GLOBAL CASSAVA END-USES AND MARKETS: CURRENT SITUATION AND RECOMMENDATIONS FOR FURTHER STUDY[1]

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co-ordinated by Dr. Guy Henry, CIRAD

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[1] This study, commissioned by the FAO, represents Phase 1 of a larger study that examines both current cassava uses and markets, and their potential in the future. The latter part (Phase 2) is commissioned by IDRC and IFAD, currently being executed, under coordination of dTP, Guelph, Ontario, Canada, and in collaboration with the European Group on Root, Tuber & Plantain.

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EXECUTIVE SUMMARY

FAO, as part of the Global Cassava Development Strategy formulation process, spearheaded by IFAD and (inter)national stakeholders, took responsibility for the initiation of the first of two studies regarding Global Cassava End-uses and Markets. The first study, subject of this consultancy report, is a desk review, aiming to *identify the current situation of end-uses of traditional and non-traditional cassava products and provide an analysis of food, feed and industrial applications; identify geographical regions for potential cassava markets and demand growth; and provide recommendations on which end uses and geographical areas would need further investigations.* The second study, financed by IDRC and IFAD, is to identify and quantify future market and product opportunities for cassava development, taking into account the collected information and recommendations from this report.

Current global cassava utilisation is 166.5 MMT, to increase to 208.8 MMT by the year 2005, showing a similar growth rate as in past trends. Projected cassava utilisation rates show a relative decrease for the food and feed shares while an expected increase for the industrial use share. The share for food remains to represent more than half of total supplies and consists mainly of fresh cassava and a large variety of processed flours and pastes. Cassava for feed consists of cut and dried flakes, chips and pellets. The group of other uses (FAO description) or industrial uses is principally made up of cassava-based starches, including hydrolysed, modified and native starches. These starches are used for the manufacturing of numerous intermediate and final products in the food processing, paper, cardboard, plywood, textile, pharma & chemical, and feed industries.

In *Africa*, the majority of cassava is for human consumption (88%). The remainder for animal feed (on and off-farm) and starch-based products (starches and alcohol). Data from COSCA studies evidence a very large variety of traditional food dishes and drinks. Some inter-regional trade of cassava roots exists and minor volumes are being exported to the EC. While the use of cassava flour is common, the partial substitution of wheat by cassava flour in bakery products, is more recent, and mostly as part of R&D projects.

Currently, only a small share of African cassava is fed to farm animals, traditionally, mostly in the form of peels. However, a growing interest exists regarding a more commercial approach to cassava's incorporation into animal feed mixtures. Several case studies evidence recent findings. Besides for national (commercial) use, several West African countries have ventured into (EC) export markets with mixed success. The major limitation to this export market is the fixed 145,000 MT quota for ACP member countries. Some minor cassava imports are occurring, but without showing a consistent trend.

Cassava starch production in Africa is still very minor but increasing. Most starch utilising industries import from the EC and/or US. However, a private sector interest does exists in several countries, regarding future starch processing investments. Evidence of this is highlighted in case studies.

In *Asia*, relatively little cassava is utilised for direct human consumption (except in Indonesia) and most is processed for chips/pellets and starch. The cassava starch industry is most important and most dynamic in Thailand, followed by Indonesia, China, India and Vietnam. While a decade ago, Thai starch represented only a fraction of total Thai root utilisation, currently, total annual Thai cassava starch production nears 2 MMT. This evolution has been partly induced by the eroding pellet export competitiveness (and subsequent over supplies of cassava roots), and partly by bullish international starch markets, especially in the fast developing SE-Asian region. Indonesia has long traditions, producing cassava chips (gaplek) for human consumption, export for feed, and for further processing into starch. However, while Thailand is mainly export-oriented, Indonesia's main cassava market is national. Similar to Thailand, the relative importance of cassava for feed is diminishing.
Another traditional cassava (sago) starch producer is India, but principally for the national market. Relative new entrants to the Asian cassava starch industry are Vietnam and China. Since their respective initial free market policy implementations, very significant investments (national and foreign joint-ventures) have been made in large scale starch processing industries, a large part of which are cassava based, and especially in Vietnam, largely export oriented. Most starch products are destined for the food processing (MSG, noodles, …), soft drinks and pharmaceutical industries.

In *Latin America and the Caribbean*, cassava continues its transition towards a market-oriented product and raw material for the processing industry. While more than 60-70% of cassava supplies is still destined for traditional food dishes, cassava starch industry capacity is increasing significantly, especially in SW-Brazil, followed by Colombia, Venezuela and recently, Paraguay. Within the industry, a trend away from native starch, towards modified and hydrolysed starches, has become evident. During the last decade, cassava utilisation for off-farm animal feed has increased its relative importance as well, especially in Colombia, and to a lesser extent in Brazil, Ecuador, Bolivia and Peru. More recent, is the uptake of cassava for the snack and convenience foods industry, especially in Brazil and Colombia. On another front, Costa Rica continues its near-monopoly of cassava root exports (for food consumption by mainly ethnic groups) to the US and EC.

The *US and the EC* have highly protected import (and subsidised export) markets. This also regards cassava products, especially cassava starches. High levies and quotas are used to protect their domestic multi-billion dollar/ECU industries. Thai cassava pellet imports to the EC, continue to decrease since the late 1980's, mainly due to CAP policy changes for domestic grain prices. Other SE-Asian pellet import quotas have remained largely unfilled. The US shows only very minor dried cassava imports. Fresh cassava (waxed or frozen) imports, mainly from Costa Rica, continue to increase, especially in the US. Nonetheless, the principal consumers of these products do not show a significant additional future demand. Specialty cassava starches are being imported to both the US and the EC, in spite of prohibitive levies (above a small quota) regarding the latter. Because of these restrictions, future market potential for cassava starches does not seem promising. Furthermore, SE-Asian cassava starches are in strong competition with US and EC starches in Asian and other markets. Both EC and EC multinationals have

become increasingly involved in cassava starch processing through joint-ventures, especially in SE-Asia, and to a lesser extent in Latin America. A relatively small and young market is made up by cassava based snack and convenience foods. Some new products (mainly from Latin America) have started to appear in US, German and Japanese markets.

Future prospects for cassava utilisation will be the main subject of the accompanying study, currently commissioned by IDRC and IFAD. This report only highlights the main determining factors concerning this potential. In addition, it discusses the main obvious trends, by continent, for which the literature provides.

The report concludes with a list of detailed *recommendations* by continent and/or country and by product group, which will serve further investigations, in particular, those of the aforementioned ongoing study.

1. INTRODUCTION

1.1 BACKGROUND[3]:

The development of the Global Cassava Development Strategy was initiated in 1996 at a "brainstorming" meeting convened by the International Fund for Agricultural Development (IFAD). Cassava was recognised by the meeting as a food security and commercial crop that lends itself to a commodity approach to poverty alleviation, given the close connection between the poverty level in many parts of Africa, Asia and Latin America and the role of cassava in these cropping and food systems in countries in these continents. The importance of farming systems issues and market linkages was also stressed at the meeting. However in order to recognise and meet the full potential of this crops, a Global Strategy was considered necessary to:

(i) *identify the opportunities for further public and private investments;*

(ii) *develop a framework for international technical co-operation for research and for technology transfer based on current constraints and opportunities;*

(iii) *identify more cost-effective institutional mechanisms for rationalising (and increasing to the extent possible) the allocation of public and private resources for research and investment; and*

(iv) *set the scene for future debates in global issues.*

The Global Strategy requires a coalition of stakeholders including cassava producers and their organisations, Governments, the donor community, technical and research agencies and their networks, NGO's and their networks and the private sector in order to achieve the objectives set out above.

The Strategy is being developed from a number of country case studies and regional reviews. A review meeting was held in June 1997 where progress was determined and a schedule for completion of the Strategy decided upon. The plans involve preparing a draft of the Strategy and refining it through a series of regional consultations in Latin America, Asia and Africa.. A Forum of representatives of all stakeholders will be held in 1999 to ratify the final Strategy and develop a plan for its implementation.

At the end of 1997, it was suggested that it would be relevant to prepare an in-depth study on global cassava utilisation and potential for future markets. Its purpose would be to identify and analyse current uses and potential markets for cassava products. This information is expected to serve cassava stakeholders in better understanding the potential of cassava in different end markets. FAO, together with IDRC and IFAD, made the decision to co-fund this study. The activity includes a Phase 1, the subject of this report, concentrating on the current utilisation and markets, and includes recommendations for further study for Phase 2.

[3] This section draws heavily on the paper by Westby *et al*. (1997).

1.2 OBJECTIVES, CHALLENGES AND LIMITATIONS:

The objectives of this desk review report are:

(i) *identify the current situation of end-uses of traditional and non-traditional cassava products and provide an analysis of food, feed and industrial applications;*

(ii) *identify geographical regions for potential cassava markets and demand growth; and*

(iii) *provide recommendations on which end uses and geographical areas would need further investigations (for Phase 2).*

The challenge for this desk study is to provide as complete a picture as possible given the provided limited resources, and given the inaccessibility or sheer absence of relevant secondary data. Besides the publicly available data and the "grey" literature, most other data needs to be obtained through internet searches. The latter is extremely time consuming and has the risk of being never ending. While the study's TOR included a suggested table of contents dividing the study by past, current and future markets/usage and product groups, the authors have divided the study by continent/region i.e. Africa, Asia, LAC, EC and US. For each region, past, current and future aspects by product group will be discussed.

2. PAST TRENDS AND CURRENT SITUATION OF END-USES

2.1 GLOBAL AGGREGATE UTILISATION TRENDS:

Current global cassava utilisation is 166.5 MMT. A preliminary report by FAO (November 1997) analyses past cassava utilisation trends and projects cassava utilisation growth rates for the year 2005. The projection results are based on FAO's econometric models. These show that, including the Uruguay Round effects, cassava production by the year 2005 will be 208.8 MMT, or an annual growth rate from 1993-95 levels of 2.3%. Hence, global production growth is similar as the one during the last decade (2.2%). Current shares of total global utilisation are 59, 24 and 17%, for food, feed and other uses, respectively. Projections for 2005 show that the shares for these groups change to 58, 22 and 20%, respectively. This indicates that both future food and feed uses will decrease slightly in favour of other uses. The latter increase will mostly consist of cassava starches.

Past cassava utilisation growth rates, by continent, are summarised in Table 1.

