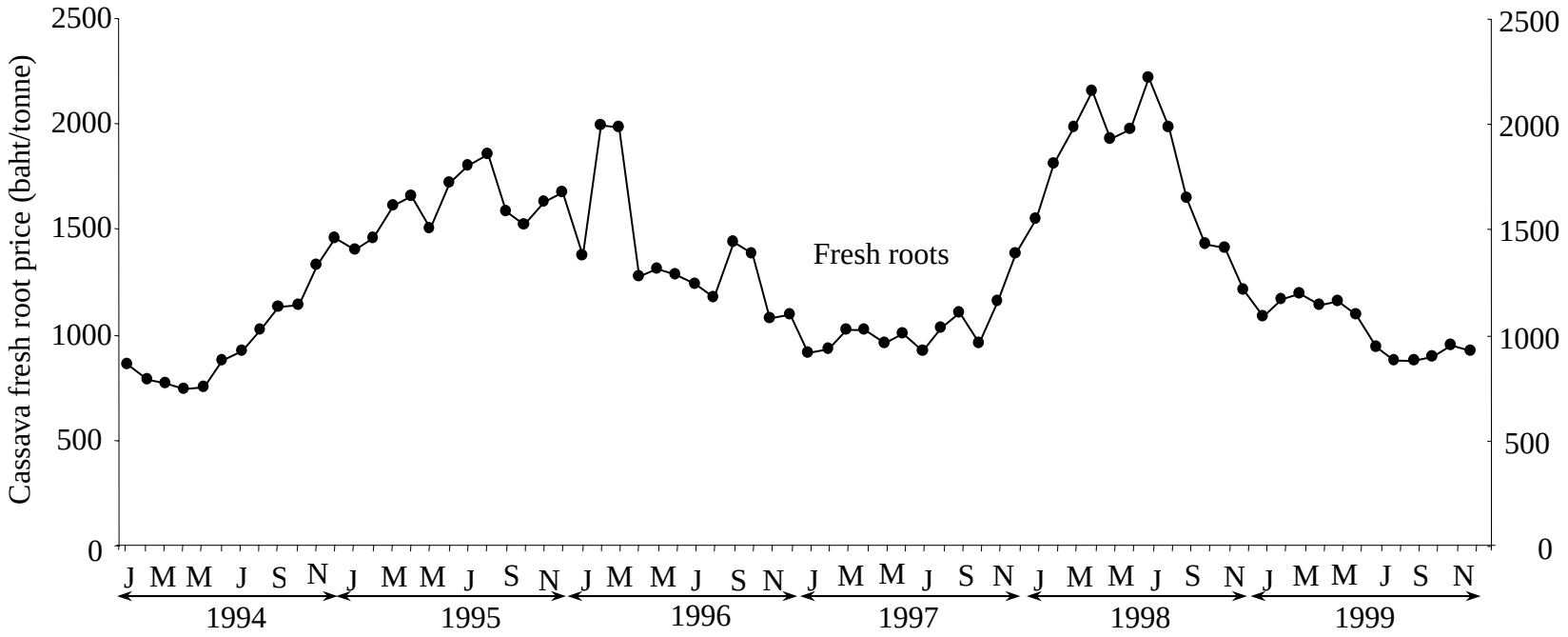

Figure 3. Monthly trend in the price of fresh cassava roots (at 30% starch content) in Nakorn Ratchasima province of Thailand from 1994 to 1999.
Source: *Thai Tapioca Trade Assoc. (TTTA), 2000.*

