GLOBAL CASSAVA STARCH MARKETS: CURRENT SITUATION AND OUTLOOK[1]

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ABSTRACT

Current global starch production is approximating 50 million tonnes. While the starch production growth rate steadily continues to surpass average population growth figures, the make-up by starch source and production regions have been changing. The world share of cassava-based starches may range between 4-6%. While Southeast Asia continues to lead as the foremost cassava starch production (and utilization) region, both within this region and in other continents the cassava starch industry and market patterns are changing. Starting in the late 1980s and accelerating during the 90s, Latin-American and (to a minor extent) African cassava starch processing has expanded. It is most likely that this basic trend will continue into the beginning of the 21st century. However, the new century brings with it both new threats as well as additional opportunities that will greatly impact on the competitiveness of cassava as a major starch source.

The paper firstly summarizes the principal global trends of starch production, utilization and markets, paying special attention to the role of cassava. In addition, individual starch regions (US, EU, Asia) and their main players will be discussed. Secondly, the foremost global and regional technical, political and economic conditions that are currently coming about will be reviewed concerning their potential impact on global starch markets. Thirdly, a synthesis is formulated as to what the most probable implications are for cassava sector researchers and developers.

INTRODUCTION

Cassava utilization has, especially during the early 1990s, accelerated outside of the traditional regions with already high cassava utilization, i.e. Thailand, Indonesia and India. Most of this renewed emphasis has been taking place in the so-called " newly opened economies " of China, Vietnam, etc. These dynamics regard especially cassava starch processing. Moreover, traditional cassava starch producers, like Thailand and Indonesia, are further expanding their industries and product portfolios. To a lesser extent this has also been the case in Latin America. However, in Africa this trend has only just started to take initial shape.

Given these recent dynamics and given the scarcity of reliable and updated information about the starch industry in general, and the cassava starch industry in particular, this Workshop offers an opportunity to present new information and highlight global cassava starch trends.

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[1] The initial (presented) paper was modified to accomodate more recent information that was generated through a consultancy of the European Group on RTB for FAO-ESCB (March 1998). The main authors for the consultancy were Guy Henry (CIRAD), Andrew Westby (NRI) and Chris Collinson (NRI), referenced as Henry *et al.*, 1998.

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Cassava starch industry aspects cannot be analyzed in isolation. Two principal forces dictate the industry, in its input and in its output markets. The first is the cassava chip and pellet industry, that compete for the same raw material as the starch industry. The second is the output market with competing starches based on potato, maize and wheat. Hence, this paper will give due attention to these two additional sectors, in its attempt to shed more light on trends in the global cassava starch market.

PAST AND FUTURE TRENDS OF END-USES, BY CONTINENT

Current global cassava utilization is estimated at 166 million metric tonnes (t). A recent paper (FAO, 1997) analyzed past cassava utilization trends. The paper, based on the results of econometric modelling, in addition, projects utilization growth rates to the year 2005. **Table 1** shows that the annual global utilization rate is projected to slow down to 1.8%, from the past 2.4%. This is mainly caused by a relative slowdown in African utilization, while growth rates in Asia and in Latin America and the Caribbean (LAC) are projected to increase. Starch utilization is included in the group of "other uses". While this group showed a global past growth rate of 4.7%, it is projected to decrease to 3.1%, but this still represents the highest growth rate compared to food and feed use. Especially for Asia and LAC, the growth rates of "other uses" will continue to be significant. The same table also shows the relative shares of the different uses in time. As such, it is projected that both the food and feed share will decrease, while "other uses" will gain in terms of global utilization share. To a large extent, this is a reflection of the dynamic global future outlook for cassava starch.

Table 1. Global cassava utilization growth rates (past and projected) and shares among various uses in 1983-1993 and 1993-2005.

Region:	World (%)	Africa (%)	Asia (%)	LAC[1)] (%)	Share of total use (%)
Total use					
1983-1993	2.4	4.3	1.6	0.2	**100**
1993-2005	1.8	2.4	2.5	1.5	**100**
Food					
1983-1993	2.4	3.9	0.1	0.2	**59**
1993-2005	2.2	2.5	2.0	0.8	**58**
Feed					
1983-1993	1.1	7.6	4.7	0.2	**24**
1993-2005	-0.2	1.8	2.5	1.3	**22**
Other use					
1983-1993	4.7	5.3	6.8	0.4	**17**
1993-2005	3.1	2.3	5.4	3.4	**20**

[1)]LAC = Latin America and the Caribbean

Source: *FAO, 1997.*

Starch, or cassava starch in the context of this paper, can be classified according to end-use or to processing technique. A practical classification used by Roper (1996) and by Sansavini and Verzoni (1998) includes four main classes: *native starch, hydrolyzates, modified starch, and others*. The industries utilizing starch can be basically divided into: food and non-food sectors. As such, starch (lysine, ...) for the animal feed sector, is included as a non-food. The list of industries that are currently using starch is very large since it is being used in thousands of end-products. Useful references for extensive listing of the sectors are Ostertag (1996), Leygue (1993), Roper (1996) and Gottret *et al*. (1997). Besides, the internet home-pages of major starch multinationals (like Cargill, ADM, Purac, Cerestar, CPC) list all possible derived products. Furthermore, a substantial number of modified starches are labelled with codes rather than names (as is the case of cationic starches for the quality paper industry). For the sake of efficiency on the one hand, and data availability on the other hand, this paper will mainly deal with starch used in the following sectors (including a non-exhaustive sample of end-products):

(a) Food Sector:

Food processing industries:	- bakery and pastry products
	- noodles, vermicelli, ...
	- soups, sauces, ...
	- ice creams, yoghurts, lactic drinks, puddings, ...
	- processed meats, ...
	- sweets, chocolates, candy, chewing gums, ...
	- marmalades, jams,...
	- canned fruits, juices, ...
	- soft drinks, beers, ...
	- snack foods,...
	- taste enhancers, color enhancers, ...
	- fat substitutes for dietary products
	- alternative protein sources
	- sweeteners, ...
	- .....

