CASSAVA PRODUCTION FOR INDUSTRIAL UTILIZATION IN CHINA – PRESENT AND FUTURE PERSPECTIVES

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ABSTRACT

Although cassava is called in China "the underground food store", as it once acted as the key crop against hunger by supplying the main food energy for people of south China in specially difficult times, presently more than 60% of cassava produced is used for industrial purposes, 30% is used for animal feed and only 10% for human food. Cassava has a strong competitively advantage in the tropical and sub-tropical cultivation systems because of the following characteristics:

1. High efficiency in transforming sunlight into bio-energy, with one of the highest potential yields of any crop.
2. Tolerance to drought and poor soils, and wide adaptability to different climates and cropping systems.
3. High extraction rate and excellent physical and chemical characteristics of starch

Because of recent characterization of cassava starch properties, market demand for cassava for the production of starch-based products has increased rapidly. This has led to an increase in the cassava growing area, which has reached about 500,000 ha in the past two years. And the cassava production system is also changing from being a small-scale subsistence crop to a large-scale commercial crop.

Being an excellent source of starch, cassava in China has a huge development potential. There are now several hundred chemical products made from starch. Especially, considering the need to protect the environment and the limited mineral oil reserves in China, at the beginning of 2002 the federal government has started a new project of producing ethanol for use as fuel in automobiles. The production of fuel ethanol will be a Chinese "sunrise industry" with an estimated value of 2.5 billion dollar per year. The fuel alcohol market could amount to about five million tonnes, if alcohol were to be added to gasoline at a 10% substitution rate. But presently the total national ethanol production is only two million tonnes. Among maize, sugarcane and cassava, the main crops to be used for ethanol production in China, cassava has a competitive advantage because of its lower cost of raw material and a simpler ethanol processing technology. For that reason, it is expected that the Chinese cassava cropping area will expand to about 600,000 to 800,000 ha during the current decade.

It is very important that new high-yielding cassava varieties and highly effective cultivation technologies are developed, and that a well-integrated production, transport, processing and marketing system is put into place. In this way, cassava will become a key link in the industrial chain in Hainan, Guangxi and other less developed provinces, resulting in an increase in people's income, which in turn will lead to social progress.

INTRODUCTION

Although cassava is called in China "the underground food store", as it once acted as the key crop against hunger by supplying the main food energy for people of south China in specially difficult times, presently more than 60% of cassava produced is used for industrial purposes, 30% is used for animal feed and only 10% is used for human food. Cassava tuberous roots can be processed into many different products due to their high (28-35%) starch content. But production of starch and fuel ethanol will become the most important cassava-based industries in future China. All this will promote a great increase in the growing of cassava.

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1. Commercial Demand for Cassava in China

Starch Market

Cassava has the following advantages with respect to its utilization in the starch industry: 1. Low production cost; 2. Can be planted in poor soil; 3. Excellent starch quality for its white, sticky and lucent characteristics. According to statistical data, total national starch production reached 5 million tonnes/year, of which 11% is cassava starch, 80% maize starch and 9% starch from other crops. Total production of starch has been increasing in recent years, while that of cassava starch has increased at a similar rate (**Table 1**).

Table 1. Total and cassava starch production (million tonnes) in China from 1995 to 2000.

Starch type	1995	1996	1997	1998	1999	2000
Total starch	2.60	2.64	2.84	3.58	4.70	5.50
Cassava starch	0.228	0.273	-	0.291	0.369	0.588

***Source**: Yearbooks of Chinese Agricultural Development, 1995-2000.*

Cassava is particularly suitable for production of modified starch. Modified starch is a main product among starch derivatives because it has become a new raw material in multiple industries. For example, modified starch is the third most important material in the paper making industry, and large amounts are also used in the textile industry. Although the amount of modified starch produced is still relatively small in present-day China, it increased nearly six times during the past seven years, from 0.06 million tonnes (MT) in 1994 to 0.33 MT in 2001; and 26.5% of it was produced from cassava. The amount of modified starch used in different industries in the United States and in China are shown in **Table 2**. By comparing the consumption of modified starch between these two countries, we can see that there is a huge developmental potential in China. At present, China has one of the largest paper making industries, ranked third in the world, and the largest textile industry. It is estimated that the total amount of paper products produced reached 4 million tonnes in 2001, and with the increasing use of high quality papers, which requires more modified starch, the total consumption of modified starch was over 0.4 million tonnes.