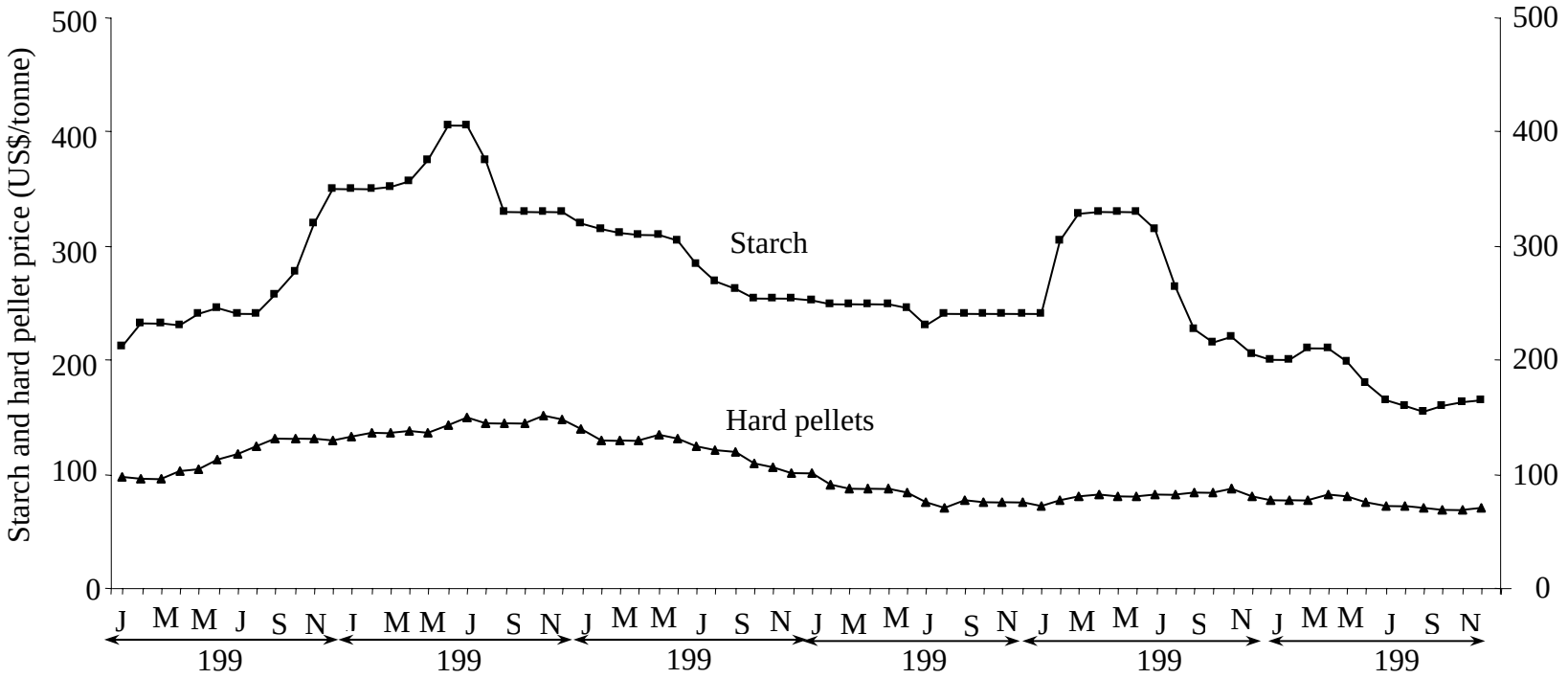

Figure 4. Monthly trend in the price (FOB Bangkok) of cassava starch and hard pellets from 1994 to 1999.
Source: *Thai Tapioca Trade Assoc. (TTTA), 2000.*

4. Cassava Marketing

The structure of the cassava market in Thailand is depicted in **Figures 5** and **6**.