(b) Non-Food Sector:

Paper, cardboard and plywood:	- carton, high quality papers, different plywoods, ...
Textile industry:	- fillers, stiffeners, ...
	- leather goods
Chemical and pharmaceutical industry:	- glues, paints, cements, ...
	- soaps, detergents, bleaches, insecticides, ...
	- explosives
	- oil drilling materials
	- biodegradable plastics, polyesters, etc.
	- industrial alcohols
	- combustibles, ethanol, oils,...
	- pharmaceuticals,vitamin C and B12, antibiotics,..
	- cosmetics, ...
	- water treatment agents

	- …
Feed industry:	- protein substitutes
	- carbohydrate sources

As mentioned before, very few updated and consistent reports exist regarding starch markets. Roper (1996), based on 1991-92 data, refers to a European starch market of 6.1 million tonnes. Information from the International Starch Institute in Denmark (Thomson, 1997) mentions the EU producing 7 million tonnes, which is consistent with AAC (1997), but a Cerestar source notes 6 million tonnes. Ostertag (1996), using largely 1992 data, calculates a global market of 33.2 million tonnes, with shares for the US and Canada of 41%, the EU 18%, and Asia 34%. A recent (still unpublished) study by Sansovini and Verzoni, using 1993 data, estimates the world market at 33.7 million tonnes.

The cassava share of global starch production is estimated by Ostertag (1996) at 6%, but by Sansavini and Verzoni (1998) as high as 10-11%. These conflicting estimates do not contribute much to a clear understanding of the global cassava starch situation. However, it seems more pertinent to analyze the cassava starch actual and potential markets at the disaggregated or country level.

II. African Cassava Starch Production and Utilization

The availability of data on household level starch production is very limited. Household level starch production does exist, as demonstrated by the data from COSCA, but is probably mainly for local food use.

There used to be a number of cassava starch factories operating in Africa, including in Uganda, Tanzania and Madagascar. Few of these are now operational and little data is available on their production. An African starch experience comes from Malawi (CFC, confidential report, 1997), where the local paper and cardboard industry is willing to buy up to 1.5 tonnes of cassava starch (for adhesives) a day, while the confectionary, plywood and food processing industries have also expressed interest to use (local) cassava starches. Similarly, one report from Uganda (CFC, confidential report, 1997) evidences the opportunity for cassava flour to partially substitute for wheat in the manufacturing of baby premixes, biscuits, ethanol and dextrins. The other report, from the same source, describes the possibility for refurbishing an old starch factory for future production of starch, glucose and dextrin for use by the pharmaceutical, food-processing and textile industries. The factory is envisioned to produce daily 15 tonnes of starches, using cassava and maize as the source crops. Following are some summarized case studies to further highlight the African starch situation.

Market opportunities in Zimbabwe

Kleih (1994; 1995) estimated the potential level of commercial/industrial use of cassava in Zimbabwe. There is currently little cassava grown in Zimbabwe, but there is a lot of interest because of recent poor maize harvests. By analysis of the future markets and rapid rural appraisals in potential production areas, the future supplies and demands for cassava were estimated. Kleih (1995) estimated a starch demand equivalent to 7,700 tonnes of chips. Demand is not certain and may only occur in the medium to long term. The major

manufacturer indicated that they will concentrate on maize for the next five years. Dry raw materials are the preferred input. Furthermore a demand for ethanol was estimated to an equivalent of 240,000 tonnes of fresh roots. Demand is not certain and may only occur in the long term once a large-scale cassava economy is established. Cheaper processing technologies would be required. 240,000 tonnes of the roots could produce 40 million liters of ethanol, equivalent to 13% of current gasoline consumption.

Domestic market potential for cassava starch in Ghana

Graffham *et al.* (1997) surveyed producers and users of starches and flours in Ghana between February and April 1996. The market for starch within Ghana comprises a number of end users who make use of maize, cassava and potato starches, which are mostly imported. The current market is approximately 4,200 tonnes per year, which compares well with figures in a survey carried out by Glucoset Limited of Ghana (Anonymous, 1994). The Glucoset survey also predicted that demand will increase to 5,600 tonnes by the year 2000. Most users have very high quality specifications with 60% of the market being for modified starches.

The use of starch from locally grown cassava would mean that less material has to be imported. Further work is required to determine whether small-scale processors can produce starch of a high enough quality, or whether there are opportunities for large-scale processing plants using cassava as a raw material.

Market potential for cassava starch and alcohol in Nigeria

Bokanga (1997) made some estimates of the potential use of cassava for alcohol and starch in Nigeria. He predicted that one factory consuming 30 tonnes of cassava chips per day for alcohol could save US$2.06 million in foreign exchange, with net returns to processors of US$1.5 million and US$0.5 million to farmers. Use of cassava for starch (based on an annual production estimate of 200,000 tonnes) would have no foreign exchange savings, but would result in US$30.12 million net income to processors and US$12.5 million to farmers.

