PRESENT SITUATION AND FUTURE POTENTIAL OF CASSAVA IN CHINA

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ABSTRACT

In China, cassava is planted mainly in the southern provinces of Guangxi, Guangdong, Hainan and Yunnan. The annual total area and production is about 400,000 ha and 6,000,000 tonnes of fresh roots, respectively. Guangxi is the main cassava producing province with more than 60% of both cassava growing area and production. Following the success of research on cassava product development and the development and dissemination of promising varieties, the cassava yield in the province has increased substantially during the last ten years.

The cassava processing industry is mainly concentrated in Guangxi and Guangdong provinces. Of the approximately 525,000 tonnes of cassava-based products processed annually in China, 73% comes from Guangxi, about 20% from Guangdong, 6% from Hainan and 2% from Yunnan. About 95% of these products are starch or modified starch. Considering the natural resource conditions and the rapid development of the cassava industry in Guangxi, it is clear that the present status and future potential of the cassava industry is more favorable in this province as compared to other provinces. Especially since the beginning of the 1990s, the cassava industry in Guangxi developed very fast. In view of the great potential to further develop this crop, the government of Guangxi has organized a group of experts to work out a future plan of cassava development in Guangxi for the next 20 years. Other cassava producing provinces have not yet developed similar plans.

INTRODUCTION

China is a very big country with a large population. There is no doubt that all kinds of products have a huge market. This is the same for cassava-based products. For example, China has now an annual per capita starch consumption of about 4 kg, which is only 1/15 of that of Americans, 1/10 of the Japanese and 1/4 of the Thais. It is clear that the future Chinese starch market will be very large. Although maize starch is the most commonly used starch, cassava starch also plays an important role in the market, especially in the southern part of China and in some specific industries (**Table 1**).

In China, 99% of the cassava growing areas are in the southern provinces of Guangxi, Guangdong, Hainan and Yunnan. The annual planting area is about 400,000 ha, with a total production estimated at 6,000,000 tonnes; Guangxi province accounts for about 60% of both the planted area and production. Of the 6,000,000 tonnes of fresh roots produced in China, it is estimated that about 49% is used in the processing of starch, alcohol and various other chemical products, 22% for animal feed processing (compound feed), 21% for on-farm pig feeding, 6.2% for human consumption (mostly for subsidiary foods), and 1.7% is waste (**Table 2**).

Cassava processing in China is mainly concentrated in Guangxi and Guangdong provinces, and the main cassava-based products are native starch, alcohol, modified starch and MSG (**Table 3**). During the 1990s many cassava-based chemical products were

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developed and are now produced on a large scale; these have become the raw material in many industries.

Table 1. Annual production ('000 tonnes) of starch and starch-derived products from various sources in China in 1998.

Total production (100%)	4,030	-modified starch	300
		-MSG	500
		-Others	NA
-maize starch (82.3)	3,320		
-cassava starch (11.7%)	470[1)]	-Guangxi (70.2%)	330
		-Guangdong (21.3%)	100
		-Hainan (6.4%)	>30
		-Yunnan (2.1%)	10
-sweetpotato starch (2.4%)	96		
-wheat starch (2.4%)	96		
-potato starch (1.2%)	48		

[1)] In addition, more than 100,000 tonnes of cassava starch were imported from Thailand.
Source: *Guangxi Starch Association, 2000; Zhao Jixiang, 2000.*

Table 2. Estimated annual cassava root production ('000 tonnes) and utilization in China in 1999/2000.

Total production (100%)	6,000
-starch and starch derived products (49%)	2,940
-compound feed (22.3%)	1,340
-on-farm pig feeding (20.8%)	1,250
-human consumption (6.2%)	370
-waste (1.7%)	100

CURRENT STATUS OF CASSAVA IN CHINA

Table 4 shows the trend in cassava area, production and yield in the three principal cassava producing provinces of China since 1954. Area, production and yield increased gradually during the 1960s, 70s and 80s, reaching a plateau of about 400,000 ha in the early 1990s. After that the area continued to increase in Guangxi but declined in Guangdong province. Yields were very low in the 1950s and 60s but increased gradually to about 13.0 t/ha in 1993; in 1998 yields are estimated to be about 15 t/ha[4].