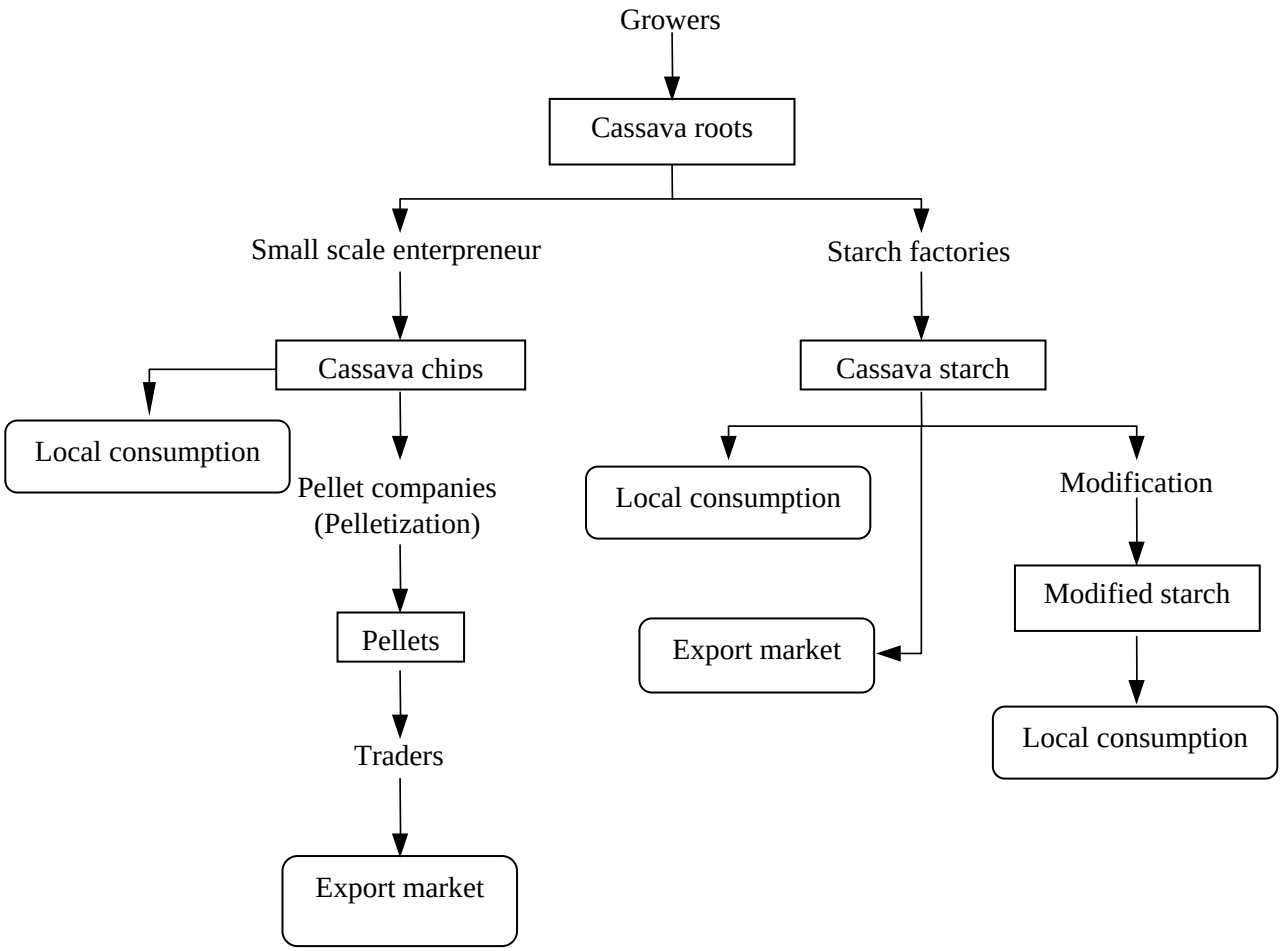

Figure 5. Marketing structure of cassava in Thailand.

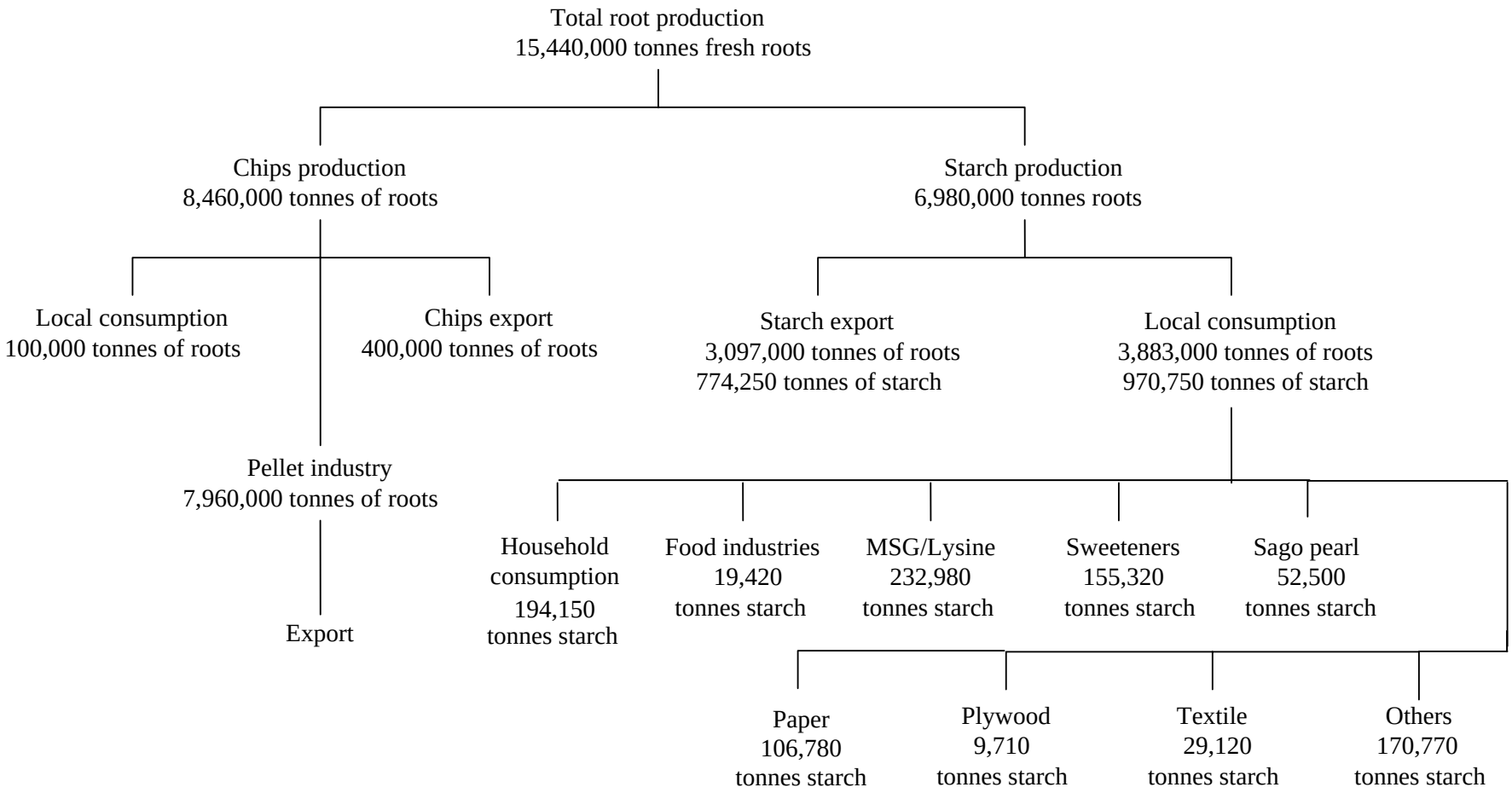

Figure 6. Distribution of cassava roots for industrial processing in Thailand in 1998.
Note: *Modified starches are partially distributed over export, food, and the paper, textile and plywood industries.*
Source: *Modified from TTTA, 1999.*

5. Government Policy

The Office of Agricultural Economics, Ministry of Agriculture and Cooperatives, formulates cassava policies. Considered in the formulation and amendment of this policy are recommendations by the Common Agricultural Policy (CAP) of the EU. The cassava policy for 1994-1998 is laid out as follows (Office of Agricultural Economics, 1994):

(a) Limitation of cultivation

Since 1983, only cassava planting in certain areas has been promoted. Twenty-three provinces (17 in the northeast and 6 in the east) were announced as economic zones for cassava. In 1987, registration of cassava growers was started. This policy was not monitored, thus the registration of all the growers has not been realized.