Trade in starch

A stage beyond the use of cassava starch by the domestic food and non-food industries is the export of starch. Data for cassava starch exports are available from FAOSTAT (FAO, 1997); these show that starch to the value of only US$16,000 was exported in 1995. The major exporting countries were Kenya and the Democratic Republic of Congo. Over the period 1992-1995 Africa was a very minor exporter of cassava starch. The only significant quantity was exported by Egypt in 1993. Since Egypt is not a major cassava producing country, this may have been produced elsewhere.

By contrast with its exports, Africa was more of an importer of cassava starch between 1992 and 1995 (9,000-6,000 tonnes). Only a small quantity of African imports could have come from African countries because total exports from these countries were very low. With appropriate development, African countries with potential comparative advantages in cassava starch production may in the future be able to supply themselves or other African nations. However, the extent to which intra-African cassava starch trade is possible will crucially depend on the cost of intra-African transport. This potential is

worthy of investigation. In terms of imports of other types of starch, north African countries tend to be the largest importers of EU starch. This may reflect their greater level of industrialization. According to data taken from the US Department of Commerce, the US is not a major starch exporter to Africa. No types of starch, other than those that appear in the tables, were exported from the US to African countries during 1996 and 1997. Cassava starch exports from Thailand to African destinations (non-specified), between 1993 and 1996, fluctuated between 2,167 and 3,200 t/year (TTTA, 1996).

Although some data have been identified on the current supply and demand for starches in Africa, more are required before recommendations can be made on the future of starch processing. Specifically, more data are required on the demands for modified starches and hydrolysis products. An important criterion in the assessment of this market potential will be the ability to produce starches of the appropriate quality for various commercial applications.

III. Asian Cassava Utilization and Markets

Chips and pellets

As extensively reported by Hershey *et al.* (1997a), Henry and Gottret (1996) and Henry *et al.* (1994; 1995), Thailand has been the principal cassava[4] chip and pellet producer and exporter for more than three decades. As the result of a series of trade policy changes throughout the late 1980s and 1990s, Thai pellet production and exports have steadily decreased from 7.2 million tonnes in 1990 to 3.6 million tonnes in 1996 (TTTA, 1996). Furthermore, the share of Thai chips has become negligible compared to that of pellets. Pellet export prices, as the cause of reduced exports, have behaved irregularly. While at the end of the 1980s and start of the 1990s the CIF Rotterdam pellet price was in the 145-165 US$/tonne range, as EU coarse grain prices started to slide so did Thai pellet prices. While in 1995, average EU pellet prices rebounded to a US$ 140/tonne level, they have since slid to a current 1998 price level of less than US$ 100/tonne (FOB price European port of DM 170-177/tonne). Hence, the Thais have not been able to satisfy their annual export quota to the EU. This is also due to competition for cassava roots from the domestic starch industry. The future potential of cassava for the domestic feed industry and its competitiveness *vis-à-vis* domestic or imported maize, needs further study.

Indonesia, as the second largest chip/pellet[5] exporter has experienced a similar export erosion trend, although with much smaller volumes. As will be further elaborated in

[4] It needs to be noted that a large share of the solid residue from the Thai cassava starch processing industry is used as raw material for the cassava pelleting industry. However, no exact figures on its utilization rate are available.

[5] Unlike Thailand, Indonesia still ships large volumes of cassava chips. Currently, exports are equally divided between chips and hard pellets. The relatively cheaper chips have been used, at times, by other Asian countries for starch processing.

the discussion on starch in Indonesia, the domestic market for Indonesia is of primary importance, especially for starch. While Indonesia has profited from its EU pellet/chip exports until the early 1990s, it has actively diversified its market, which currently is almost equally divided between the EU and Asia (Taiwan, Japan, Hong Kong, China,..) and others. Future processing emphasis in Indonesia will further shift to starch rather than chips and pellets. Little hard information is available regarding future potential of cassava for domestic feed utilization. This needs further attention.

Starch situation in Thailand

Thailand is the largest cassava starch producer, manufacturing approximately 2 million tonnes of native and modified starches, of which less than half is exported. Sriroth (1997), reports that the industry currently is made up of 52 factories, down from 96 in 1974. **Table 2** shows the domestic cassava starch utilization, by industry, as a percent of the total 1994 production of 1,121,625 tonnes of starch for domestic use.

TTTA (1994) estimates the annual starch export growth rates for the main starch products between 1987 and 1992 as follows: native 10.5%, modified 33.8%, sorbitol 48.9%, monosodium glutamate (MSG) 12.8%, glucose syrup 9.4% and sago 8.3%. These figures speak for themselves regarding the dynamics of the Thai starch industry. As the industry becomes more competitive and hence, more secretive, traditional information sources in Thailand are becoming very reluctant to share their latest data. The latest (1996) TTTA Annual Yearbook only mentions exports, but gives no national utilization information.

Starch exports in 1996 are estimated at 800-900,000 tonnes. Principal destinations are foremost Japan and Taiwan, followed by USA, Mexico, China, Singapore, Hong Kong, the Netherlands, Philippines and Indonesia. It is interesting to note that even with the very steep EU tariffs, 28,577 tonnes of starch were exported to the Netherlands! It is yet another indication[6] of the competitively low price of Thai starch, which during 1996 averaged US$ 280-300/tonne *versus* EU potato starch at US$ 600; the latter dropped to US$ 550/tonne during the year, due to favorable EU export subsidies (while US maize starch was US$ 300/tonne). The latest Thai starch industry information (May, 1999) mentions a “Super High Grade Starch” price of US$ 200/tonne FOB Bangkok (TTTA, 1999).