Given that FAO utilises a cassava use classification of *food, feed and other*, whereby processing (starch) falls into the latter class, it seems more transparent for the current analysis (especially because of the increasing use of starch based products), to

classify cassava uses by: *food* (traditional: fresh, flours and pastes), *feeds* (chips, pellets and leaf mixtures), and *starch based uses* (food and non-food sectors). The latter classification has been adopted in this report and is followed in its analyses by country.

Table 1: Global historic cassava utilisation trends (FAO 1997)

ANNUAL GROWTH RATES (%)	**WORLD**	**AFRICA**	**ASIA**	**LAC**
Total Use 1984-94	2.2	4.2	1.8	0.7
Food 1984-94	2.4	3.8	0.1	0.7
Feed 1984-94	0.9	8.3	7.8	0.6
Other Use 1984-94	3.8	4.7	5.4	1.1

Source: FAO.

2.2 FOOD, FEED AND INDUSTRIAL USES: AN OVERVIEW

2.2.1 Food products:

Most traditional products are included in this group, since cassava originally was developed for human consumption purposes. In LAC, besides fresh cassava, a large variety of cassava products exist including ones that are dried, toasted or fermented, etc.. The largest share is made up of fresh cassava (Colombia and Paraguay) and *farinha de mandioca* (Brazil). In Africa, an even larger variety of processed cassava products for human consumption exists (see the section on Africa for further detail). While the primary interest for cassava regards its roots, several traditional applications make use of the leaves, as mostly evidenced in Asia, notably in Indonesia. Leaves are also important as a vegetable in certain areas in Africa. Furthermore, more recently, cassava leaves are being used (once dried and milled) as an experimental mineral supplement for babies and young children, in NE-Brazil (CNPMF 1996). Pertinent references on cassava products for food use can be found in various CIAT publications *(http://www.ciat.com/*), in Agbor Egbe *et al*. (1995) and in Dufour *et al*. (1996).

2.2.2 Feed products:

Most commonly known products used for animal feed are dried cassava chips and pellets. There is a large variety of sizes and forms of chips, especially in Asia (at household level). Roots used for chips are either peeled or unpeeled. Pellets exist as

native (soft, non-steam pressured) or hard pellets (steam pressured). The latter is mainly used for export purposes. In addition, cassava leaves are being used in Asia for small household-level fish production. In Brazil, cassava leaves are being mixed with cassava chips or starch waste, for on-farm pig feeding. Recently, a similar experience has been reported from Nigeria. All possible uses for cassava in animal feeds are extensively discussed by Buitrago (1990) and supplemented in CIAT (1989).

2.2.3 Industrial uses: starches, starch derivatives (and by-products):

Starch or cassava starch, in this context, 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, hydrolysates, modified starch, and others*. The industries utilising 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. Good references to the literatature for extensive listings of the sectors are Ostertag (1996), Leygue (1993), Roper (1996) and Gottret *et al*. (1996). In addition, the internet home-page of major starch multinationals (like Cargill, ADM, Purac, CERESTAR, CPC) list all possible derived products. 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 report will mainly deal with starch used in the following sectors (including a non-exhaustive sample of end-products):

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, colour enhancers, ...
- fat substitutes for dietary products
- alternative protein sources
- sweeteners, ...

Non-Food Sector

Paper, cardboard and plywood: - carton, high quality papers, different plywoods, ...

Textile industry: - fillers, stiffeners, ...
- leather goods

Pharma and chemical industry: - glues, paints, cements, ...
- soaps, detergents, bleaches, insecticides, ...
- explosives
- oil drilling materials
- biodegradable plastics, polyesters, etc.
- industrial alcohols
- combustibles, ethanol, oils,...
- pharmaceuticals, vit. C, vit. B12, antibiotics, ...
- cosmetics, ...
- water treatment agents

Feed industry: - protein substitutes
- carbohydrate sources

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

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 analyse the cassava starch actual and potential markets at disaggregated or country level.

2.3 CASSAVA UTILISATION BY GEOGRAPHIC REGION: AFRICA

2.3.1 Fresh, flours and pastes for food:

2.3.1.1. Traditional products

The majority of cassava grown in Africa is for human consumption (88.7% of production according to FAOSTAT cited in Bokanga 1997). The most comprehensive study of cassava utilisation in Africa in recent years has been the Collaborative Study of Cassava in Africa (Nweke 1988). Analysis of data from the first phase of this study, a

village level survey in six countries (Ghana, Tanzania, Nigeria, Democratic Republic of Congo, Cote D'Ivoire and Uganda), reveals a vast array of products with varying importance. From the initial 233 villages across the six Africa states, 147 different names were used to describe 623 products. For data analysis, these products were aggregated into nine product categories using key processing steps as indicators (Table 2; Natural Resources Institute 1992).

Table 2. Product types by country for the first three ranked products in each of 233 villages, COSCA Phase 1.

Product Type	Cote D'Ivoire	Ghana	West Nigeria	East Nigeria	Tanz-ania	Uganda	Zaire	Total	%
Cooked Roots	35	20	-	11	9	33	-	108	17
Roasted Granules	7	19	18	24	-	-	-	68	11
Steamed Granules	30	1	-		-	-	1	32	5
Flours/ Dry Pieces	21	27	17	35	61	52	66	279	45
Fermented Pastes	4	10	19	21	1	-	20	75	12
Leaves	-	-	-	-	1	3	2	6	1
Drinks	-	-	-	-	-	6	-	6	1
Sedimented Starch	22	-	3	3	-	-	-	28	4
Unclassified	-	5	4	4	2	2	4	21	3
Total								623	100

Note: The figures in the columns indicate the number of times a particular product type was ranked as one of the first three most important in the 233 surveyed villages.
Source: Natural Resources Institute (1992)

Further analysis of the Phase 1 COSCA data (Westby, 1993) has enabled more detailed characterisation of products according to the processing steps involved. This analysis is shown schematically in Figure A1 and is quantified in Table A1, both contained in Annex A. Slight discrepancies between Table 2 and Table A1 are due to the more accurate manual form of classification used for the latter Table.

As a rule, cassava processing is more sophisticated in East Africa than in West Africa. For example, in Uganda the most important "products" are fresh root and then sun-dried flour. The additional products, cassava beer, distilled spirit and kabalagala, are all produced from the flour. With the possible exception of fresh cassava in some countries, the processing of traditional products is the most important use of cassava across Africa. Future developments in this area will depend on the socio-economic climate and food preferences of consumers.

2.3.1.2 Use of cassava flours a substitute for wheat flour

Cassava flour is common in Africa and, provided the quality is high, there is the potential to replace wheat flour in a number of recipes including bread, biscuits, cakes etc. Djoussou and Bokanga (1997) have shown that, with a 15% substitution rate of

wheat flour with cassava, Nigeria could save up to US$14.8 million in foreign exchange annually. US$12.7 million would go to cassava processors and US$4.2 million to cassava farmers. Researchers in Ghana (Annor-Frempong et al. 1996) have been investigating the use of cassava as a filler in comminuted meat products and they report a potential saving of US$150/tonne in the final product.

The use of cassava flour in bread was summarised by Bokanga (1997). He points out that wheat imports to the region have decreased, but bread is still largely being consumed. He cites a recent survey in Nigeria and Cote D'Ivoire where it was shown that the quasi-totality of the bread consumed in the survey area was from composite flour (wheat mixed with cassava, sorghum or maize flour). Cassava flour has been added to bread in Cote D'Ivoire since 1982.

Research work at the International Institute of Tropical Agriculture (IITA) has led to the development of other bakery products using cassava flour as a substitute for wheat. These include doughnuts, cakes, biscuits, croquettes and chinchin. Kapinga et al. (1997) adopted a cautious approach to the dissemination of these products in Lake Zone, Tanzania. This involved the following stages: (i) identification of the initial need to diversify cassava utilisation, (ii) a feasibility study; and (iii) an interactive pilot phase where information was obtained on the factors that would facilitate sustainable uptake of the technology.

Table 3. Most commonly prepared cassava products in pilot dissemination areas of the Lake Zone, Tanzania.

Cassava Product	Number of people still making the product after five months				
	Mwanza - Urban (n=17)	Mwanza - Rural (n=11)	Mara Urban (n=5)	Mara Rural (n=5)	Total
Doughnut	15	10	4	3	32
Cake	3	1	2	4	10
Biscuit	1	1	0	1	3
Chinchin	4	10	2	3	19
Croquette	1	1	0	0	2

Note: Products contained 100% cassava flour.

There was potential for some new products, but not for others (Table 3.). This was reflected in the high take up rates in both the pilot and wider dissemination phases of only certain products. The most effective dissemination route for these products was through Church and women's groups (Kapinga et al. 1997). Returns to labour investment when using cassava were significantly improved (Kapinga et al. 1998).

2.3.1.3 Fresh roots

One of the weaknesses of data from the first phase of COSCA was that it did not

distinguish between the relative importance of fresh roots and processed products. Cooked fresh roots were recorded as processed products in some but not all of the countries surveyed. The importance of fresh roots can be estimated (in terms of expenditure) from household expenditure surveys such as the Ghana Living Standards Survey (Ghana Statistical Service 1995). Analysis of this data (Table 4) shows that even within one country there are great differences in the amount and ways in which cassava is consumed.

Table 4: Home consumption of cassava by region in Ghana taken from Ghana Living Standards Survey in 1992.

Average annual per capita value of reported home consumption of cassava (1992 Cedis)			
Region	Roots	Gari	Other forms
Western	8465	424	27
Central	12365	205	77
Eastern	12685	61	332
Gt Accra	227	0	488
Volta	5076	326	3705
Ashanti	6563	3	20
Brong-Ahafo	4697	39	510
Northern	150	9	1690
Upper West	11	0	17
Upper East	0	0	0
Ghana	5858	107	675

Cross border trade in cassava products within Africa exists, but there is little data available to quantify it. As an example, it has been reported (Anon. 1997) that a Zambian company bought US$50,000 worth of fresh roots for processing into flour for export to Angola and the Democratic Republic of Congo. The future expansion of cross- border trade is difficult to predict without a better understanding of the current situation.

The United States and European Union form a large share of the world's import demand for fresh cassava. Supply to these destinations is dominated by exports from Costa Rica. By comparison, African exports are very small. Out of the African exporters, only Ghana is a significant supplier. Other minor suppliers include Benin, Madagascar, Senegal, and Tanzania. The potential for export to Europe and the US will be dictated by the price competitiveness and marketing ability of African cassava exporters against Central and South America's competitors.