(b) Substitution crops

An attempt to persuade cassava growers to plant intercrops and partially replace cassava with high value crops, such as maize, mungbean, peanut, jute, sesame, and castor bean, was started in 1983/84.

(c) Rubber plantation

With financial support from the EU (1990-1997), a group of cassava growers was trained and plants of new varieties of rubber were distributed to three provinces in the northeast of Thailand (the main cassava planting area). Fruit orchards were also established and supported with EU funding.

(d) Marketing incentive

Traders or companies who export cassava chips and pellets were allocated export quotas to the EU market, but were required to seek new markets outside the EU to receive incentive quotas (in proportional figures to exports to non-EU countries).

CASSAVA PROCESSING

1. Cassava Chips Industry

Cassava chip factories are small-scale enterprises and most have no formal company registration. The manufacture of cassava chips is recognized as an agricultural activity; factories belong to farmers or small business men and are located in close proximity to the growing area. The chipping factories are installed with simple equipment, consisting mainly of a chopper. Roots are loaded into the hopper of the chopping machine by tractor; after chopping into small pieces, the chips are sun-dried on a cement floor. The chips are spread to a specific density (kg/m^2), ensuring a consistent final moisture content. During drying, which typically requires 2-3 days, a vehicle with a special tool for turning over the chips is used to ensure uniform drying. Economic loss occurs as a result of weight loss of the chips, caused by wind that blows the dry particulate matter; this is also a major problem leading to air pollution. **Figure 7** presents a pictorial representation of the chipping process.

When it starts raining, chips must be quickly pushed into piles and covered with plastic. This prolongs the drying time and inevitably results in lower chip quality. The final moisture content should be below 14%. Normally it takes 2.00-2.50 kg of fresh roots (with 25% starch content) to produce 1 kg of chips (14% moisture content).

(a) (b)

(c) (d)

Figure 7. Chips processing : (a) Root transportation (b) Conveyor and chopper (c) Drying area and (d) Turning chips by tractor

The Market: Chips are sold to pelleting manufacturers who either directly export the chips/pellets or sell to traders. In most cases, the small chipping factories sell their products to large factories that in turn sell a consolidated consignment to pellet manufacturers. Time from purchase of chips to their sale is rapid. Factories in Thailand do not have silo facilities for storage, and all transactions are direct; middlemen or brokers are not involved. Nakhorn Ratchasima province has the highest chip and pellet production in Thailand, and the pellet price in this province is the standard trading index to set the Bangkok market pellet price.

Local consumption of chips: The quantity of cassava chips used locally for animal feed in 1996 was around 100,000 tonnes; this is estimated to increase to 1,000,000 tonnes in 2000,

equivalent to 2.5 million tonnes of fresh roots. The uncertainties of unstable prices and supply of maize and soybean cake, used for animal feed, are mirrored by the cassava chip market.

Export markets: Cassava chips are exported mainly to non-EU countries, either directly by pellet manufacturers (but not chip factories), or by export companies. Since 1981, Thailand has exported to the EU mainly hard pellets rather than chips (**Table 4**). In this form, less dust is created, lowering the impact of environmental pollution during the loading and unloading of ships at the port.

Table 4. Quantity (tonnes) of cassava products exported from Thailand from 1966 to 1999.

Year	Chips	Pellets	Hard Pellets	Starch	Total
1966	521,328	-	-	173,671	694,999
1967	506,169	97,096	-	204,153	807,418
1968	417,282	314,788	-	143,568	875,638
1969	87,844	773,908	-	124,772	986,524
1970	22,620	1,061,065	-	142,914	1,226,599
1971	8,706	966,278	-	146,368	1,121,352
1972	3,905	1,109,363	-	124,453	1,237,721
1973	23,908	1,508,598	-	179,929	1,712,425
1974	105,713	1,924,647	-	254,967	2,285,327
1975	67,989	2,036,110	-	141,676	2,245,775
1976	63,721	3,252,439	-	241,200	3,557,360
1977	104,786	3,564,529	-	122,466	3,871,781
1978	312,598	5,727,531	-	135,028	6,275,157
1979	202,844	3,677,204	-	123,409	4,003,457
1980	256,212	4,452,579	-	148,483	4,957,274
1981	413,122	4,978,137	608,212	109,724	6,309,195
1982	487,247	5,214,592	1,479,856	125,632	7,607,327
1983	266,157	2,391,530	1,637,827	174,194	4,669,708
1984	155,775	2,893,327	2,905,316	464,875	6,419,293
1985	127.161	1,102,432	5,386,950	497,370	7,113,913
1986	68,662	251,161	5,508,254	459,048	6,287,125
1987	97,078	18	5,653,244	369,056	6,119,396
1988	368,328	18	7,183,239	555,746	8,107,331
1989	120,391	-	9,032,918	645,529	9,798,838
1990	269,150	-	7,285,423	656,291	8,210,864
1991	142,472	-	6,044,973	707,051	6,684,228
1992	320,643	-	7,724,387	750,425	8,576,686
1993	71,566	-	6,635,439	653,276	7,360,281
1994	9,909	-	4,732,643	923,561	5,716,113
1995	169,607	-	3,127,525	845,006	4,141,599
1996	2,700	-	3,604,411	893,365	4,500,476
1997	138,586	-	4,016,106	1,140,377	5,295,069
1998	237,162	-	2,961,486	770,096	3,968,744
1999	222,058	-	4,118,549	931,923	5,272,530