[6] The current financial and economic crisis in Thailand (and in SE-Asia as a whole), has many serious negative implications for the country, its economy and its people. However, as regards cassava product exports, the huge devaluation of the Baht (currently 37Baht= 1US$, compared to 25 Baht two years ago), should have significant positive repercussions for the international competitiveness of Thai cassava based products, such as starch. Since most of cassava starch production and processing inputs are non-imported, domestic factors (land, labor), that have risen only marginally in price, cassava product prices have become relatively cheaper, allowing for higher profit margins (for exporters, if at same export prices) and/or increased export market expansion (at lower prices).

Table 2. Domestic utilization of starch in Thailand in 1994, as a percent of total domestic starch use.

Chemically modified starches	25.41%
MSG (80%) and lysine(20%)	12.10%
Glucose/fructose syrup	11.97%
Food processing	11.87%
Paper	11.49%
Physically modified starches	7.37%
Sago pearl	3.56%
Plywood	2.14%
Textile	1.86%
Sorbitol	1.55%
Adhesives	1.19%
Others	9.49%

***Source**: Thai Tapioca Flour Industries Association, 1994.*

The TTTA (1996) source also notes a 1997 (starch) export target of 955-970,000 tonnes, of which 30% are dextrins and modified starches, and 70% native starch (p.37). Internal TTTA activities point towards a growing export market interest for the Soviet Republic and China. Additional export opportunities for Japan are totally policy dependent, and as yet, unclear to predict.

While traditionally, the export market has constituted the primary Thai objective, several reports (Titanapawatanakun, 1997) point out the growing importance of the domestic market (as another means for market diversification). The author estimates that for the food sector, MSG and lysine demand will grow fastest, while in the non-food sector, it will be paper and other industrial uses (p.63). However, with the current financial crisis, these earlier assessments may need to be revised.

Several Thai research groups with government and private industry support, have undertaken considerable amounts of research on new cassava starch-based product formulations (ethanol, SCP, food colorants, starch-based plastics, etc) starch waste valorization, improved cassava varieties, etc. (Sriroth, 1997; Ratanawaraha *et al*., 1997). Furthermore, Maneepun (1997) mentions the following "new promising uses for tapioca starch", as: (i) improved quality and cheaper maltose syrups for brewery industry, (ii) malto-dextrins manufactured from physically modified starch (rather than chemically modified), for use as fat replacers, and (iii) cyclo-dextrins for food and pharmaceutical uses (p. 81).

Starch situation in Indonesia

Traditionally, Indonesia's primary starch market has been the domestic market (Henry *et al*., 1995), principally being used for the manufacturing of food snacks such as

krupuk. However as the industrial and economic development has steadily increased, other uses (also in the non-food industries) have become important. A study by Gunawan (1997) notes that in 1992, "direct" cassava consumption was only 21.5% of total supplies (p.35), and that about 34-35% of total cassava available was processed in medium- and large-scale processing industries, and 45% was used in households, mini- and small-industries, and non-formal sectors (p.36).

Cassava processing includes animal feed (chips/pellets) and starches. Due to decreased EU cassava prices, and increased domestic (and foreign) cassava demand, Indonesia's chip/pellet exports have decreased from 1.2 million tonnes in 1990 to 600,000 tonnes in 1996 (FAOSTAT, 1997). Gunawan (1997) notes that "*...domestic demand has increased tremendously because cassava products have many different (domestic) uses, such as feed, plywood industry, and glucose and fructose industries*" (p.39). In addition, information from the US private industry (personal communications, E. Tupper, 1997) reports that currently the Indonesian annual per capita paper consumption is at 12 kg, with an estimated annual growth rate of 14%[7]. At an average inclusion rate of 35-45 kg of modified starch per ton of paper, this presents a significant derived demand growth potential for cassava (modified) starch in Indonesia. Currently, the larger share of the "more sophisticated" starches is being imported in Indonesia, mainly from the US and Thailand. However, during 1995-97 (up to the financial crisis) significant new investments (both foreign and national) have been made in the construction of large-scale vertically-integrated factories for manufacturing of modified starches (personal communications, P. Temprom, 1997), indicating a trend towards increased self-sufficiency regarding up-scale starch production. The bottom line is that currently no reliable and updated data exists regarding Indonesia's starch production, nor its starch utilization shares, by industry.

Starch situation in Vietnam

Cassava starch production in Vietnam, before the start of the 1990s consisted largely of small household-level processing units in addition to several state-owned (run-down) larger-scale units (Dang Thang Ha *et al*., 1996; Dao Huy Chien, 1997), mainly producing dry and wet native starch (for noodles, cakes, alcohol, etc.) and to a lesser extent maltose (for candy manufacturing, ...). Starting in the 1990s, following "the run for cheap local labor and inputs, coupled to expanding domestic markets", large-scale modern cassava starch processing factories were constructed in the major cassava production areas of southern Vietnam. While in the beginning these were largely joint ventures with Japanese, Korean and Taiwanese multinationals (Vedan, Ajinomoto, AAA etc.), during the second half of the 1990s, local Vietnamese private factories sprung up, in addition to joint ventures with major European and Thai starch companies (PROAMYL, 1997-98; Henry *et al.*, 1995). Limited and ad-hoc information (personal communications, J. Wang, 1996) points to the fact that from the start MSG has been the primary product market objective of the these new factories (for both national and export markets). However, the product

[7] Compared to the US with 332 kg (2% growth) and Japan with 230 kg (6% growth).

portfolio seems to have changed since the mid-1990s. This needs to be investigated since no new data exists.