2.3.1.4 Cassava leaves

Although the majority of data available for cassava relates to the roots, cassava leaves are very important in some countries. In the Democratic Republic of Congo cassava leaves have greater market value than roots (Lutalldio and Ezumah 1981). It has been estimated that cassava leaves account for approximately 68% of all vegetable output in the country (Tshibaka and Lumpungu 1989).

2.3.2 Flours, chips and leaves for feed:

2.3.2.1 Domestic animal feed

Only 1.4% of current cassava production in Africa is thought to be used in animal feed compared with 2.9% in Asia and 33.4% in the Americas (FAOSTAT data cited by Bokanga 1997). Cassava is used to a certain extent already in livestock rations in some locations, for example in Madagascar (Thorne 1992). At the household level, cassava peeling are commonly thrown out for animals to feed upon. Many of these animals are free range (for example in Brong Ahafo, Ghana; Gogoe 1996). Little data is available to quantify this use of by-products.

The use of cassava in livestock feed is a potential market opportunity with expanding urban markets and increased demands for meat. Research that has been undertaken has shown that incorporation of cassava into, for example, poultry layer diets in Cameroon, can result in up 41.8% savings in feed costs (Banser et al. 1996). The use of cassava in domestic livestock rations also offers an alternative to exporting cassava chips. Two case studies of the potential domestic use of cassava are presented below.

2.3.2.2 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 (refer to Table A2 in Annex A). Partial crop budgets calculations were used to show that cassava can compete against other cash crops in communal lands. Cotton, which is the main competing crop, is more profitable on a net income per season basis but less if income per labour day is used as an indicator. Other cash crops (groundnuts and sunflower) and the subsistence crops (maize and small grains) were less competitive using both indicators (Kleih 1995).

2.3.2.3 Cassava for livestock feed in Ghana

The recent expansion of the commercial feed sector in Ghana has increased the demand for maize contributing to high seasonal price variations and a need to import maize to cover this shortfall (Hector et al. 1996). A feasibility study examining the production, utilisation and cost-benefit of cassava substitution to farmers and poultry producers was carried in December 1995 (Barton et al. 1995). It was concluded that cassava chipping could expand market opportunities and improve on financial returns on the crop to farmers. Cassava could have effectively substituted for maize over a six month period in 1995/96 and could have offered a reduction of 10% in comparative feed costs (assuming ration performance was not impaired). Participative research has been initiated to develop suitable cassava chip production systems and confirm the fitness for use of cassava in poultry and pig rations.

2.3.2.4 Imports of dried cassava for animal feed

By world standards, African dried cassava imports were small between 1992 and 1995 (Table 5). The major importing countries (Egypt, Morocco and South Africa), as might be predicted, do not produce significant quantities of the crop. They also experienced an astonishing 99.7% decline in imports by quantity during this period. This may have reflected improved domestically grown feed availability in the major importing countries, or simply a decline in the competitiveness of dried cassava on the international feed markets.

Dried cassava exports from Africa were relatively stable between 1992 and 1995 (Table 6). However, Tanzania, the major exporter according to the figures, exported a surprisingly constant volume and value of dried cassava between 1993 and 1995. This requires confirmation, since it may well be an estimation based on incomplete data series. Further data validation may be needed regarding Ghana, if one considers a case study of that country, in which, according to a Ghanaian exporter (Pessey 1997), Ghana exported several thousand tonnes of cassava chips in 1995 but these exports do not appear in the country's official data bases.

Table 5. Imports of dried cassava into African countries.

	1992		1993		1994		1995	
	Quantity Tonnes	Value '000 US$	Quantity Tonnes	Value '000 US$	Quantity Tonnes	Value '000 US$	Quantity Tonnes	Value '000 US$
Botswana	10	7	63	37	93	31	7	7
Cameroon	0	0	0	0	0	0	17	1
Egypt	27528	3670	52500	6000	0	0	0	0
Kenya	773	114	510	63	9	0	8	1
Morocco	59457	4423	49508	3947	11500	1035	0	0
Reunion	0	0	7	2	0	0	0	0
Senegal	0	0	3	1	30	1	0	0
South Africa	29699	1410	4088	0	0	0	3	4
Zambia	0	-	0	-	0	-	3	-
Africa Total	**117467**	**9624**	**106679**	**10050**	**11632**	**1067**	**38**	**13**

Definition: Includes peeled, sliced and sun-dried (cassava chips), as well as dried, ground and compressed cassava (pellets). Used mainly as livestock feed.
Source: FAOSTAT database

Table 6. African exports of dried cassava

	1992		1993		1994		1995	
	Quantity Tonnes	Value '000 US$	Quantity Tonnes	Value '000 US$	Quantity Tonnes	Value '000 US$	Quantity Tonnes	Value '000 US$

Cameroon	10	10	1	0	0	0	1	1
Benin	38	5	0	0	0	0	0	0
Kenya	0	0	100	46	116	39	0	0
Madagascar	0	0	5449	237	9327	492	6732	462
Malawi	25	3	0	0	25	3	25	3
Zimbabwe	0	0	0	0	0	0	28	3
Senegal	0	0	0	0	163	2	3	0
South Africa	0	0	0	0	0	0	37	12
Tanzania	32000	3200	21000	1800	21000	1800	21000	1800
Total Africa	**32073**	**3218**	**26550**	**2083**	**30631**	**2336**	**27826**	**2281**

Definition: Includes peeled, sliced and sun-dried (cassava chips), as well as dried, ground and compressed cassava (pellets). Used mainly as livestock feed.
Source: FAOSTAT database

Several pieces of ad-hoc information bring evidence to the fact that West African cassava chip exports (to EC) are increasing. This seems to be the case for Ghana, Ivory Coast and Cameroon. Similar information from Nigeria needs further verification. In a further section on the EC pellets imports, further more detailed information follows. One of the major issues facing potential exporters from African countries is the prices paid by importers of the chips. These have been extremely low recently making it difficult for exporters (See Ghana case study as an example). Nweke and Lynam (1996) estimated that only 10% of Nigerian processors produced chips at less or equal to the monthly mean world market price (FOB) of the commodity in January and February 1996.

2.3.3 Starch-based applications:

2.3.3.1 Household level starch production

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 (Table A1), but is probably mainly for local food use.

2.3.3.2 Commercial scale starch production

There used to be a number of cassava starch factories operating in Africa including ones 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, where the local paper and cardboard industry is willing to buy up to 1.5 MT of cassava starch (for adhesives) a day, while the confectionery, plywood and food processing industries have also expressed interest to use (local) cassava starches.

2.3.3.3 Domestic market for cassava starch: Case study in Ghana.

Graffham et al. (1997) surveyed producers and users of starches and flours in Ghana between February and April 1996 (Table 7). The market for starch within Ghana comprises a number of end users who make use of maize, cassava and potato starch, which is mostly imported. The current market is approximately 4,200 tonnes per annum, which compares well with figures in a survey carried out by Glucoset Limited of Ghana (Anon. 1994). The Glucoset survey also predicted that demand will increase to 5,600 tonnes by 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. Bokanga (1997) made some estimates of the potential use of cassava for alcohol and starch in Nigeria. He predicted that one factory consuming 30 tons 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.

Table 7. Market for starch (maize, cassava and potato) in Ghana in 1996 (Adapted from Graffham *et al.* 1997).

Sector	**Market share (%)**	**Tonnes per annum (estimated)**	**Requirements**
Textiles	40%	1680	High quality specifications in terms of purity and microbiological quality
Pharmaceuticals	20%	840	Medium specification, require high level of purity and consistent product quality with respect to viscosity.
Paper	10%	420	Low specification, require low fibre and particulate contaminants.
Food	3%	126	High quality specifications in terms of purity, microbiological quality and specialised pasting characteristics for particular products.
Plywood (glue extenders) + others	27%	1134	Low specification, require low fibre and particulate contaminants.
Total		**4,200**	

2.3.3.4 Trade in starch

A stage on from the use of cassava starch by the domestic food and non-food industries is the export of starch. Data for starch cassava exports are available from FAOSTAT that 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. This said, imports were significantly (Table 9) less than exports in 1993.

By contrast with its exports, Africa was a significant importer of cassava starch between 1992 and 1995 (Table 8). Only a small quantity of African imports could have come from African countries because total exports from these countries were so low. With appropriate development, African countries with potential comparative advantages in cassava starch production may in 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 (refer to tables in Annex A), north African countries tend to be the largest importers. This may reflect their greater level of industrialisation. According to data taken from US Department of Commerce, the US is not a major starch exporter to Africa. No types of starch, other than the those that appear in the tables, were exported from the US to African countries during 1996 and 1997. Cassava starch exports from Thailand for African destinations (non-specified), between 1993-96, fluctuated between 3,200 and 2,167 MT/year (TTTA 1996).

Table 8. African cassava starch imports

	1992		1993		1994		1995	
	Quantity Tonnes	Value '000 US$	Quantity Tonnes	Value '000 US$	Quantity Tonnes	Value '000 US$	Quantity Tonnes	Value '000 US$
Congo, Rep.	1	1	4	4	0	0	0	0
Egypt	62	31	113	86	0	0	7	12
Gabon	0	0	160	31	31	6	0	0
Madagascar	12	4	19	8	20	6	0	0
Mauritius	59	22	71	22	66	22	144	74
Morocco	11	20	0	0	0	0	0	0
Mozambique	2800	1100	2700	900	2700	900	2700	900
Zimbabwe	0	0	0	0	3	2	0	0
Reunion	186	82	156	58	178	66	249	120
Rwanda	52	49	52	49	52	49	52	49
Senegal	2	3	1	3	1	3	54	24
South Africa	6263	1523	5692	1209	10050	2118	3124	848
Africa Total	**9448**	**2835**	**8968**	**2370**	**13101**	**3172**	**6330**	**2027**

Source: FAOSTAT database.

Although some data have been identified on the current supply and demand for starches in Africa, more are required before recommendations can be given 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.

2.4 CASSAVA UTILISATION BY GEOGRAPHIC REGION: ASIA

2.4.1 Fresh, chips and flours for food

Most information regarding food use in Asia has very recently been reviewed by Hershey *et al*. (1997a) as part of IFAD's Global Cassava Strategy. Hence, let it suffice here to distil the main pertinent trends of this report and add some complementary information.