The total amount of modified starch used in the textile industry in China will be much higher than that in the US. It should be pointed out that much of the modified starch used in these fields, such as paper making, food industry and fish feed is derived from cassava starch.

But several problems must be resolved in cassava starch production:

1) There are too many small processing units that have high production costs. It is essential to build new factories with over 0.2 million tonnes production capacity per year.
2) There are few factories producing starch derivatives and the amount is still small. Modified starch production is of primary importance.

3) The present cassava production system can not supply enough raw material for the cassava starch industry. Improved cassava production systems need to be developed.

Table 2. The total amount of modified starch and its proportional share used in different industries in the United States (1994) and China (1997).

Industry	United States (1994)		China (1997)	
	Percentage	Modified starch (MT)	Percentage	Modified starch (MT)
Paper industry	63.1	1.36	38.5	0.08
Food industry	27.9	0.60	8.7	0.018
Textile industry	3.0	0.065	26.4	0.055
Fish feed	-	-	24.0	0.05
Others	6.0	0.13	2.4	0.005
Total	100.0	2.155	100.0	0.208

***Source**: Hua Ou Starchy Net.*

Fuel Ethanol Market

China has been developing a fuel ethanol plan since 2001. It plans to produce pure ethanol used as automobile fuel for the purpose of decreasing mineral oil imports and reducing environmental pollution; secondly, other grain crops should be used mainly for food production. All affairs related to this plan have already been carried out publicly and technologically. The alcohol market could amount to 5 million tonnes per year if fuel ethanol were added to gasoline at a level of 10%. But presently the total national ethanol production capacity is only 2 million tonnes. The development of the fuel ethanol industry will be China's "sun-rise industry", with a value of 2.5 billion dollars per year.

Internationally, the technology of fuel ethanol production has already been developed. In Brazil, production of fuel ethanol started in 1975, and over 10 million tonnes of fuel ethanol, equivalent to 43% of the gasoline consumption, is presently used. The fuel ethanol is being added to gasoline as a higher level of 22%. In the United States, production of fuel ethanol increased rapidly with about 6 million tonnes being produced in 2001. Many countries with rich agricultural resources have been pushing their fuel ethanol policy. All countries that developed large-scale fuel ethanol production have gained great benefits, such as the promotion of agricultural productivity, increased energy savings, creation of employment, increased public income and improved air quality.

Naturally, the economic benefits of fuel ethanol depend on its prize in relation to that of gasoline; the price is influenced by the cost of the raw materials and the processing costs. Maize, sugarcane and cassava are the main crops used for ethanol production in the world. Experts have pointed out that cassava is the best energy crop to produce ethanol. This is because the ethanol yield of cassava per unit land area is the highest among all known energy crops (**Table 3**). Moreover, it is less complicated to set up a cassava ethanol factory because of lower investment and a simpler processing technology due to the special

starch characteristics of cassava. Production of useful by-products made from various parts of the cassava plant can also decrease the cost of cassava ethanol.

Table 3. Comparison of ethanol yield produced from different energy crops.

Crops	Yield (t/ha/year)	Conversion rate to sugar or starch (%)	Conversion rate to ethanol (L/tonne)	Ethanol yield (kg/ha/year)
Sugarcane	70	12.5	70	4,900
Cassava	40	25	150	6,000
Carrot	45	16	100	4,500
Sweet sorghum	35	14	80	2,800
Maize	5	69	410	2,050
Wheat	4	66	390	1,560
Rice	5	75	450	2,250

Source: *P.J.M. Rao, 2000.*

2. Cassava Production in China

Table 4 shows that the area of cassava cultivation has increased steadily between 1993 and 2001, but the yield is still rather low in China.