Source: *Thai Tapioca Trade Association, 2000.*

China, Korea and Japan still import cassava chips from Thailand, but for purposes other than feed, such as for ethanol fermentation. The high carbohydrate content of cassava chips is of value for biotechnological conversion; this utilization will secure a continued future for the cassava chips industry.

2. Cassava Pellets Industry

The pellets industry began a few years after the start of cassava exports to the EU (around 1967). Development of this product was stimulated by a need to improve the uniformity in shape and size of cassava chips required by the compound feed producers/users. In addition, during transportation, loading and unloading of chips dust generation caused serious air pollution, placing pressure on the importers in Europe to improve the nature of cassava products handled by the ports. Production of pellets involves pressing chips, and extrusion through a large die. The heat and moisture in the chips helps in the formation of a pellet-like shaped product, known as a soft pellet. Later process developments involved grinding of chips followed by steam extrusion; this created strong pellets upon cooling, known as hard pellets. Exports of hard pellets began in 1981; by 1987 hard pellets dominated pellet production in Thailand and by 1989 these were virtually the only pellets exported to Europe.

The raw material (cassava chips) for pellet manufacture, is purchased from chip drying yards; pellet factories do not produce chips. The purchase price is directly dependent on the export price of pellets in Bangkok. Quality of the chips is also an important consideration. The standard quality of chips is:

Moisture content = max. 16%
Sand = max. 4%
(The sum of the two factors should not exceed 20%)

Moisture content exceeding 16% results in a price penalty, but no reward is given if the moisture is less than 16%.

Competition for raw material by the pellet factories favors those with a large capacity and these always occupy a large proportion of the export quota; these factories can offer a higher price for chips.

There are approximately 200 pelleting factories in Thailand with a total capacity of about 10 million tonnes per year. However, the EU quota is only 5 million tonnes and this is the sole market for this product. The factories are therefore working only at 50% of their capacity (3-4 months per year).

The manufacturing process for pellets is shown in **Figures 8** and **9**.

3. Cassava Starch and Starch-based Industries

At the time that cassava was introduced into the southern part of Thailand (1786-1840), a cottage-scale industry for production of cassava meal or cassava flour was adopted from neighboring countries, Malaysia and Singapore.

Conversion of fresh cassava root, by grating, mixing with water followed by sedimentation and sun-drying (or conductive heating) produces a product traditionally