Outside of Kerala (India) and isolated mountain areas of Vietnam and China, most cassava in Asia for direct food purposes is first processed. As incomes increase over time, also these areas will reduce their non-processed cassava intake in favour of the preferred rice. On-farm cassava flour consumption, seems to behave in a similar way to non-processed cassava in Asia, as it is also substituted for rice as economic conditions improve. Nonetheless, on-farm, in the poorer Asian rural areas (Indonesia, Vietnam and China) cassava may remain as an emergency or buffer crop in times of rice scarcity. However, this is not the primary nor the preferred use. Off-farm, as experienced in Indonesia (Damardjati *et al.* 1997), the Philippines and Vietnam (Nghiem 1993), cassava flour may encounter alternative growth markets, as a cheaper (partial) substitute for wheat in the bread and pastry industries. So far, only isolated experiences have been reported.

2.4.2 Chips and pellets for feed

2.4.2.1 Off-farm animal feeding (national and export):

As extensively reported by Hershey *et al.* (1997a), Henry and Gottret (1996), Henry *et al*. (1995) and Henry *et al.* (1994), 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 80s and 90s, Thai pellet production

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

and exports have steadily decreased from 7.2 MMT in 1990 to 3.6 MMT in 1996 (TTTA 1996). Furthermore, the share of Thai chips has become negligible compared to the pellet share. Pellet export prices, as the cause of reduced exports, have behaved irregularly. While at the end of the 80s and start of the 90s the c.i.f. Rotterdam pellet price was in the 145-165 US$/MT range, as EC coarse grain prices started to slide, so did Thai pellet prices. While in 1995, average EC pellet prices rebounded to a US$ 140/MT level, they have since slid to a current 1998 price level of less than US$ 100/MT (fob price European port of DM 170-177/MT). Hence, the Thais have not been able to satisfy their annual export quota to the EC. This is also due to competition for cassava from the domestic starch industry. The future potential of cassava for the domestic feed industry and its competitiveness vis-à-vis domestic or imported corn 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 the discussion on starch (in Indonesia), the domestic market for Indonesia is of primary importance, especially for starch. While Indonesia has profited from its EC pellet/chip exports until the early 90s, it has actively diversified its market, which currently is almost equally divided between the EC 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 utilisation. This needs further attention.

2.4.2.2 On-farm animal feeding:

On-farm cassava utilisation for animal feed has been a common practice throughout Asia. However, currently, and especially in the more isolated (non-starch industry influenced) areas of Vietnam and China, this activity has received increasing attention (UPWARD 1996; Hershey *et al.* 1997a; Henry and Howeler 1996). The explanation for this is straightforward: as in these countries, incomes rise, protein (especially pork) consumption will augment, especially in the faster developing urban areas. More isolated farmers, that have a tradition of fattening some pigs every year (for Tet celebrations and as a fallback source of capital) with farm produce by-products and roots and tubers, see the rising pig prices and demand, and react by steadily increasing their number of pigs, etc., etc. As large-scale pig production units are still relatively scarce (but increasing rapidly), most pork production, still comes from individual household production. The role of root and tubers has become increasingly important for this particular development process. Additional research is needed to quantify the future potential of cassava for on-farm pig feeding. These type of analyses have been included in proposed integrated collaborative projects by national and international agencies in these countries (PROAMYL 1998; CIP 1997; IFPRI 1998).

[5] Unlike Thailand, Indonesia still ships large volumes of 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.

2.4.3 Starch-based applications in Asia

2.4.3.1 Starch situation in Thailand:

Thailand is the largest cassava starch producer, manufacturing approximately 2 million MT 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. The same author reports the domestic cassava starch utilisation, by industry, as follows (% of total 1994: 1,121,625 MT):

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%*

TTTA (1994) reports estimates of annual starch export growth rates for the main starch products between 1987 and 1992 as: native (10.5%), modified (33.8%), sorbitol (48.9%), 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 (such as TTTA) are becoming very reluctant to share their latest data. The latest (1996) TTTA Annual Yearbook only mentions exports, but gives no national utilisation information.

Starch exports in 1996 are estimated at 800-900,000 MT. Principal destinations are foremost Japan and Taiwan, followed by USA, Mexico, China, Singapore, Hong Kong, Netherlands, Philippines and Indonesia. It is interesting to note that even with the very steep EC tariffs, 28,577 MT of starch were exported to the Netherlands! This is yet another indication[6] of the competitively low price of Thai starch, that during 1996

[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 54Baht= 1US$, compared to 26 Baht, less than a year 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

averaged US$ 280-300/MT versus EC potato starch at a high of US$ 550, while during the year dropping to US$ 500/MT, due to favourable EC export subsidies (while US corn starch was US$ 300/MT). The latest Thai starch industry information (31/1/98) mentions a "Super High Grade Starch" price of US$ 240/MT fob Bangkok (TTTA 1998).

The TTTA (1996) source also notes a 1997 (starch) export target of 955-970,000 MT, of which 30% was expected as dextrins and modified starches, and 70% native starch (p.37). Internal TTTA activities point towards a growing export market interest for China and the Soviet Federation. The latter opportunity may be more of a longer term nature, due to the current economic instability of the country. Additional export opportunities for Japan are totally policy dependant, and as yet, unclear to predict.

While traditionally, the export market has constituted the primary Thai objective, several reports (including 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 (unforeseen?) 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 formulation (ethanol, SCP, food colorants, starch based plastics, etc) starch waste valorisation, 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) maltodextrins manufactured from physically modified starch (rather than chemically modified), for use as fat replacers, and (iii) cyclodextrins for food and pharmaceutical uses (p. 81).

2.4.3.2 Starch situation in Indonesia:

Traditionally, Indonesia's primary starch market has been the national 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 EC cassava prices, and increased domestic (and foreign) cassava demand,

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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 lowered prices).

Indonesia's chip/pellet exports have decreased from 1.2 million MT in 1990 to 600,000 MT 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, confidential information from the US private industry (personal communications, E. Tupper 1997) reports that currently the Indonesian annual per capita paper consumption[7] is at 20 KG, with an estimated annual growth rate of 14%. 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 modified starches manufacturing (Personal communications, P. Tremprom 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 utilisation shares, by industry.

2.4.3.3 Starch situation in Vietnam:

Cassava starch production in Vietnam, before the start of the 90s consisted largely of small household level processing units in addition to several state-owned (run-down) larger scale units (Thang Ha *et al.* 1997; Ngiem 1993; 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 90s, following "the run for cheap local labour 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 90s, 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 portfolio seems to have changed since the mid-90s (This needs to be investigated since no new data exists).

During the early 90s a cassava starch market assessment was conducted (Thang Ha *et al.* 1997), showing that the 1992 national cassava starch production was around 90,000 MT and projected to reach 200,000 MT by the year 2000 (mainly due to increases in MSG production[8]). If Vietnam would follow similar industry trends as in Thailand and

[7] Compared to the US with 332 KG (1% growth) and Japan with 180 KG (6% growth).

[8] MSG industry information points out that Taiwan as the world's number one MSG consumer, consumes an average 1 Kg/year/cap. Even at a conservative rate of 0.5 KG/yr/cap, the domestic Vietnamese MSG consumption could be 60-70,000 MT per year by the year 2000 (personal communications, J. Wang, 1995).

China, one would expect increased productions of, especially, hydrolysed and modified starches in the future.

2.4.3.4 Starch situation in China:

Data on (cassava) starch in China before the 90s are, at best, sketchy and mostly in Chinese. A first post-80s assessment, though still in Chinese, was written up by Shu Ren and Henry (1993), followed by English and up-dated versions by Shu Ren and Henry (1996) and Shu Ren (1997). These publications report that in 1992, cassava starch production in South China was estimated at around 200,000+ MT, based on a regional availability of 1.2 million MT of chips[9]. For the major 10 factories in Guangxi alone, an annual starch output of 80,000 MT was calculated. At that time, the cassava starch product portfolio included: native starch, fructose, sorbitol, mannitol, 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 of 150 factories with an installed capacity of 3000 MT/day, producing 280,000 MT. The industry output consisted of roughly 10% modified and hydrolysed 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 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 source crop (p.4). More recent, but still unpublished[11], information validates the continuation of this upscaling trend. Unfortunately, this latter information does not include a quantification of the industry's product utilisation shares, nor expected growth rates.

[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 cassava dried 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 S-China by Henry and Howeler (1996).

[11] Proceedings of the International (Cassava) Starch and Starch Derivatives Conference, held in Nanning, China, 4-11 November 1996, are still in the process of translation and editing (in collaboration with NRI and CIAT).

2.4.3.5 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 1994). Salem district alone, with roughly 720 units, represents 80% of the states output. Total Indian cassava starch and sago output is estimated at 200-300,000 MT. The share of sago versus starch is unknown, neither the utilisation rates for food and non-food sectors. Additional information is needed. Apart from India, the Philippines has had some cassava starch extraction operations. Most starch is imported from the US, Thailand and the EC. Contradicting sets of information exist about new cassava starch investments (by San Miguel) and the success of these. Again, better information is required.

2.5 CASSAVA UTILISATION BY GEOGRAPHIC REGION: LATIN AMERICA and THE CARIBBEAN (LAC)

2.5.1 Fresh and flours in LAC:

Past cassava fresh and flour trends and current situation in LAC have been extensively analysed and reported by, among others, Henry and Gottret (1996) and Hershey *et al.* (1997b). Suffice it to point out that, consumption of fresh cassava in Colombia and Paraguay, and farinha in NE-Brazil will increase with decreasing cassava prices (relative to its major substitutes) in rural and urban areas, for the lowest income groups. Furthermore, in NE-Brazil, studies (Henry 1996a) have shown evidence, that urban consumers (on the average) were willing to pay more for better quality farinha. This points out that higher quality cassava products may expand traditional demand in these areas. The traditional farinha de mandioca industry in Southern Brazil has been under increasingly heavy competition (for raw materials) by the growing starch industry. Drought conditions in NE-Brazil have boosted the demand for farinha (from the South) for the past several years, but this is not sustainable. At this moment, it is not clear what these industries future will be (CERAT 1997).

In Colombia, Peru, Brazil (Ceara) and Ecuador, integrated cassava project experiences, show the (limited) potential of cassava to partial substitute wheat flour in bakery, pastry and snack food industries (Ospina *et al.* 1997; Eguez 1997; Henry 1996a). The conditions to benefit from this potential, however, are very site specific and require detailed feasibility studies.