Table 4. Estimated total area, yield and production of cassava in China from 1993 to 2001.

Year	Area ('000 ha)	Yield (t/ha)	Production (million tonnes)
1993	280	11.43	3.20
1994	300	12.15	3.64
1995	323	13.68	4.42
1996	339	13.41	4.55
2001	412	14.21	5.85

Source*: Yearbook of Chinese Agricultural Development, 2001.*

During the past 50 years some newly developed varieties have replaced the older ones (**Table 5**). From the 1950s to the 1970s, several land races and locally selected clones were cultivated for the purpose of human food; these were characterized as being sweet, of high quality but with low yields. During the 1980s to 1990s, some new varieties with higher yield and better adaptation were bred by hybridization and were subsequently released; this promoted the rapid development of cassava production. Since 1995, high starch content and high yield have become the most important breeding objectives in response to the fast development of the cassava processing industry. Now, we have some excellent varieties with starch contents up to 35% and a high yield potential of over 75 tonnes/ha, such as SC 6 and SC 8013.

Table 5. Principal casava varieties used in China during the past 50 years.

Time	Variety	Starch content (%)	Characteristics
1950s	Mianbao (bread) cassava	30-35	early, good quality, sweet but low yield
	Nuomi (sticky rice) cassava	30-35	early, sweet and good quality
1960s	SC 205	28-30	dwarf, wind resistant, bitter
	SC 201	25-28	tall, long duration with red root inner peel
1970s	SC 6068	28-30	early, better quality
1980s	SC 124	28-30	tolerant to drought and cold, wide adaptation, high yield
	Nanzhi 188	27-29	early, resistant to diseases, high yield
1990s	SC 8002	28-30	high yield
2000s	SC 8013	28-32	high yield
	SC 6	28-35	dwarf, wind resistant, wide adaptation

Some of the limiting factors relating to cassava production in China include the following aspects:

1) Cassava is grown by small producers and in widely dispersed areas.
2) There is little communication between producers and the processing industry.
3) The processing industry is still underdeveloped.
4) Large areas suitable for cassava planting have not yet been exploited.

3. Establishment of the Cassava Industrial System

Being faced with the chance for rapid development and considering the present unsatisfactory state of cassava productivity, a proposal based on modern biotechnology is suggested as follows:

- Rebuild the present cassava starch factories into modern cassava starch and fuel ethanol processing enterprises with a production capacity of over 0.2 million tonnes per year. In fact, cassava fuel ethanol factories with 0.6 and 0.2 million tonnes production capacity are being built in Guangdong and Guangxi provinces, respectively.
- Breed more varieties with higher yield potential and starch content using modern methods of molecular biology.
- Develop tissue culture propagation techniques in order to supply massive numbers of plantlets of new varieties for large-scale planting.
- Map out specific cassava production districts that will supply the requirements of the local processing industries.

4. Perspective

Being a highly efficient energy crop, cassava has a strong competitive advantage in tropical and sub-tropical areas because of the following crop characteristics:

1. Highly efficient in transforming sunlight into bio-energy, with one of the highest potential energy yields.
2. Tolerance to drought and poor soils, and wide adaptability to different climates and cropping systems.

3. High extraction rate and excellent physical and chemical characteristics of the starch.

Although cassava is still a small crop in present-day China, with no more than 0.5 million ha area, it has the potential to become a major crop and increase its production several fold, following on the rapid increase that has already occurred up to 2000.

It is estimated that the Chinese cassava cropping area will expand to about 0.8 to 1.0 million ha in the current decade. Through the development of a *production-transport-processing* or so-called "*negotiation agriculture*" system, cassava will play a major role in the industrial chain in Hainan, Guangxi and other less developed provinces, resulting in an increase in people's income, which in turn will lead to social progress.

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