[4] FAOSTAT shows the cassava area for China in 1999 to be 235,045 ha producing 3,750,658 tonnes and a yield of 16.0 t/ha. However, these data do not correspond at all with locally produced estimates of 400,000 ha and a production of 6 million tonnes.

Table 3. Estimated annual cassava root production and utilization ('000 tonnes) in China in 1998.

Total production (100%)	6,000		
-Guangxi (62%)	3,700	-starch + starch derived products (50%)	1,850
		-chips for compound feed (20%)	740
		-on-farm pig feeding (20%)	740
		-human consumption (8%)	300
		-waste (2%)	70
-Guangdong (24%)	1,450	-native starch (34%)	500
		-modified starch (14%)	200
		-sweeteners (3%)	46
		-compound feed (23%)	~334
		-on-farm pig feeding (21%)	~300
		-human consumption (3.4%)	~50
		-waste (1.4%)	~20
-Hainan (7.5%)	450	-native starch (>33%)	>150
		-chips for compound feed (30%)	133
		-alcohol (16%)	72
		-on-farm pig feeding (15%)	68
		-human consumption (<4%)	18
		-waste (2%)	9
-Yunnan (6.7%)	400	-on-farm pig feeding (35%)	140
		-chips for compound feed (34%)	136
		-native starch + alcohol (30%)	120
		-human consumption + waste (1%)	4

Source: *Adapted from Guangxi Starch Association, 2000; other sources.*

1. Guangxi Province

Presently, Guangxi is the most important cassava producing province in China. Before 1995, the cassava area and production in Guangxi comprised about 40% of that in China, always being less than in Guangdong province (**Table 4**). After 1995, Guangxi has become the principal cassava producing province, both in terms of planting area and root production. The cassava area in Guangxi is now about 260,000 ha producing 3,700,000 tonnes of fresh roots (**Table 5**), or approximately 62% of the national area and production (**Table 3**). The average yield in 1998 was 14.2 t/ha, a marked improvement over the yield of 8.9 t/ha in 1991 (**Table 4**).

Guangxi is located in a mountainous area, and the natural conditions are very poor compared with those of other southern provinces. Soils are very unfertile and acid, while many areas are quite dry. Cassava is a very suitable crop. Everyone agrees that Guangxi is the place most suitable for growing cassava, even though the yields are rather low. In many places of Guangxi, cassava is a very important traditional crop, previously eaten as a staple food; but now cassava is considered an income resource of farmers who sell to factories, either in the form of fresh roots or dry chips. In many areas, they also use it for animal feeding. Both in the past and now, most farmers plant cassava with poor management; they

apply fertilizers but not in the correct way. Actually, they don't care about the yield, and for many farmers who have small areas of cassava (less than 0.2 ha), cassava is only a secondary crop, the more important one being the intercrop, such as peanut, watermelon, mungbean, etc.

Table 3 shows that every year about 50% of the 3,700,000 tonnes of cassava roots produced in Guangxi is used for processing into starch, modified starch, alcohol and other kinds of chemical products; 20% is made into chips which are sold to factories, including for export to other provinces; 20% is used for on-farm animal feeding and another 10% for other uses (Guangxi Starch Association, 2000).

Table 4. Cassava area, yield and production in China, 1954-1998.