During the early 1990s a cassava starch market assessment was conducted (Dang Thang Ha *et al.*, 1996), showing that the 1992 national cassava starch production was around 90,000 tonnes and projected to reach 200,000 tonnes by the year 2,000 (mainly due to increases in MSG production[8]). If Vietnam would follow similar industry trends as in Thailand and China, one would expect increased productions of, especially, hydrolyzed and modified starches in the future.

Starch situation in China

Data on cassava starch in China before the 1990s are, at best, sketchy and mostly in Chinese. A first post-1980s assessment, though still in Chinese, was written up by Jin Shu Ren and Henry (1993), followed by English and up-dated versions by Jin Shu Ren and Henry (1994) and Jin Shu Ren (1996). These publications report that in 1992, cassava starch production in South China was estimated at slightly over 200,000 tonnes, based on a regional availability of 1.2 million tonnes of chips[9]. For the major ten factories in Guangxi alone, an annual starch output of 80,000 tonnes was calculated. At that time, the cassava starch product portfolio included native starch, fructose, sorbitol, mannitol, maltol, alcohol, MSG, citric acid, denatured starch, glucose and glucose syrup. For 1996, Henry (1996b) reports that the Guangxi (as the most important cassava starch producing province[10]) starch industry was made up of 150 factories with an installed capacity of 3,000 tonnes/day, producing 280,000 tonnes/year (**Table 3**). The industry output consisted of roughly 10% modified and hydrolized starches, and 90% native starch. The same source reports that the industry's annual growth rate estimation was >16%, especially regarding the chemically modified starch supplies.

As referred to in earlier sections, during the last five years the Chinese cassava starch industry has enjoyed significant attention from national and especially foreign investors. Henry and Howeler (1996) already noted the industry's trend towards new or

[8] MSG industry information points out that Taiwan is the world's largest MSG consumer, (1 kg/year/cap). Even at a conservative rate of 0.5 kg/year/cap, the domestic Vietnamese MSG consumption could be 60-70,000 tonnes per year by the year 2,000 (personal communications, J. Wang, 1995).

[9] It is pertinent to point out that, contrary to most other countries, Chinese (and to some extent, Vietnamese) cassava starch processing depends to a large extent on dried cassava chips as raw material. For further information on this, see Henry and Howeler (1996).

[10] For additional more detailed 1994 primary information on the cassava processing industries of Guangdong, Guangxi and Hainan, see the report of a RRA in South China by Henry and Howeler (1996).

refurbished large-scale factories at a cost regarding small-scale units and old-fashioned large state-owned factories. A report by Howeler (1997) mentions the construction of a series of five large-scale new starch factories for the production of bio-degradable plastics. Four of these are already in operation in the provinces of Guangxi, Shandong, Jiangsu and Xinjiang. A fifth is being constructed in Hainan. At least two of these factories will use cassava as the principal raw material (p.4). More recent, but still unpublished, information validates the continuation of this upscaling trend. Unfortunately, this latter information does not include a quantification of the industry's product utilization shares, nor expected growth rates.

Starch situation in other parts of Asia

In the Indian state of Tamil Nadu, there exists a large concentration of small- to medium-scale cassava starch and sago producers (Shegaonkar, 1995). Salem district alone, with roughly 720 units, represents 80% of the state's output. Total Indian cassava starch and sago output is estimated at 200,000-300,000 tonnes. The share of sago *versus* starch is unknown, neither the utilization rates for food and non-food sectors. Additional information is needed. Apart from India, the Philippines has some cassava starch extraction operations. However, most starch is imported from the US, Thailand and the EU. Contradicting sets of information exist about new cassava starch investments (by San Miguel) and the success of these. Again, better information is required.

IV. Starch Production and Utilization in Latin America and the Caribbean (LAC)

Starch situation in Brazil

Cassava starch production increased from 200,000 tonnes in 1990 to approximately 300,000 tonnes in 1997 (Vilpoux, 1997; 1998). Roughly 70% of Brazil's starch utilization is based on domestic maize starch, bringing the total industry, currently, at an estimated 1 million t/year (Vilpoux, 1998). Hence, Brazil's starch expansion has been typically maize-based. Maize starch manufacturing is concentrated with two large international (of US origin) companies: CPC International/Refinacao de Milho Brasil, and Cargill, both based in Southern Brazil. The cassava starch industry represents small- to medium-sized companies, distributed in the states of Sao Paulo, Minas Gerais, Sta. Catarina, Parana (and lately also moving into Mato Grosso do Sul).

Table 3. Comparison of key economic and technical parameters of the cassava starch industry in China (Guangxi), Thailand and South Brazil (Sta Catarina, Parana states), 1996.

Parameter :	Thailand	Guangxi, China	South Brazil
Cassava yield (t/ha)	14	13	20
Starch content in roots (%)	12-28 (Av.22)	25-27	28
Rural labor cost ($/day)	4.0	1.25	7
Cost of root production ($/t)	30-35	27.5	-
Labor cost for root production($/ha)	-	19.6	-
Cost 50 kg of 15-15-15 fertilizer ($)	16	12.5	-
Land rent/ha crop cycle ($)	200	20	200