2.5.2 Chips and leaves for feed

Ospina *et al*. (1997), Henry *et al*. (1994) and Hershey *et al*. (1997b) have extensively reported on the cassava chip experiences and its future potential for animal feed in Brazil and Colombia. Gottret *et al*. (1997) reports a calculated demand potential (by the feed industry) in Colombia of > 500,000 MT per year, at certain relative prices and quality levels. Actual cassava chip utilisation averages 30-50,000 MT. Similar and higher figures have been reported for Ceara state of Brazil (Henry 1996a), depending on the

cassava inclusion rates. In Ceara, the potential demand (for chicken and pig feed rations) is augmented by the demand from dairy farmers (for supplementation with cassava chips during the dry season).

2.5.3 Starch-based applications in LAC

2.5.3.1 Starch situation in Brazil:

Cassava starch production increased from 200,000 T in 1990 to approximately 300,000 MT in 1997 (Vilpoux 1998). Roughly 70% of Brazil's starch utilisation is based on domestic corn starch, bringing the total industry, currently, at an estimated 1 million T/yr (Vilpoux 1998). Hence, Brazil's starch expansion has been typically corn-based. Corn 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 11 : Brazilian starch and starch derivatives utilisation, by industrial sector, 1997 (MT)

Starch Type	Food sector				Paper sector		Textile sector	Other sectors	Total
	sweeteners	bakery pastry	powder products	others	paper	cardboard			
Native starch	2.100	26.500	93.000	1 09.100	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
Hydrolysed									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**	**96.000**	**1.022.950**

Source : Vilpoux (1998)

Current utilisation of starch is detailed in Table 11. 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 hydrolysed (sweeteners), and 11% is (other) modified starch. Vilpoux (1998) notes that in 1997, the food industries that increased their starch utilisation the most, where 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 especially for 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.

2.5.3.2 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 25-30T/ha/yr. 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 corn starch, mostly imported from the US.

2.5.3.3 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 Valley with a total average production of 23,000 MT from approximately 200 small-scale processing units. Several larger units producing native cassava starch operate in the Atlantic Coast region. Colombian starch utilisation is principally (still) satisfied by starch imports from the US (corn), Venezuela (cassava), Brazil (cassava/corn), and sometimes from Ecuador (cassava). Several corn source 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 based starch. Colombian native starch was priced in 1996 at US$500-550/MT versus imported corn starch at US$ 450-480/MT. At these prices, Thai and even Brazilian starch could possibly 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.

2.5.3.4 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 manufacturing of "*chipas*", a

typical snack. However, more recently, growing interest exists from Brazilian starch manufacturers, across the border (Parana and Mato Grosso do Sul), for joint-venture investments in large scale cassava starch manufacturing (> 200 MT/day), taking advantage of relatively lower land and labour prices (This information needs to be confirmed and quantified). Most starch utilised in Paraguay currently, originates from Brazil, and to a lesser extent from the US (corn starch).

2.6 CASSAVA UTILISATION IN THE EUROPEAN COMMUNITY (EC) AND THE US

2.6.1 Fresh cassava for food:

Table A4 summarises EC fresh cassava imports for the last five years. Note that the figures for 1993 and 1994 relate to the EC with 12 members, while 1995/96/97 figures relate to the EC with 15 members. No data are currently available to assess how much more cassava was imported to the EC as a result of Austria, Sweden and Finland's entrance to the communty. However, none of these countries has large ethnic populations from developing countries (those most likely to consume fresh cassava) and consequently we can safely assume that the enlargement of the EC had little effect on fresh cassava imports. The same table indicates that imports have increased both in value and quantity over recent years. Costa Rica dominates supplies, while Ecuador, Surinam and Ghana supply much smaller, though still significant, quantities.

In 1997, the UK imported approximately 940 tonnes of fresh cassava (estimated from data supplied by the Home Grown Cereals Authority, UK). At 23% of the estimated 1997 EC imports, this figure indicates that the UK is one of the major buyers within the EC. Since consumers in the UK tend to come from ethnic minorities, the market size is limited. Cassava enters the country either as fresh whole roots, which have been preserved in clear wax and fungicide, or as frozen pieces, which arrive in refrigerated containers. The UK market is currently oversupplied. Traders either predict a decline in the market, or at most, a continuation of the current level of sales (personal communications, various traders, New Spitalfield Market, London). Prospective entrants to the EC market would have to be competitive with exporters from Costa Rica, who operate highly efficient market channels.

US Department of Commerce trade figures summarised in Table A5, reveal significant imports of cassava to the US. The figures relate to cassava, frozen, fresh or dried. However, the US imports either very little or no dried cassava (personal communication, Linda Wheeler, USDA Foreign Agricultural Service) and so the figures in the table can be assumed to relate almost entirely to fresh or frozen cassava.

2.6.2 Chips and pellets for feed:

The European Union feed market for dried cassava is well established. European

feed millers buy cassava pellets and chips as substitutes for feed grain, basing their purchase decisions on cassava's relative price competitiveness. To understand what determines cassava's competitiveness, a review of supply and demand influences is required.

2.6.2.1 Supply to the EC

The EC's major suppliers of feed cassava are, in order of importance, Thailand and Indonesia (FAO Food Outlook, various issues). Both countries predominately supply cassava in the form of pellets. EC feed cassava imports are regulated by quotas but since neither Thailand nor Indonesia has exceeded their quotas over recent years, the quotas have not directly influenced supply. However, the stock-check system which the Thai government uses to allocate EC quotas, has tended to decrease competition among exporting companies. The system grants export licences on the basis of past export performance and current stockholding, thereby discouraging new exporters from entering the market. Rather unsurprisingly, a clear relationship exists between the size of the cassava harvest in Thailand/Indonesia, and the quantity of dried cassava which is available for export. Both countries have domestic industries which demand large quantities of cassava. Thailand in particular has recently followed a policy of promoting value added cassava processing, thus creating a significant cassava starch industry (personal communication, Trakulken Feed, Rotterdam). With such large domestic demand, anything which influences the size of the Thai/Indonesian cassava harvest has an impact on supplies of cassava pellets to the EC.

2.6.2.2 Demand in the EC

To make cassava a suitable substitute for feed grains, it must be mixed with a source of protein. Soymeal is commonly used in this role. When deciding whether or not to buy cassava, feed millers compare the price of the cassava/soymeal mix with the price of domestic feed grains. Consequently, soymeal prices affect the demand for feed cassava. For instance, high soymeal prices tend to reduce demand for cassava.

Among other influences, feed grain prices in the EC are affected by international feed grain prices and the size and quality of the European grain harvest. International feed trade is dominated by maize. The US and Argentina are the world's largest maize exporters, and to a considerable extent, supply conditions in these two countries determine world maize prices.

Grain harvests in Europe are affected by weather conditions and European Community agricultural policies. The weather not only affects the size of the European harvest but also its quality. During ripening, adverse weather conditions decrease grain quality, and thereby increase the quantity of grain which is available on the feed grain markets.

As regards EC policies, in recent years the EC has steadily decreased the percentage of arable land which qualifies for "set-aside" payments. Under this scheme, farmers are paid to take land out of production. The reduction of set-aside has effectively

increased recent EC grain harvests. International freight rates and the fortunes of the EC livestock industries also influence the demand for feed cassava.

For several years, barley has been the most competitive feed grain in EC markets. In the recent two decades, prices of cassava/soybean mixtures were on the average lower than corresponding barley prices in EC markets. However, in October 1997, EC barley prices dropped below their intervention price and thus triggered intervention buying by the EC. Such buying will probably continue well into 1998 (personal communication, EC Interventions Board, Reading, UK). Intervention buying effectively establishes a floor price in the EC barley market. 1998 is therefore unlikely to witness further barley price decreases. With an expected decrease in the price of imported maize in 1998, maize prices, rather than barley prices, may once again become more relevant for comparisons between the price of cassava/soymeal mix and the prices of its cereal competitors.

2.6.2.3 Recent changes in EC market conditions for cassava feed

At 3.4 million tonnes, EC imports of dried cassava in 1997 were only marginally lower than the corresponding figure for 1996. However, dried cassava prices reached a ten year low. The 1997 January to September average dried cassava price was US$110/tonne, down US$42 from the 1996 average (FAO Food Outlook, November 1997). The 1997 price reflected the following:

- Low EC grain prices. In 1997 the area on which EC farmers were allowed to claim subsidy under the set-aside scheme was reduced from 10% to 5%. This stimulated production and placed downward pressure on EC grain prices

- High soymeal prices. From 1990 to 1995 average annual soymeal prices (c.i.f. Rotterdam from Argentina) were approximately US$200 per tonne. In 1996 and 1997, prices were US$268 and US$279 per tonne respectively (FAO Food Outlook, November 1997)

- Less than expected demand for cassava from the EC pig industry (caused by the outbreak of swine fever in several EC countries).

In early 1998, cassava pellets were trading at approximately US$100 per tonne (personal communication, Alfred Toepfer International Gmbh, Hamburg). Reacting to low export forecasts, the Thai government suspended the stock-check system during 1997, thereby increasing competition among dried cassava exporters. This weakened the Thai exporters' collective bargaining position.

According to recent analysis conducted by DG-VI of the European Commission (Prevost 1997), the average annual prices of cassava-soymeal mix and barley have been equivalent for the past two years. While such figures disguise weekly changes in relative competitiveness, the message remains clear: against high soymeal prices and decreasing barley prices, cassava has only maintained its competitiveness by becoming

cheaper.

At the end of 1997, the European Commission extended its import quota arrangements for Thai cassava and cassava products. As before, the quota is limited to 5.5 million tonnes. Indonesia and China have separate quotas, both considerably less than the Thai quota. Other WTO members share an import quota of approximately 145,000 tonnes, while non-WTO members share a smaller quota. All imports of dried cassava attract a 6% ad valorem EC import duty. In principle, ACP countries enjoy privileged access to EC cassava markets. In practice, such access has been less favourable than the access which is allowed under normal EC trade provisions (personal communication, DGVI of the European Commission, Brussels). This situation may change as new ACP/EC agreements emerge.

The foregoing descriptions of EC feed cassava trading illustrate the complicated and unpredictable nature of the market. However, trading has existed for many years and will doubtless continue for many more. Prospective entrants to the market should therefore not be discouraged. However, they must prepare themselves both for stiff competition from South-East Asia and for mixed trading fortunes on the EC market.