	Area ('000ha)				Yield (t/ha)				Production ('000t)			
Year	Guangdong	Guangxi	Hainan[1)]	Total	Guangdong	Guangxi[2)]	Hainan[1)]	Total	Guangdong	Guangxi[2)]	Hainan[1)]	Total
1954	40.45	67.45	-	107.90	7.43	1.89	-	3.97	300.5	127.6	-	428.1
1955	27.53	62.65	-	90.18	4.27	1.69	-	2.48	117.7	106.1	-	223.8
1956	60.07	93.01	-	153.08	2.19	1.88	-	2.00	131.8	174.8	-	306.6
1957	89.01	104.32	-	193.33	3.55	2.62	-	3.05	316.3	273.0	-	589.3
1958	109.07	132.57	-	241.64	7.52	3.74	-	5.45	820.8	495.6	-	1,316.4
1959	131.70	118.84	-	250.54	6.22	3.54	-	4.95	819.7	421.0	-	1,240.7
1960	86.27	127.91	-	214.18	2.77	2.07	-	2.35	238.8	264.1	-	502.9
1961	117.27	104.35	-	221.62	2.82	3.33	-	3.00	331.1	347.6	-	678.7
1962	-	183.55	-	-	-	3.09	-	-	-	567.8	-	-
1963	-	153.43	-	-	-	2.98	-	-	-	457.0	-	-
1964	110.07	154.31	-	264.38	3.12	3.11	-	3.12	343.5	480.7	-	824.2
1965	98.38	158.52	-	256.90	3.57	3.18	-	3.33	351.8	503.5	-	855.3
1966	106.86	102.22	-	209.08	3.35	2.48	-	2.92	358.2	253.3	-	611.5
1967	-	70.30	-	-	-	7.41	-	-	-	521.1	-	-
1968	-	73.67	-	-	-	6.60	-	-	-	486.4	-	-
1969	126.47	124.73	-	251.20	4.72	5.21	-	4.96	597.1	650.2	-	1,247.3
1970	164.49	145.60	-	310.09	5.09	4.86	-	4.98	837.2	708.0	-	1,545.2
1971	-	129.61	-	-	-	4.89	-	-	-	633.9	-	-
1972	167.54	124.48	-	292.02	3.79	6.32	-	4.87	635.0	786.8	-	1,421.8
1973	152.47	107.90	-	260.37	3.89	5.74	-	4.66	593.9	619.6	-	1,213.5
1974	134.00	100.85	-	234.85	3.98	5.08	-	4.45	533.7	512.3	-	1,046.0
1975	135.15	131.90	-	267.05	3.79	5.92	-	4.84	512.3	781.3	-	1,293.6
1976	102.23	110.47	-	212.70	3.82	5.08	-	4.47	390.3	561.2	-	951.5
1977	90.75	74.57	-	165.32	4.57	5.70	-	5.09	415.2	425.6	-	840.8
1978	175.16	131.02	-	306.18	5.08	5.91	-	5.44	890.4	774.8	-	1,665.2
1979	185.90	155.99	-	341.89	5.51	6.01	-	5.74	1,025.2	937.9	-	1,963.1
1980	177.58	207.76	-	385.34	6.15	6.95	-	6.58	1,092.6	1,443.6	-	2,536.2
1981	173.17	190.39	-	363.56	7.06	7.63	-	7.36	1,223.6	1,452.8	-	2,676.1
1982	167.27	175.17	-	342.44	8.07	8.02	-	8.04	1,349.3	1,404.8	-	2,754.1
1983	131.27	120.64	-	251.91	8.03	8.12	-	8.07	1,054.1	980.0	-	2,034.1
1984	127.07	94.00	-	221.07	10.81	7.70	-	9.49	1,373.7	723.5	-	2,097.2
1985	125.07	100.75	-	225.82	9.71	7.78	-	8.55	1,146.5	783.6	-	1,930.1
1986	148.79	134.15	15.33	298.27	10.20	9.06	10.66	9.71	1,518.2	1,215.0	163.4	2,896.6
1987	181.09	198.97	27.44	407.50	12.19	10.00	12.98	11.18	2,208.6	1,990.7	356.2	4,555.5
1988	187.53	211.21	28.93	427.67	11.71	8.36	13.61	10.19	2,195.9	1,766.5	393.7	4,356.1
1989	173.09	210.67	26.23	409.99	12.23	8.22	13.55	10.26	2,117.3	1,732.0	355.4	4,204.7
1990	174.40	219.37	24.17	417.94	12.27	8.83	12.79	10.50	2,140.6	1,937.6	309.2	4,387.4
1991	173.36	221.53	18.59	413.48	12.72	8.98	11.54	10.81	2,205.6	1,991.0	275.9	4,471.5
1992	-	213.32	19.17	-	-	9.92	12.55	-	-	2,120.7	305.9	-
1993	-	207.60	24.90	-	-	11.50	13.05	-	-	2,381.9	324.9	-
1994	-	234.80	-	-	-	12.30	-	-	-	2,889.4	-	-
1995	-	272.90	-	-	-	13.70	-	-	-	3,738.4	-	-
1996	-	288.90	-	-	-	13.70	-	-	-	3,873.7	-	-
1997	-	273.30	-	-	-	14.20	-	-	-	3,885.9	-	-
1998	-	260.50	-	-	-	14.20	-	-	-	3,701.6	-	-

[1)] Hainan was part of Guangdong province before 1990.