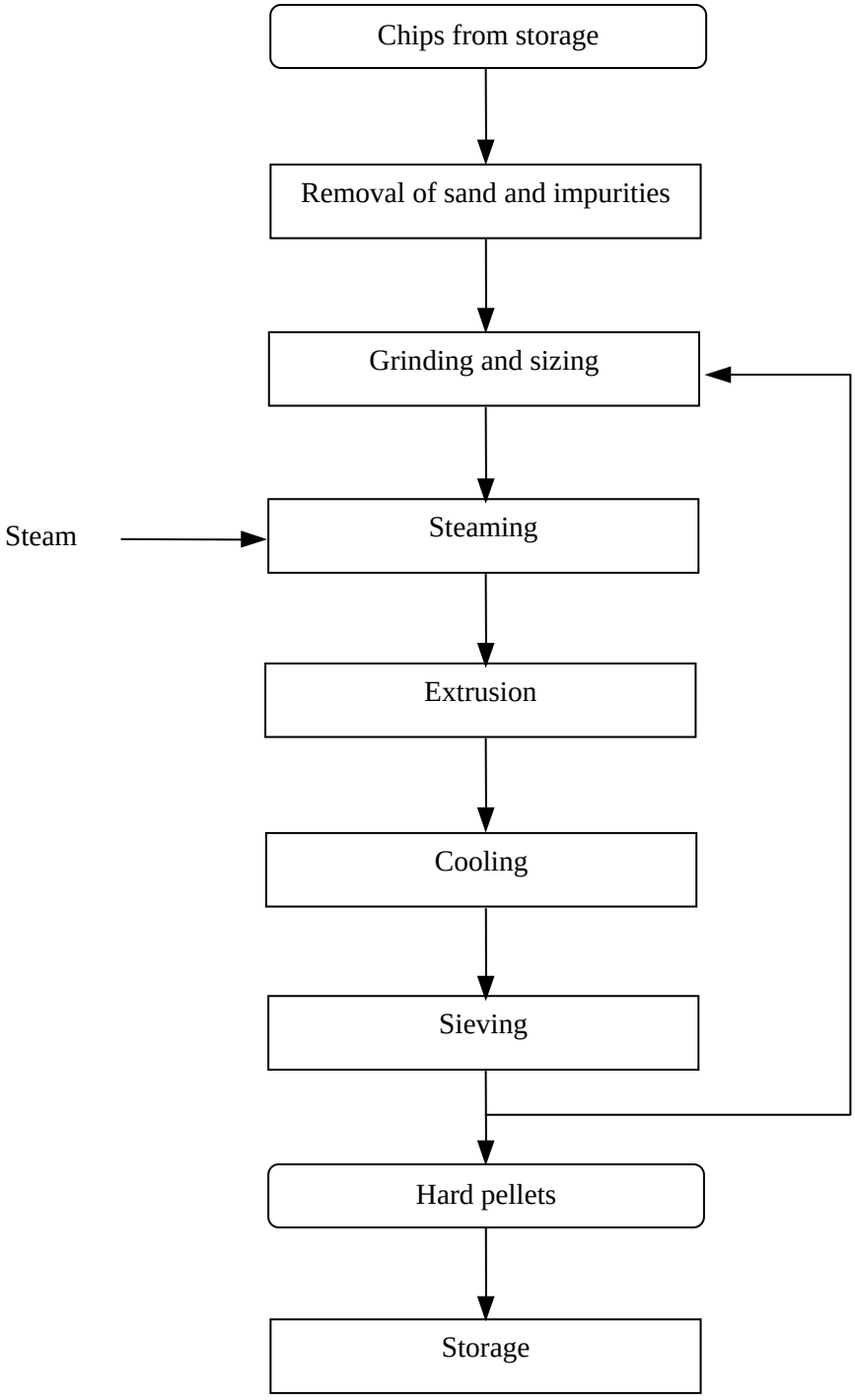

Figure 8. Process for production of cassava hard pellets.

(a)

(b)

(c)

(d)

Figure 9. Pellets processing : (a) Grinding of chips by hammer mill (b) Extrusion (through a die press) (c) Cooling chamber and (d) Storage of pellets

called “cassava flour” but now called “cassava starch”. Cassava starch may be further processesed to make sago pearl, which is a traditional dessert for the people in the southern part of Thailand.

Demand for cassava starch increased dramatically and this led to the development of the modern starch manufacturing process in the 1970s. A survey conducted in 1996 indicate that at that time there were 41 modern factories registered to the Thai Tapioca Flour Industries Trade Association. These factories were working with modern separation

and drying processes. The processing time (from the grating of fresh root to dried starch) is estimated to be less than 30 minutes. Presently, factories using the sedimentation process do no longer exist in Thailand.

The process for production of cassava starch manufacturing is essentially the same for all factories, and is shown in **Figure 10**. About 4.75 tonnes of fresh roots produce one tonne of dry starch.

About 40% of cassava starch, i.e. 600,000-800,000 tonnes, is used domestically and 60% i.e. 700,000-900,000 tonnes, for export (**Table 5**) (The Thai Tapioca Flour Industries Trade Association, 1999).

Distribution from factories is by three outlets; 1) direct sale for general consumption and local factories, 2) sale to intermediary dealers for domestic retail and export, and 3) direct export.

Table 5. Production and export(tonnes) of cassava starch from Thailand, 1991-1998

	Domestic		Export		Total	
Year	Starch	Root	Starch	Root	Starch	Root
1991	559,000	2,795,000	860,681	4,303,405	1,149,681	7,098,405
1992	615,810	3,079,050	946,749	4,733,745	1,562,559	7,812,795
1993	680,358	3,401,790	1,041,422	5,207,110	1,721,780	8,608,900
1994	754,004	3,770,020	936,390	4,681,950	1,690,394	8,451,970
1995	723,269	3,435,527	857,852	4,074,797	1,581,121	7,510,324
1996	759,434	3,607,311	905,136	4,299,396	1,664,570	7,906,707
1997	770,000	3,657,500	1,155,738	5,489,755	1,925,738	9,147,255
1998	650,000	3,087,500	784,835	3,727,966	1,434,835	6,815,466

Source: *The Thai Tapioca Flour Industries Trade Association, 1999.*

3.1 Domestic market (see Table 6 and Figure 6)

Monosodium glutamate (MSG)/lysine: Highest consumption of cassava native starch is by the MSG (four factories) and lysine (one factory) industries. Starch consumption for production of these products is in the proportion 80:20 by the MSG and lysine industries, respectively. Production of commercial MSG in Thailand utilizes only two carbohydrate sources for inoculation: molasses and cassava starch. To produce one tonne of MSG, factories need either about 2.4 tonnes of cassava starch or 7.0 tonnes of molasses.