2.6.3 Starch situation in the EC:

EC starch production in 1994 was estimated at roughly at 6 MMT. By 1997, this is estimated at 7 MMT (AAC 1997). According to the same source, the principal starch source crops are corn (51.5%), wheat (25.5%) and potato (23%). During the last 3-4 years, the share of corn has increased significantly. A recent private industry source, noted by Sansavini and Verzoni (1998), estimates that the EC 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 EC starch utilisation, by industry, as:

Sweets and drinks:	*33-34%*
Processed foods:	*21-22%*
Pharma and chemicals:	*15-16%*
Paper and corrugating:	*27-28%*
Feed:	*2%*

Through import tariffs and quotas, the European starch market is highly protected. Nonetheless, there exists an ACP-countries quota of 25,000 MT, of which 10,000MT is allocated to Thailand. In recent years, the full quota has not been satisfied by Thailand (Coccia 1998). Regarding imports above this quota, Coccia (1998) cites "The International Custom Journal of the European Union" (1994-95) tariffs as follows:

A. Duty of ECU 150/ton within the limit of the annual tariff quota of 8,000 tons of manioc (cassava) starch intended for the manufacture of :a) food preparations put up for retail sale and falling within heading N.o 19.01 , or b) tapioca in the forms of

grains and pearls, put up for retail sale and falling within heading N.o 19.03.

B. Duty of ECU 150 per ton within the limit of an annual tariff quota of 2,000 tons for manioc (cassava) starch intended for the manufacture of medicaments falling within the heading n.o 30.03 or 30.04. Qualification for this quota is subject to conditions laid down in the relevant Community provisions.

However, Coccia (1998) also notes, that the document titled: "The Results of the Uruguay Round", WTO-World Trade Organization, 1996 reports much higher tariffs than those published in the Custom Journal. In fact, for cassava starch, flours and products rates of duties are as follows:

a. For Cassava Flour, Tariff code 1106.20, the base rate of duty is of 204 ECU/ton and will be reduced to 131 ECU /ton, by the year 2004.

b. For Cassava Starch, under tariff 1108.14, the base rate of duty is 260 ECU/ton and will be reduced to 166 ECU , by the year 2004.

c. For tapioca, under tariff code 1903.01, the base tariff rate is 10% ad valorem + 236 ECU /tons to be reduced to 6.4% + 151 ECU /ton.

Nonetheless, as export data series from the US show (USDA-ERS 1997), small volumes of US corn starches (3-4,000 MT/YR) are imported to the EC, mainly to the UK and the Netherlands.

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[12] with cassava and corn 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, companies like Avebe, Roquette, Amylum, and others have been seeking to learn more about the basics of cassava during the past decade, (PROAMYL 1997-98; CERAT 1997) and to analysing the comparative advantages of starch factory construction in North vs. South Vietnam vs. S-China vs. Thailand (vs. Brazil vs. Venezuela). While most emphasis has been on cassava as the “hot new” starch source crop, new corn starch joint-ventures[13] in Asia are also being considered. Besides, starting

[12] 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.

[13] Sansavini & Verzoni (1998) cite a CERESTAR source regarding a new 350,000 MT corn 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).

the early 90s, 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).

2.6.4 Starch situation in the US:

While the US (and Canada) do not use cassava as a starch base, but mainly corn (or molasses), some understanding of its industry is important for the following reasons: (i) US corn 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 corn-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 corn-based starches and derivatives include: native, modified starches, sweeteners (HCFS), ethanol, industrial alcohol, citric acid, lactic acid and lysine. USDA-ERS (1997) data shows the following US market demand for some of the "hottest" product groups:

Product	*1996/97 volume (000MT)*	*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

In 1997, total import volume was 12,000 MT at an average value of US$ 309/MT (most corn starches exported from the US are valued at US$ 450-650/MT....). 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 cannot be accessed for individual country cassava starch exports (US Department of Commerce 1997).

3. FUTURE PROSPECTS FOR CASSAVA UTILISATION

3.1 DETERMINING FACTORS:

Future development and growth of cassava product utilisation will largely depend on economic development, policy and R&D-led factors. From this report it has become clear that most historical cassava utilisation growth (both positive and negative) was policy induced i.e. Thai chip export growth to the EC, and the relative inability of cassava starch to further penetrate protected EC and Japanese markets. The importance of policy interventions will remain key to future cassava product market expansion. Expected future WTO regulation changes may relatively favour the potential for cassava starches at a further reduction of cassava chip trade.

Cassava (and competing source crops) research, development, technology transfer and industry investments, represent another key group of determining factors. These factors will influence both the supply and demand side for cassava products. On the demand side, given cassava's relative research lag, cassava research continues to discover specific traits that can potentially give a cassava product a comparative advantage over other competing crops and products, and hence, broaden its demand. On the supply side, production, processing and marketing technologies can reduce per unit costs of raw materials (roots) and processed products. This can subsequently increase cassava's competitiveness in established product markets. An important prerequisite for this is the integration of research with transfer mechanisms, among which, the private sector. Historically, international cassava R&D investments have been insignificant compared to primary crops, like wheat, rice and maize. Nonetheless, considerable technology progress has been achieved and key cassava R&D efforts are underway in the major cassava producing countries. It would be highly useful to have a more quantitative assessment of global past and ongoing cassava R&D projects and their expected impact, in order to analyze the current and future "gap". Logically, R&D of competing source crops will influence cassava's competitiveness as well, especially regarding starch markets.

Expected future economic development of cassava producing countries and other less developed countries, is directly correlated to increased demands for starches and animal feed stuffs. Hence, this, together with population growth, will further expand demand for cassava-based products, especially for higher value products. For example, paper (including 30-40 KG of starch per MT) consumption is 8, 45 and 330 KG/cap/yr, in India, Brazil and the US, respectively.

As mentioned earlier, the second phase of the Study on Global Cassava End-Uses and Markets, will specifically analyse the potential of future cassava markets. Hence, in this report, only the more obvious and general trends regarding cassava's future potential, will be highlighted.

3.2 FOODS:

The previous sections have already included some specific examples regarding future growth potential for several product groups. While traditional fresh root consumption in Colombia and Paraguay is subjected to negative effects of increasing urbanisation, decreasing cassava prices relative to its principal substitutes, can boost per capita consumption, especially for the lowest income classes in urban areas. The same argument is valid for *farinha de mandioca* in North and North-eastern Brazil. Furthermore, regarding this latter product, quality improvement can also lead to increased consumption. Cassava-based snack and convenience food products are only starting to enter consumer markets (Colombia, Brazil, Germany, the US and Japan). Considerable additional investments will be needed to expand this market.

In Africa, one of the most likely developments in the future is the improvement in traditional processing to increase productivity (reduce drudgery) and reduce costs. This can generally be equated with the commercialisation of these traditional foods. This often implies some form of mechanisation. For the products mentioned in Figure A1, the machines involved include screw presses for dewatering, mills for dried chips and graters for fresh roots.

Another potential future approach in Africa is the development of more convenient forms of traditional products. This approach has been suggested for fu-fu in Nigeria (Sanni et al. 1998), where a dried form of the food would have a longer shelf life and be easier to prepare than the current wet paste. It was proposed that this would improve the competitiveness of the product against gari which has become more popular in recent years. Similar approaches may be appropriate for other products such as agbelima and placali. Nweke (1997) proposed that such “ready-to-serve” products had the capability to compete with grains.

Exported fresh cassava (mainly from Central America and to a lesser extent from West Africa) for EC and US markets shows additional, but however, limited growth potential for “exotic foods” markets. Improved marketing efficiencies translating in lower prices, may boost future demand. Partial substitution of wheat by cassava flour for bakery and pastry industries has been successful (in most cases) in several countries of the three cassava producing continents. However, most experiences are still at a semi-experimental level and/or have not been widely diffused. Nonetheless, increased future attention (including detailed market and feasibility studies) to this activity, especially in Africa constitutes an important development path.

3.3 FEEDS:

The “traditional” EC feed market is still dominated by Thai pellet exports. Although Thai pellet export profit margins have been under severe pressure, the exports will continue as long as CAP policies do not drastically change, since the pellet industry still has not yet written off long-term investments. The current Thai financial crisis may boost

exports in the short term. Medium and long-term prospects are almost entirely dependant on world corn and soybean prices, EC domestic grain prices, and future EC policy changes. Continuing bullish starch demand in Thailand (and its export markets) will add additional pressure on Thai pelleters, in their competition for raw materials. A positive point is that increasing starch supplies, also increases (cheap) starch by-products that serve the pelleting industry as an additional raw material.

Some evidence from Africa indicates a growing potential for on-farm and off-farm cassava chips (+leaves) utilisation for animal feed. However, this seems to be very site specific and hence, this needs to be studied case by case (region by region). West-African cassava chip export potential (to EC) in the short-run is limited by the EC quota of 145,000 MT (at the low 6% tariff). Exports above this quota are prohibitive because of the high tariff. The success of the export of cassava for animal feed will depend on their value within Europe and the costs of production and transport. Cassava for feed utilisation has foremost a potential domestically rather than for export!

Future diffusion and/or intensification of cassava chipping and drying in LAC (beyond the current regions), depends largely on the ability of cassava chippers to further integrate with the private sector (with help of government and research support). In addition, national and international coarse grain prices, coupled to government interventions play an important role. The potential market exists, but the organization and integration of producers, processors, marketers and consumers need to be significantly improved.

On-farm utilisation of dried cassava chips (or flour) in Vietnam and China to supply expanding urban pork demand will continue to increase (especially in non-starch industry areas), but in the longer term, an increasing number of pigs will be fattened in specialized large-scale units (that may or may not be partially fed on cassava), reducing the profit margins for isolated and small household pig producers.

3.4 STARCHES:

Previous sections have left a clear impression that increasing and strong starch demand is driving the industry to novel partnerships, source materials and partners. While it seems that Asia is the current « hotspot » for both supply (cheap factors of production) and demand (bullish economic development), LAC is increasingly showing a profitable market as well. Future lowering of import regulation levels in high starch demand countries especially in Asia (and Europe) may further boost demand for cassava starches. It is however, dependant on cassava starch industry's technology adopters to successfully compete with potato and corn starches in the emerging markets (especially requiring modified and hydrolysed starches). It will be necessary however, to first identify which will be the most appropriate starch market segments for subsequent targeting.