Harvesting time	70% in 5 months	100% in 4 months	100% in 10 months
Months of (major) harvests	Nov-March	Nov-Feb	May-Oct; Feb-May
No. of starch factories	41	150	75
Total installed capacity (t starch/day)	6,000	3,000	1,500-2,000
Total production (t starch/year)1995	1,800,000	280,000	350,000
Annual growth rate (%)	10	>16	-
Modified starch from cassava (t/year)	540,000 (30%)	30,000 (<10%)	<10%
Conversion rate roots to starch (%)	25	25	25
Factory labor cost ($/day)	5.0	1.87	-
Factory gate cassava root price ($/t)	40	37-41	45-55
Water use per t starch (m^3)	15-30	40	18
Cost of water ($/$m^3$)	0.28	0.003	-
Starch production cost in factory ($/t)	210-220	225-250	350-400
Tax (VAT) (%)	7	20-22	10
Price of starch at factory gate ($/t)	225-250	325	400
Waste water treatment	39 oxidation ponds; 2 biogas	mostly oxidation ponds; dumping	anaerobic; ponds
Starch content of residue (% dry weight)	50	35-40	70
Residue utilization	export as feed or local animal feed	ethanol prod. or animal feed	animal feed
Peel utilization	compost or mushroom prod.	compost	-

Source**:** *Internal data from industry association and key informants in Brazil (10/96) and China (11/96).*

Current utilization of starch is detailed in **Table 4**. This shows 69% of total starch for the food sector, 16.7% for the paper industry, and 5% for the textile industry. It also shows that 43% is native, 46.2% is hydrolyzed (sweeteners), and 11% is (other) modified starch. Vilpoux (1998) notes that in 1997, the food industries that increased their starch utilization the most were the frozen and dehydrated foods sectors (with 18.2%). Furthermore, the same source notes that the future starch demand growth (modified and native) in the food sector will be mainly in the ready and semi-ready product lines. Other US private sector information (PROAMYL, 1996) notes the potential increasing demand for cationic starches for the high-quality paper industry.

Starch situation in Venezuela

Little hard data exists regarding the cassava starch situation in Venezuela. Scattered first hand information reports that there are currently two large-scale integrated (with root production) starch factories. One of these operates a 7,000 ha cassava farm, partly irrigated, with an average productivity of 25-30 t/ha/year. The roots are processed into native starch and glucose syrup. While the latter represents still a small share, the immediate objective is to increase this product output. The primary market is Venezuela, but native starch exports

for the Colombian paper industry have also been reported (at a very competitive price *vis-à-vis* Colombian starches).The main starch source in Venezuela remains maize starch, mostly imported from the US.

Starch situation in Colombia

The main cassava starch products in Colombia are sour starch and native starch. Some sketchy information reports about recent investments in the department of Cauca for a cassava-based glucose syrup factory (Gottret *et al*., 1997). However, no data are available on production or capacity figures. The cassava sour starch production is mainly concentrated in the Cauca Department with a total average production of 13,000 tonnes from approximately 200 small-scale processing units. Several larger units producing native cassava starch operate in the Atlantic Coast region. Colombian starch utilization is principally (still) satisfied by starch imports from the US (maize), Venezuela (cassava), Brazil (cassava/maize), and sometimes from Ecuador (cassava). Several maize-based starch factories (Maizena) have existed, but these seem to be in the process of closing down (needs to be confirmed). Gottret *et al*. (1997) reports the relatively high prices of Colombian cassava starch. Colombian native starch was priced in 1996 at US$500-550/tonne *versus* imported maize starch at US$ 450-480/tonne. At these prices, Thai and even Brasilian starch could possibly be imported at a significant profit. It needs to be noted that the Colombian starch market is in the hands of only a very few operators, dictating imports and market prices.

Starch situation in Paraguay

Very little hard data on cassava starch is available for Paraguay. Henry and Chuzel (1997) have noted that small volumes of cassava starch have traditionally been manufactured in small-scale household processing units for the manufacturing of "*chipas*", a typical snack. However, more recently, growing interest exists from Brazilian starch manufacturers,

Table 4. Brazilian starch and starch derivatives utilization (tonnes), by industrial sector, in 1997.

Starch type	Food sector				Paper sector		Textile sector	Other sectors	Total
	Sweeteners	Bakery pastry	Powder products	Others	Paper	Cardboard			
Native	2,100	26,500	93,000	109,100	66,300	43,500	20,000	77,000	**437,500**
Modified									**113,250**
Acid modified	2,600			1,500	29,900	4,300	30,000		68,300
Cationic					1,800	200			2,000
Anfoteric					24,300				24,300
Dextrins/pregel.			100	300	100	50	100	18,000	18,650
Hydrolyzed									**472,200**
Glucose syrups	141,200	800	3,100	30,400			200	1,000	176,700
Glucose powder	200	100	300	5,100			100		5,800
Maltose syrups				271,500					271,500
Malto-dextrins	400	300	2,800	14,400			300		18,200
Total	**146,500**	**27,700**	**99,300**	**432,300**	**122,400**	**48,050**	**50,700**	**9,600**	**1,022,950**

Source : *Vilpoux, 1998.*

across the border in Parana and Mato Grosso do Sul, for joint-venture investments in large-scale cassava starch manufacturing, taking advantage of relatively lower land and labor prices (this information needs to be confirmed and quantified). Most starch utilized in Paraguay currently originates from Brazil, and to a lesser extent from the US (maize starch).

V. Starch Situation in the European Union (EU)

EU starch production in 1994 was estimated roughly at 6 million tonnes. By 1997, this is estimated at 7 million tonnes (AAC, 1997). According to the same source, the principal starch source crops are maize (51.5%), wheat (25.5%) and potato (23%). During the last 3-4 years, the share of maize has increased significantly. A recent private industry source, noted by Sansavini and Verzoni (1998), estimates that the EU starch output includes 52% sugars, 28% native starch and 20% modified starches. This seems roughly in accordance to Roper's 1994 and AAC's 1997 (51%, 27.5% and 21.5%, respectively) estimates. The three sources are in agreement about the EU starch utilization, by industry, as:

Sweets and drinks:	*33-34%*
Processed foods:	*21-22%*
Chemicals and pharmaceuticals:	*15-16%*
Paper and corrugated card board:	*27-28%*
Feed:	*2%*

Through import tariffs and quotas, the European starch market is highly protective of its national industries from foreign competition. Nonetheless, there exist an ACP-countries quota of 25,000 tonnes; this includes Thailand, which annually exports 10,000 tonnes to the EU.