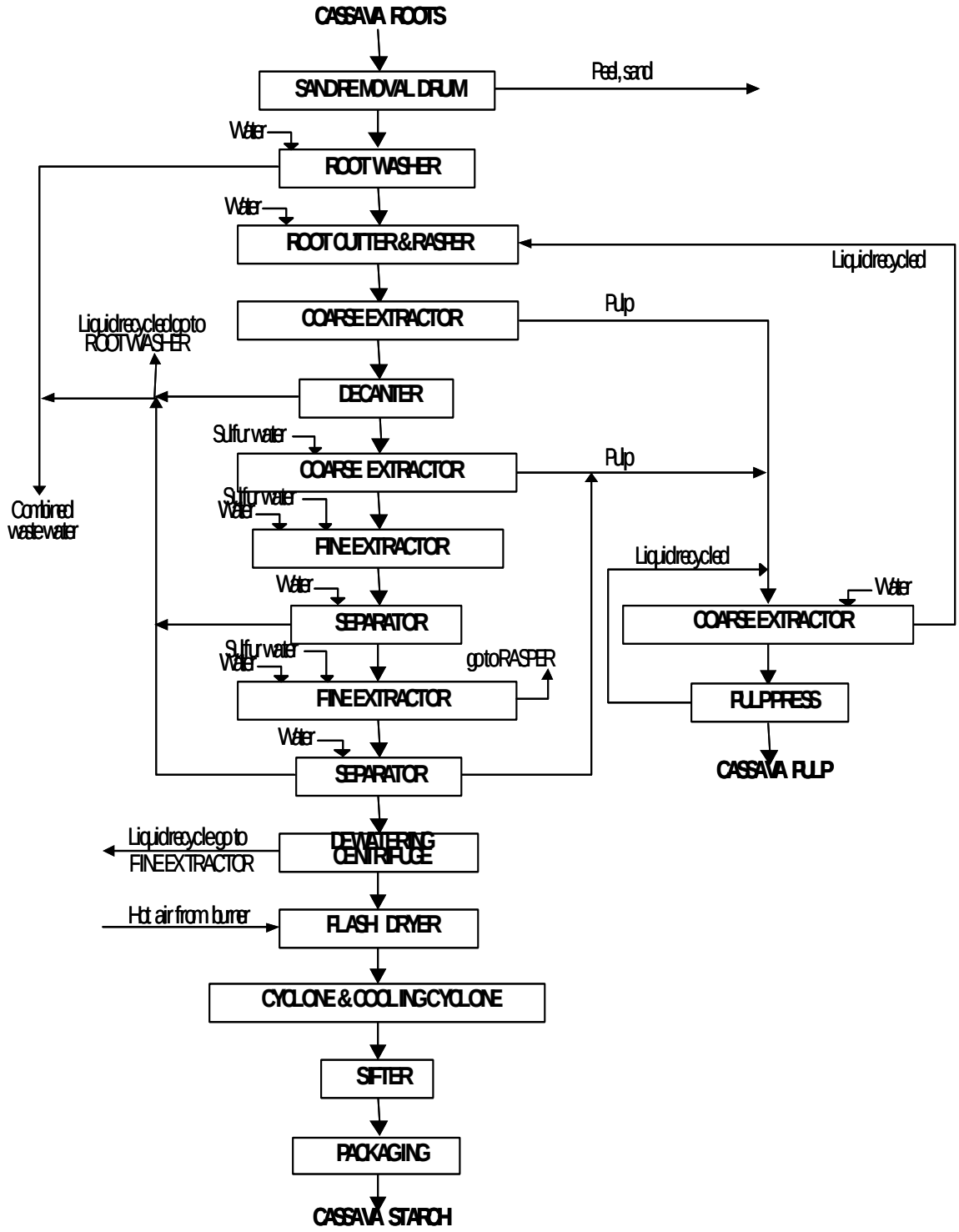

Figure 10. Example of the cassava starch manufacturing process in Thailand.

Table 6. Annual demand for cassava starch for the production of sweeteners and MSG/lysine in Thailand.

Products	Quantity of starch used (tonnes/year)	Product (kg/kg of starch)
High fructose	60,000	1.00
Glucose syrup	45,000	0.90-0.95
Dextrose monohydrate	20,000	1.75
Dextrose anhydrous	500	0.50
Sorbitol	30,000	1.20
MSG/Lysine	232,980	0.42

Source: *Sriroth, 1998.*

Sweeteners (glucose/fructose/sorbitol): There are 14 factories manufacturing glucose syrup (two also produce sorbitol) and two large international sorbitol producers (Ueno Co., Ltd., Japan, and Lucky Chemical Co., Ltd., Korea). In 1998 there was only one factory producing high fructose syrup (about 60,000 tonnes per year).

Food/sago industry: Cassava starch is widely used by the food industry, especially for canned products. Properties of cassava starch as a binding and thickening agent play important roles in many products such as ice-cream, noodles and puddings. It is also used as a filler in wheat flour to control protein content. The amount of starch used in the sago industry is 6% of total domestic cassava starch consumption.

Paper/textile/plywood: Cassava starch has the properties of gel formation and retrogradation. For this reason it is widely used in the paper industry for surface treatment (sizing). In the textile industry it is used for yarn treatment and in the plywood industry for its binding properties. Starch consumption in paper, textile and plywood industries are 11, 3 and 1%, respectively, of total domestic cassava use (The Thai Tapioca Flour Industries Trade Association, 1999).