Africa seems to have various potentials markets for cassava starches. The small starch volumes that are currently consumed are largely imported (from US and EC). Although these volumes are small, the EC and US multinationals keep a very firm grip on

their markets. Furthermore, near future cassava market expansion 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, as local investors observe growing starch demand on the one hand, and cheap starch source crops on the other hand. However, while on paper, it maybe relatively easy to demonstrate that cassava starch production is feasible in many countries of Africa, significant technical, financial, institutional and organisational 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

4. ISSUES AND RECOMMENDATIONS FOR FURTHER STUDY

Some specific recommendations (by country/continent and domain/industry) recommendations have already been made regarding further study needs. In this section, the authors will attempt to pull together the individual recommendations for each continent and/or country (since Phase 2 study activities are planned in this manner).

US and Canada:

1. Disaggregated price, production and export data-series, by type of starch and utilising industry are required. This will be crucial to assess future growth rates and relative potential. US Industry Census data seems to be one of the possible data sources. Industry analyses by LMC International of Oxford will be of great use.

2. Data on the structure and future growth potential of the US fresh cassava market.

EC and other European countries:

3. Disaggregated price, production and export data-series, by type of starch and utilising industry. Assessment of Eastern European country markets is needed. Selected industry visits are essential. LMC International industry data will be vital.

4. Further insight into the “fresh” cassava imports may be useful, in order to assess and quantify future import growth (from African versus Latin exporters). Targeted interviews with selected importers in France, the UK, Germany (and perhaps Spain) will be necessary.

5. EC policies have significant effects on current and future cassava product trade. Further insights regarding expected policy changes and subsequent ex-ante impact analysis, is necessary. This implies further study of policy regulations and a visit to pertinent European Commission officers in Brussels.

Asian cassava importing countries (Japan, Taiwan, Hong Kong, Korea, ...)

6. Recent domestic feed and starch market data are required (by utilising industry), in addition to current policies and expected policy changes, in order to assess import growth potential. Japan in particular merits attention.

Asian cassava import/export countries (Thailand, Vietnam, China, Indonesia, Philippines, ...)

7. Updated data-series need to be assembled and analysed regarding domestic (i) on-farm and off-farm cassava chip supplies, costs and prices; (ii) root production costs and farm-gate prices; (iii) quantity of starch types, costs, factory-gate prices and by-product utilisation and value; (iv) starch utilisation industry shares and growth rates; and (v) direct and indirect cassava sector policies. Visits to selected cassava producers/flour/starch association managers, seems a first step. Cassava export association visits will be necessary for insights regarding expected future export assessments.

8. An assessment of the current and expected future impact from the on-going Asian financial and economic crisis vis-à-vis cassava sector developments seems crucial.

Latin America and the Caribbean:

9. Complementary and updated information for Colombia, Paraguay and Venezuela is required regarding (i) on-farm and off-farm cassava chip supplies, costs and prices; (ii) root production costs and farm-gate prices; (iii) quantity of starch types, costs, factory-gate prices and by-product utilisation and value; (iv) starch utilisation industry shares and growth rates; and (v) direct and indirect cassava sector policies.

10. Brazilian starch information needs to be validated and more quantitative information is required regarding future domestic starch growth markets.

11. Future potential of partial wheat substitution by cassava flour will need site-specific studies that may be more pertinent for inclusion in integrated cassava project proposals. This is also recommended for higher quality traditional cassava products i.e. fresh cassava (*in bolsa*) in Colombia and Paraguay, *farinha de mandioca* (Brazil), and pre-cooked and frozen packaged cassava (all countries).

12. Fresh cassava exporters from Central America (Costa Rica) could be contacted to help assess future growth and alternative product portfolio possibilities.

Africa:

13. Regarding the potential for on and off-farm (national) cassava utilisation for animal feed detailed studies regarding supply and demand aspects need to be conducted on a one to one basis for each « potential » region. Some information for some (parts of) countries exist and are being used, but much is lacking. For many regions, a qualitative potential exists, but quantitative data needs to validate this. This regards on-farm and off-

farm, and regarding the appropriate scale. A review of on-going experiences across projects (and countries) seems most useful.

14. Virtually the same recommendation can be made regarding the potentials for improved processed traditional products, products with partial wheat substitution, and cassava starch based products. More quantitative data needs to be collected (site-specific) and policies analysed. A first step may be to critically evaluate on-going projects across the regions.

15. For most of the recommendations above it is not sufficient just to collect and analyse more data. The data also has to be made easily and widely available. A mechanism is also needed for updating this valuable information.

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ANNEXE A

Figure A1. Interrelationship of cassava products based on their processing steps in the initial six COSCA countries (Westby 1993).

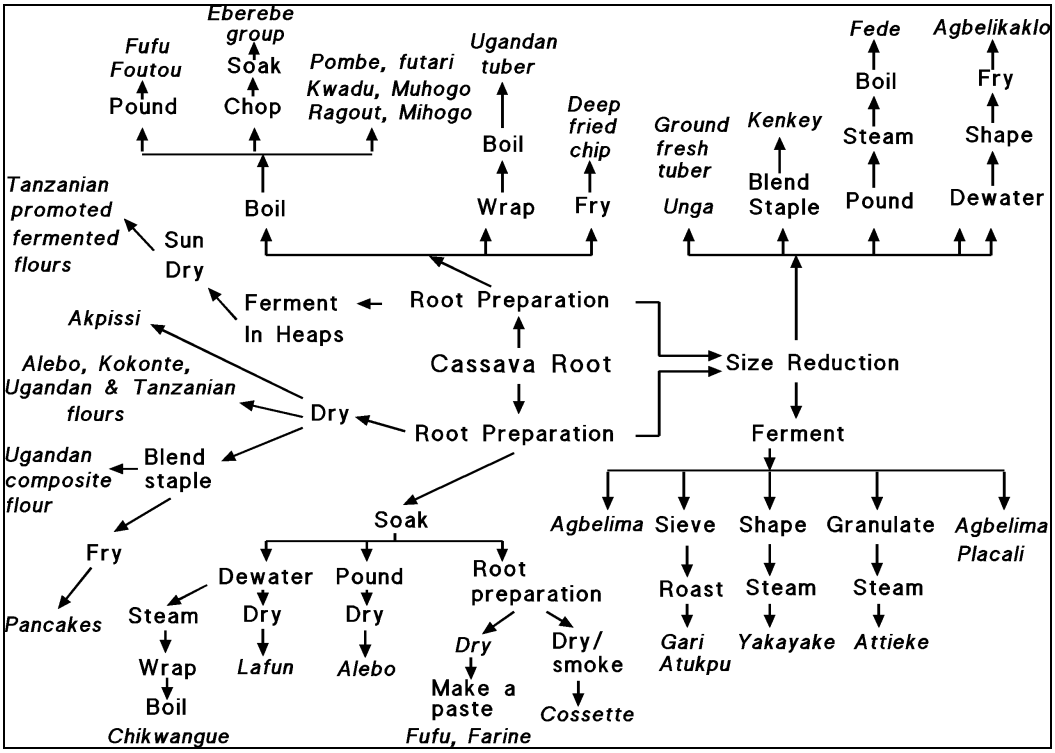

Table A1. Distribution of cassava products using the categories provided in Table 1 (main report) and Figure A1.

Product Group/ Product Type	No. of alternative names	Country	No of villages where ranked 1st	2nd	3rd*	Total no villages (% of surveyed in country)
1. Fresh Roots						**108**
Ererebe group	6	Nigeria	0	1	10	11 (18%)
Foutou/fufu	2	Cote	16	9		32 (80%)
	1	D'Ivoire	6+1			15 (50%)
Tuber	12	Ghana	10	3	2	31 (97%)
Other		Uganda	29	2	0	19
		Various				
2. Roasted Granules						**78**
Gari	2	Cote	1	2	4+1	8 (20%)
		D'Ivoire	7	13	2	22 (73%)
		Ghana	25	22	1	48 (79%)
		Nigeria				
3. Steamed Granules						**35**
Attieke	1	Cote	15	12	7	34 (85%)
Others	1	D'Ivoire				1
		Ghana				
4. Dried flours/pieces						**267**
Acid soaked	6	Nigeria	21	1	3	25 (40%)
Alebo	1	Zaire	15	16	0	33 (92%)
Cossette	2	Zaire	7	12	7+4	30 (83%)
Fufu	1	Nigeria	2	6	4	12 (20%)
Lafun	3	Nigeria				6
Others						
Air dried	5	Nigeria	10	1	2	13 (20%)
Alebo	2	Uganda	0	7	4	11 (34%)
Kabalagala	2	Ghana	9	8	11	28 (93%)
Kokonte		Cote	3	8	5+2	18 (45%)
	12	D'Ivoire	6	10	5+7	28 (93%)
Cassava flour	5	Tanzania	0	14	7	21 (66%)
(Tz)	5	Uganda	1	5	2	8 (25%)
Cassava Flour	2	Uganda				5
(Ug)		Various				
Composite flour			12	5	3+8	28 (93%)
Others	1	Tanzania				1
Mould fermented		Uganda				
Tanzanian						
Others						
5. Fermented pastes						**47**
Grated roots	2	Ghana	3	3	3+1	10 (33%)

Agbelima Placali <u>Soaked roots</u> Akpu (fufu) Chikwangue	2 6 3	Cote D'Ivoire Nigeria Zaire	4 8 11 8 13 19 12 2 5+5	23 (58%) 40 (63%) 24 (64%)
6. Products from leaves Total	5	Zaire, Ug, Tz		7
7. Drinks Total	14	Zaire, Uganda		22
8. Sedimented starches Starch	1	Nigeria	0 2 2+1	5 (8%)
9. Unclassified **Total**	5			5

* The number after the number f villages ranking the product third is the number of villages where the ranking was not recorded.

Table A2. Demand for cassava products in Zimbabwe (adapted from Kleih 1995)

Sector	Quantity and product required	Fresh root equivalent (tonnes)	Comments
Stockfeed	20,00 tonnes of dried chips or meal in the short term 115-118,000 tonnes or dried chips in the medium and long terms	54,000 310,000-508,000	Immediate demand from stockfeed manufacturers in Harare, Bulawayo, Gweru and Triangle. Besides the large manufacturers, dried cassava can be sold to commercial farmers and ranches, as well as communal livestock schemes.
Starch	7,700 tonnes of chips from peeled roots	23,000	Demand is not certain and may only occur medium to long term. The major manufacturer indicated that they will concentrate on maize for the next five years. Dry matter is preferred input.
Flour	500 tonnes of high quality root meal,	2,000	Demand is not certain and may only occur in the long term.
Brewing	10,000 tonnes of dried chips from peeled roots	30,000	Demand is not certain and may only occur in the medium to long term.
Ethanol	240,000 tonnes of fresh roots or equivalent in dried chips	240,000	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 could produce 40 million litres of ethanol, equivalent to 13% of current petrol consumption.