Export data series from the US (USDA-ERS, 1997) show that small volumes of US maize starches (3-4,000 tonnes/year) are imported to the EU, mainly to the UK and the Netherlands. In addition, as noted in a previous section, Thailand exports considerable volumes of cassava starch above its allotted (10,000 tonnes) quota, especially to the Netherlands.

Total EU starch exports in 1996 are estimated at 1.1 million tonnes (AAC, 1997). The shares of native, sweeteners and modified starches of total exports were 45, 25 and 30%, respectively. EU potato starch exports increased from 122,981 tonnes in 1990 to 292,142 tonnes in 1996, an increase of 42%. The estimated starch exports value over the same period increased by 31%. 1996 EU potato starch exports were valued at 121.2 million ECU (EUROSTAT, 1998). Principal destinations of EU potato starches were: US, Mexico, Thailand, Japan, Taiwan, Hong Kong and South Korea. Especially the SE-Asian countries import increasing volumes.

While European starch multinationals are relatively well protected from cassava starch imports from Asia (although they still want higher import protection plus higher export refunds...), they all are increasingly involved in both vertical and horizontal

integration[11] with cassava and maize starch based industries in Asia, and to a minor extent in LAC. Countries of particular interest are Thailand, Indonesia, China and Vietnam (and Cambodia). Hence, executives of Avebe, Roquette, Amylum, and others have been seeking to learn more about the basics of cassava in the past few years (PROAMYL, 1997-98; CERAT) and to analyzing the comparative advantages of starch factory construction in north vs. south Vietnam vs. South China vs. Thailand (vs. Brazil vs. Venezuela). While most emphasis has been on cassava as the "hot new" starch source crop, new maize starch joint-ventures[12] in Asia are also being considered. Besides, starting in the early 1990s, an increasing number of joint ventures of molasses/cassava sourced starch manufacturing are occurring between Japanese, Taiwanese, Korean and Thai multinationals with local investors in China and Vietnam, i.e. Ajinomoto, Vedan, AAA, Vethai, ... (Henry, personal observations, 1996-97).

VI. Starch Situation in the United States (US)

While the US (and Canada) do not use cassava as a starch base, but mainly maize (or molasses), some understanding of its industry is important for the following reasons: (i) US maize starch makes up the largest global volume of starch (and derivatives), directly competing with potato, wheat and cassava starches; and (ii) the fact that there is evidence of increasing horizontal integration of US traditionally maize-based starch companies, through joint-ventures, into (national) cassava-based starch companies in SE-Asia and LAC. This trend is similar to what is happening with the major European starch multinationals (PROAMYL, 1997-98).

The main US maize-based starches and derivatives include native starch, modified starches, sweeteners (HCFS), ethanol, industrial alcohol, citric acid, lactic acid and lysine. USDA-ERS (1997) data (**Table 5**) shows the US market demand for some of the "hottest" product groups.

The US is a net exporter of maize starch and starch derivatives. The major products (for food processing) in 1996 were: starch, glucose, glucose syrup (<20% fructose), pure fructose, glucose syrup (20-50% fructose), fructose syrups + solids, dextrins, and modified starches (US Department of Commerce, 1997). The most important volumes are exported to NAFTA members Canada and Mexico, Asia (Japan, Malaysia, Korea, Philippines, Indonesia, Taiwan,...), LAC, EU (UK, Netherlands,...), and Israel. 1997 US maize starches exports have increased by 8% over 1996.

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[11] Information has also been found about a major joint-venture of Cargill with Purac (daughter of Dutch-based CSM) in Nebraska, US, for the production of lactic acid (USDA-ERS, 1997), evidencing a US-European integration as well.

[12] Sansavini and Verzoni (1998) cite a Cerestar source regarding a new 350,000 tonne maize starch factory in Jilin province of China, as a joint venture between the Jifa Group and Cerestar, for a total investment of US$ 100 million. Production of native starch, modified starch, malto-dextrins, maltose, protein powder, glucose, isomaltose, vitamin C, ... are to be envisioned (Jifa Group Corporation, home-page, 1998).

Table 5. Volume, value and future growth of the major starch-derived products for domestic utilization in the USA in 1996/97.

Product	1996/97 volume ('000 tonnes)	1996/97 value (million US $)	Future growth (%)
Sweeteners (HCFS)	14,900		2-3% annually
Ethanol	2,580		4-6% (depends)
Citric acid	240	340-380	8-10% annually
Lactic acid	27	25-30	4-9% annually

***Source**: USDA-ERS, 1997; Sansavini and Verzoni, 1998..*

The US Department of Commerce (1997) report details of US imports of cassava starch. In 1997, total import volume was 12,000 tonnes at an average value of US$ 309/tonne (most maize starches exported from the US are valued at US$ 450-650/tonne). US cassava starch imported in 1997 originated mainly from Thailand (97%), but also included very small imported volumes from Brazil, Colombia, Costa Rica, Philippines and Ghana. Data for these latter countries can not be accessed for individual country cassava starch exports.