Citric acid: There are only two factories manufacturing citric acid in Thailand. One uses cassava pulp from starch factories as the raw material (about 5-6 tonnes/day) for its solid state (surface) fermentation. The other, recently established, uses cassava chips as raw material for its submerged fermentation process. About 40 tonnes of chips are needed to produce 6 tonnes of citric acid per day.

4. Export/International Market

Of the various cassava-based products mainly cassava starch and pellets are exported (**Table 7**). In the future, the export of cassava starch will be more significant in both value and volume. Thailand exports not only native cassava starch but also the

modified products, for example, chemically and physically modified starch, sago, seasoning powder, sorbitol and liquid glucose.

Table 7. Quantity (tonnes) and destination of cassava products exported from Thailand during 1998 and 1999.

	Chips		Hard pellets		Starch	
Country	1998	1999	1998	1999	1998	1999
Africa	-	-	-	-	11,432	13,838
Australia	-	-	-	-	13,223	11,993
Bangladesh	-	-	-	-	3,668	7,034
Belgium	-	-	27,165	73,148	77	94
Brazil	-	-	-	-	263	410
Canada	-	-	-	-	8,623	2,779
China	182,100	155,261	-	-	28,412	61,555
France	-	-	-	-	4,555	3,863
Germany	-	-	3,500	-	924	384
Hong Kong	-	-	-	-	39,702	48,043
Indonesia	-	-	-	-	65,079	41,725
Italy	-	32,277	-	26,616	-	-
Japan	-	-	20,886	16,603	204,152	234,007
Laos	-	-	-	-	1,769	205
Malaysia	-	-	-	-	46,936	80,195
Mexico	-	-	-	-	660	234
Netherlands	-	24,720	2,486,686	3,409,728	13,816	14,526
New Zealand	-	-	-	-	1,289	465
Norway	-	-	-	-	902	689
Philippines	-	-	5,500	-	13,612	19,710
Poland	-	-	-	-	-	-
Portugal	-	9,800	52,125	57,125	-	-
Saudi Arabia	-	-	-	-	53	45
Singapore	-	-	-	-	41,826	46,382
Spain	-	-	194,075	535,329	-	-
Sri Lanka	-	-	-	-	525	1,158
South Korea	55,040	-	171,549	-	4,031	6,113
Sweden	-	-	-	-	1,906	1,680
Switzerland	-	-	-	-	560	6,397
Taiwan	-	-	-	-	212,676	277,761
U.K.	-	-	-	-	2,555	1,563
U.S.A.	-	-	-	-	39,086	38,199
Other	-	-	-	-	7,784	10,876
Total	**237,162**	**222,058**	**2,961,486**	**4,118,549**	**770,096**	**931,923**

Note: starch data only for Jan-Nov, 1999.
Source: *Thai Tapioca Trade Association, 2000.*

Future exports of cassava starch are expected to increase, as under the new GATT agreement the Thai government has agreed to maximum market access of cassava starch

and modified products with the European Union (EU), South Korea, and Japan (The Thai Tapioca Flour Industries Trade Association, 1994; 2000).

1) EU will grant market access for Thailand's cassava starch upto 10,000 tonnes per year. The current tariff rate is 170.59 ECU per tonne; and the tariffs for import above the quota of 10,000 tonnes is 260 ECU per tonne; this will be reduced to 166 ECU per tonne by 2000.

2) Japan will reduce the tariff for cassava and related products within two years, as follows:

- Flour and meal for animal food production will be exempt; for others the current rate of 25% will be reduced to 15% in 2000.
- Cassava starch: in 1995 the tariff was 140 yen per kg; this will be reduced to 119 yen per kg in 2000. In addition, Japan is also committed to improve market access of dextrins and esterified starch by reducing the tariff from 8% in 1995 to 6.80% in 2000.

3) South Korea will grant market access for Thailand at an annual import volume of 1 million tonnes of cassava pellets with a 3% tariff, and a volume of 2,400 tonnes of cassava starch with 9% tariff.

CONCLUSIONS

Since 1959, cassava-based products have been a major export commodity for Thailand, assisted by relatively easy market access to the EU (until 1992). In a bid to meet the increased demand, rapid growth in the industry also led to weaknesses.

Productivity and demand: Enormous increases in cassava production in the past, with rather low yields, required a large planting area. The current reduction in demand for cassava will result in a large amount of land becoming available, but being unsuitable for other crops without large investments.

Policy: Systems for rewarding contracts to companies involved in the cassava industry are not yet fully in place to cope with a reduced export demand. The government needs to implement procedures that will grant fair access to as many companies as possible.

Thailand has demonstrated that cassava can be more than a subsistance crop, and that a large-scale and complex industrial system can be developed around this crop. Value addition to cassava has been a gradual process, and one that is still under way. Long term survival will necessitate that higher-value starch-derived products be developed from cassava and that appropriate markets be created. Thailand is unique in that despite the large scale of the cassava products industry, primary raw material production systems have remained small-scale. Farmers livelihoods have not been compromised as the range of products required by export markets has created competition between root buyers. This situation may not be maintained in the long term as Thailand becomes dependent on a narrower range of products and quality requirements of export markets well become more demanding.

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