Table A3. EC Wheat starch exports to African countries

	1993		1994		1995		1996	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
	Tonnes	'000 US$	Tonnes	'000 US$	Tonnes	'000 US$	Tonnes	'000 US$
Morocco	118	31.9	107.7	18.3	6.2	4.8	7	3.1
Algeria	0	0.0	0	0.0	0	0.0	4.8	2.0
Tunisia	8.4	4.5	9.6	4.8	12	7.3	14.4	8.9
Egypt	16.8	5.5	16.2	19.3	6.7	7.5	18.8	16.1
Senegal	5.5	5.1	3.9	3.6	10.1	8.7	7.9	7.0
Ivory Coast	6.4	6.0	12.2	12.2	7.2	5.3	13.1	6.5
Benin	1	1.5	0	0.0	0	0.0	2.6	3.2
Cameroon	0	0.0	2.6	11.1	3.2	13.6	2	2.0
Zaire	0	0.0	13.7	4.7	8.3	3.5	5.2	2.0
Kenya	0	0.0	0	0.0	13.5	5.5	24.1	9.2
Madagascar	0	0.0	0	0.0	0	0.0	7.3	3.3
Reunion	0	0.0	0	0.0	0	0.0	2.8	2.9
Total	**156.1**	**54.5**	**165.9**	**74.0**	**67.2**	**56.0**	**110**	**66.0**

Source: DG VI, EUROSTAT

Table A4. EC potato starch exports to African countries.

	1993		1994		1995		1996	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
	Tonnes	'000 US$	Tonnes	'000 US$	Tonnes	'000 US$	Tonnes	'000 US$
Morocco	45.4	12.6	0	0.0	142.2	79.4	584.5	345.9
Algeria	1280	362.1	6	2.3	360.4	196.9	136.8	77.7
Tunisia	16.5	5.1	0	0.0	17.4	9.0	19.5	15.1
Libya	0	0.0	0	0.0	2.7	7.5	0	0.0
Egypt	0	0.0	121	72.0	101	51.0	100	82.6
Cape Verde	1.3	2.7	2.8	5.7	1	2.3	2	3.4
Guinea Biss.	0.6	0.7	0.1	0.5	0	0.1	0.1	0.5
Ghana	6	3.6	0	0.0	15.3	10.2	20	8.6
Nigeria	0	0.0	4.9	10.0	1	1.6	18.5	12.4
Angola	0.4	1.1	5.4	8.6	0.9	2.5	8	25.8
Reunion	0	0.0	0	0.0	23.8	48.3	6.6	14.3
Zambia	0	0.0	0	0.0	1.5	1.4	0	0.0
Zimbabwe	82.5	22.0	29.6	12.5	105	47.1	63	35.7
Lesotho	0	0.0	0	0.0	2	6.2	0	0.0
Total	**1432.7**	**409.8**	**169.8**	**111.6**	**774.2**	**463.3**	**959**	**622.0**

Source: DG VI, EUROSTAT

Table A5. Imports of Fresh Cassava to the EC, by Country of Origin

Definition: Fresh and whole or without skin and frozen manioc, whether or not sliced, for human consumption.

	1993*		1994*		1995**		1996**		1997***	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
	Tonnes	'000 US$	Tonnes	'000 US$	Tonnes	'000 US$	Tonnes	'000 US$	Tonnes	'000 US$
EC Total	**3 409**	**1 914**	**3 480**	**2 509**	**4 022**	**3 015**	**5 001**	**3 571**	**4 147**	**3 187**
Costa Rica	2 502	1 532	2 747	2 015	3 485	2 590	4 089	2 807	3 658	2 699
Ecuador	0	0	5	3	76	50	219	161	230	219
Surinam	133	68	411	213	188	133	272	205	26	18
Ghana	91	45	124	63	89	75	220	210	152	134
Malaysia	8	7	7	6	17	16	34	27	36	31
Barbados	0	0	0	0	17	13	22	15	1	1
Brazil	20	12	0	0	0	0	34	41	5	5
St Vincent	4	3	49	62	29	30	4	5	6	6
Dominican R.	0	0	8	2	28	10	10	8	0	0
Vietnam	2	3	10	10	7	7	22	16	7	17
Philippines	0	0	0	1	10	12	8	10	11	14
Honduras	131	86	63	45	20	18	0	0	0	0
Singapore	11	9	6	5	14	13	2	7	0	0
Nigeria	0	0	0	0	1	2	16	13	0	0
Ivory Coast	7	7	0	0	14	9	0	0	2	29
India	0	0	2	4	0	0	15	7	0	0
Guatemala	0	0	0	0	0	0	10	10	3	2
Indonesia	15	32	35	67	9	21	2	5	0	0
Trinidad,Tob	0	0	0	0	0	0	11	13	0	0
Togo	0	0	0	0	10	7	0	0	0	0
El Salvador	0	0	0	0	0	0	0	0	9	7
Guyana	0	0	0	0	0	0	8	5	0	0
Grenada	0	0	4	4	7	6	0	0	0	0
Thailand	424	63	6	6	0	0	3	4	1	2
Jamaica	0	0	0	0	3	2	0	0	0	0
Congo	0	0	0	0	1	1	0	0	1	1
Cameroon	0	0	1	0	0	0	1	3	0	0
Zaire	0	0	0	0	0	1	1	1	0	0
Venezuela	32	23	0	0	0	0	0	0	0	0
USA	18	9	0	0	0	0	0	0	0	0
Dominica	9	10	0	0	0	0	0	0	0	0
Hong Kong	0	0	2	3	0	0	0	0	0	0
St Lucia	1	3	0	0	0	0	0	0	0	0

Notes: *
=EC12
** = EC15

*** = EC15 preliminary figures

Sources: DG VI and EUROSTAT.

Table A6. Imports of Fresh Cassava to the US, by Country of Origin

	'1996		1997*	
	Quantity	Value	Quantity	Value
	Tonnes	'000 US$	Tonnes	'000 US$
US Total	**32 343**	**16 070**	**34 285**	**21 044**
Colombia	39	18	0	0
Costa Rica	31 744	15 691	32 953	20 317
Dominican R.	78	26	170	142
Ecuador	31	11	221	118
Egypt	4	10	4	12
Fiji	0	0	2	12
Ghana	64	24	52	16
Honduras	21	7	26	14
Hong Kong	0	1	8	4
India	0	0	2	1
Indonesia	20	44	0	0
Ivory Coast	0	0	0	2
Jamaica	0	3	19	25
Malaysia	5	4	0	0
Mexico	66	0	154	31
Nicaragua	0	0	4	4
Nigeria	18	19	0	0
Panama	0	0	102	35
Peru	9	8	0	0
Philippines	198	188	201	199
Thailand	3	4	0	0
Tonga	40	11	12	13
Venezuala	0	0	344	94
Vietnam	3	1	12	4

Notes: * = Estimated values
Source: US Department of Commerce web site

ANNEXE B

Supplementary internet web-sites bibliography[14] on cassava, related and derived product utilisation, markets and trade (especially starches and derivatives):

http://www.undp.org/
http://www.rockfound.org/
http://www.macfdn.org/
http://www.bellanet.org/
http://www.info.usaid.gov/
http://www.ntis.gov/data.htm
http://www.ifis.co.uk/online.html
http://www.mda.state.mn.us/docs/agdev/biotech/interbio.htm
http://www-fst.ag.ohio-state.edu/People/MANGINO/Curriculum/Syllabi/630-01.html
http://www.cato.com/biotech/
http://www.centers.agri.umn.edu/misa/site1.html
http://www.orst.edu/food-resource/references/carbohydrate/starch.html
http://www.nal.usda.gov/
http://www.ars.usda.gov/
http://www.nal.usda.gov/bic/
http://www.ntis.gov/
http://europa.eu.int/cj/en/index.htm
http://www.census.gov/
http://www.nal.usda.gov/bic/www.html
http://www.oecd.org/ehs/service.htm
http://www.reeusda.gov/nri/abstract95/food.htm
http://www.fedworld.gov/cgi-bin/waisgate
http://www.info.usaid.gov/resources/
http://www.info.usaid.gov/cgi-bin/wwwwais
http://www.info.usaid.gov/enric/index.html
http://www.scripps.edu/
http://www.peg.apc.org/~aushs/intsites.htm
http://www.nbiap.vt.edu/
http://www.reeusda.gov/
http://www.nbiap.vt.edu/isb-marks.html
http://www.itc.org/
http://www.wto.org/
http://www.agritrade.org/
http://tradeport.org/
http://ciber.bus.msu.edu/busres/statinfo.htm
http://www.europages.com/business-info-en.html
http://www.ntu.edu.sg/library/statdata.htm
http://www.wri.org/wri/wr-96-97/
http://www.worldbank.org/
http://www.fao.org/
http://www.ilo.org/
http://www.worldbank.org/html/extdr/backgrd/ibrd/ibrd.htm
http://www.imf.org/

[14] Collected by the authors and by courtesy of Dr. David Verzoni, University of Bologna, Bologna, Italy

http://www.usitc.gov/tr/GOVERNM8.HTM
http://lib-www.ucr.edu/infomine/finding.html
http://lib-www.ucr.edu/govpub/
http://www.usitc.gov/tr/NEWSGRO7.HTM
http://www.usitc.gov/tr/INDUSTR2.HTM
http://www.ift.org/meet/techprog.html
http://www.ifc.org/PUBLICAT/PRESS/DATE/1993/PAAGRIBU.HTM
http://www.scisoc.org/aacc/pubs/journ/cc/cctc.htm
http://www4.linknet.net/S_POTATO/Index.htmhttp://www.csi.ad.jp/ABOMB/
http://www.odci.gov/cia/publications/nsolo/
http://www.agriculture.com/worldwide/partners/agonline.html
http://www.xc.org/echo/bdcompc7.htm
http://www.hort.purdue.edu/newcrop/crops/cropfactsheets/apios.html
http://www.cato.org/pubs/pas/pa-241.html
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