FUTURE OUTLOOK FOR CASSAVA STARCH UTILIZATION

Previous sections leave a clear impression that increasing and strong starch demand is driving the industry to novel partnerships and novel sources of raw materials. While it seems that Asia is the current " hotspot " for both supply (cheap production factors) and demand (bullish future economic development expectations in spite of the current financial crises), LAC is increasingly showing a profitable market as well. Future lowering of import regulation levels in high starch demand countries, especially in Asia (Japan) and EU, may further boost demand for cassava starches. It is, however, dependent on cassava starch industry's technology adopters to successfully compete with potato and maize starches in the emerging markets (especially requiring modified and hydrolyzed starches). It will be necessary to first identify which will be the most appropriate starch market segments for subsequent targeting. Because of the competitiveness of the market, the leading starch companies have this information, smaller companies can only follow these leaders, but will therefore lag behind. Increasingly, economies of scale and internationalization form the key elements towards the highest profit margins in this industry.

Competition between starch sources are based on a variety of factors. The principal ones have been included in **Table 6** for comparison. The relatively low productivity of cassava is due to the lack of research (and technology transfer) in comparison with that of other raw materials. Hence, while maize, potato and wheat are already near their potential

Table 6. Qualitative comparison[1)] of starch from different raw materials.

Parameters	Maize	Wheat	Potato	Waxy-maize	Cassava
Raw material productivity	***	***	***	***	*
Raw material price competitiveness	***	**	*	***	***
Starch conversion efficiency	***	**	*	***	**
Valueof byproducts	**	***	*	**	*
Cost of waste disposal	*	*	**	*	***
Starch price competitiveness	***	**	*	**	***
Food industry application	**	**	***	***	***
Non-food industry application	***	***	**	**	**
Sweeteners application	***	**	*	***	**
Relative R&D advance	***	***	***	***	*

1) The following scoring scheme is used for the importance of various factors: *** high, ** intermediate, * low

yield ceilings, cassava still has a vast potential for additional yield increase. An important limiting factor for cassava as a starch source is the issue of waste management and by-products. The former is relatively expensive, while the latter is highly undervalued. From this table, one could argue that, *ceteris paribus*, the future competitiveness of cassava as a starch source seems to be technology dependent. However, the cassava starch situation is even more dependent on global and regional trade policies and the future changes of these. Current starch market prices (**Table 7**) do show that cassava starch can compete with other sourced starches. However, as earlier discussed, the major production/consumption markets of the US, EU and Japan are highly protected by trade policies. For example, the EU compensates its (wheat, potato) starch producers' high costs with export refunds (**Table 8**).

Africa seems to have various potential markets for cassava starches. The small starch volumes that are currently consumed, are largely imported from the US and EU. Although these volumes are small, the EU and US multinationals keep a very firm grip on their markets (monopolistic!). Furthermore, near future cassava market expansion, in the short-run, will be undoubtedly satisfied by the multinationals. Current local interest for cassava starch manufacturing seems mostly limited to relatively small-sized cases. However, the interest is growing in almost all major cassava producing countries (Uganda, Nigeria, Ivory Coast, Ghana, ...), as local investors observe growing starch demand on the one hand, and a cheap starch source crop, i.e. cassava, on the other hand. However, while on paper it may be relatively easy to demonstrate that cassava starch production is feasible in many countries of Africa, significant technical, financial, institutional and organizational constraints need to be overcome. Nonetheless, the opportunities seem to be present. Significant further technical, sector and starch market analyses are required in Africa to validate this theoretical local supply potential. An in-depth analysis regarding appropriate scale of starch processing units, is also most needed.

Table 7. Comparison of selected starch prices, 1996 – 98 (US$/t).

	Avg.	Avg.	Jan-Mar

	1996	1997	1998
US maize starch (food use)	607	748	780
US maize starch (non-food use)	475	445	425
US maize gluten meal	366	381	326
EC potato starch (food use)	488	467	431
EC potato starch (non-food use)	503	380	307
EC wheat starch (food use)	708	669	517
EC wheat starch (non-food use)	335	366	349
EC wheat gluten	743	623	621
Thai cassava starch (native)	361	319	297
SE-Asia MSG	1,170	1,190	1,100
SE-Asia citric acid	1,150	1,070	1,010
US lysine	2,280	2,470	2,160
US ethanol	362	317	293
US sorbitol	920	950	860

Source : *Adapted from LMC International, various issues, 1998.*

Table 8. EU starch refunds on selected commodities (in ECU and US $).

	New minimum price	Compen-sation	Total refund	New minimum price	Compen-sation	Total refund
	ECU			US$		
Potatoes[1)]						
92/93	241.2	40.0	281.2	277.6	46.0	323.7
93/94	208.0	40.0	248.0	245.6	47.2	292.9
94/95	192.0	56.0	248.0	239.8	69.9	309.8
95/96	176.0	72.0	248.0	226.7	92.7	319.4
Maize[2)]						
Jun/97	126.9	7.6	134.5	144.3	8.7	152.9
Wheat[2)]						
Jun/97	119.2	-	119.2	135.5	-	135.5

Source: [1)] *CAP monitor, July 1, 1997.*
[2)] *Agra Europe, April 1, 1997.*

While in Latin America, during the last decade, foreign investments have helped in pushing the starch industry development, it is still unable to compete with Asian cassava starches. As **Table 3** shows, several basic factors of production and processing are too

costly. Further investment outlays will be needed to better equip and concentrate the industry. In addition, the industry's marketing activities need considerable improvements.

The cassava starch future outlook remains positive, since upcoming future global trade negotiations are expected to further decrease trade restrictions, benefiting cassava starch market potential. The major challenge remaining is to fully benefit from cassava's technology gap.

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