[2)] In Guangxi, production and yield calculated by multiplying data on dry slices by three.

Source: *B. Stone, 1987; Guangdong Statistics Bureau, 1971-1980; Guangxi Agric. Bureau, 1990-1994.*

2. Guangdong Province

Guangdong is the most developed province in China. Because of the low economic value of cassava, the crop has been gradually replaced by other crops, starting in the mid 1990s. Especially in the eastern coastal area there is now very little cassava grown. The cassava area and production in Guangdong province is gradually decreasing and is now mainly concentrated in the western part of the mountainous area, as well as in the coastal area in the south (Henry and Howeler, 1996).

Table 5. Cassava area, production and yield in districts and cities of Guangxi province of China from 1991 to 1998.

	Area ('000 ha)							
	1991	1992	1993	1994	1995	1996	1997	1998
Guangxi	**221.5**	**213.3**	**207.6**	**234.8**	**272.9**	**288.9**	**273.3**	**260.5**
Nanning city	13.3	12.4	14.1	16.3	22.7	23.4	22.7	20.6
Liuzhou city	6.0	4.9	4.6	4.6	4.5	4.7	3.7	2.8
Guilin city	3.2	3.1	2.8	3.0	3.1	3.3	3.7	3.4
Wuzhou city	3.9	3.8	3.5	3.5	4.0	4.0	30.2	28.9
Beihai city	6.7	7.7	8.5	9.1	10.8	11.7	9.7	9.4
Guigang city[1)]	-	-	-	-	-	17.4	16.2	16.0
Nanning district	34.2	31.9	34.9	36.2	41.1	40.9	37.9	32.6
Liuzhou district	28.3	26.7	25.0	23.6	25.3	27.9	24.2	22.2
Guilin district	8.2	7.6	7.7	9.1	10.2	11.1	11.4	11.6
Wuzhou district	34.2	34.5	34.5	35.1	38.7	41.4	-	-
Yulin district	38.8	37.1	37.7	45.4	43.0	26.1	26.1	25.8
Bose district	11.1	11.2	11.9	12.5	24.8	31.5	29.2	27.3
Hechi district	18.3	17.0	8.9	19.3	23.1	22.9	23.4	23.1
Qinzhou district	15.3	15.5	13.8	15.5	19.3	20.2	18.5	19.4
Hezhou district[2)]	-	-	-	-	-	-	14.7	14.6

	Production ('000 tonnes)							
	1991	1992	1993	1994	1995	1996	1997	1998
Guangxi	**1991.0**	**2120.7**	**2381.9**	**2889.4**	**3738.4**	**3873.7**	**3885.9**	**3701.6**
Nanning city	158.8	167.4	216.4	288.5	438.1	445.8	450.4	414.9
Liuzhou city	37.0	36.9	39.6	39.3	46.4	64.4	40.8	32.7
Guilin city	25.5	25.5	29.2	33.8	40.6	43.0	42.5	38.9
Wuzhou city	26.8	24.8	27.2	30.8	40.0	40.4	466.7	459.5
Beihai city	139.7	209.5	230.0	236.0	299.2	261.5	253.6	246.3
Guigang city[1)]	-	-	-	-	-	200.6	316.3	222.3
Nanning district	240.3	242.2	296.4	470.6	546.8	473.6	452.4	393.5
Liuzhou district	169.4	146.8	157.7	165.2	201.7	225.5	201.9	195.1
Guilin district	47.2	58.5	78.0	101.2	129.5	140.5	150.1	136.9
Wuzhou district	355.7	389.1	460.3	519.3	551.3	612.5	-	-
Yulin district	419.1	445.0	490.1	508.7	547.0	441.0	422.0	438.6
Bose district	94.5	100.7	125.0	135.0	333.5	381.3	370.4	366.0
Hechi district	123.0	107.0	70.3	154.4	233.1	229.6	239.2	247.6
Qinzhou district	154.0	167.4	161.7	201.3	301.0	257.2	257.2	285.1
Hezhou district[2)]	-	-	-	-	-	-	195.5	193.0

Table 5. (continued)

	Yield (t/ha)							
	1991	1992	1993	1994	1995	1996	1997	1998
Guangxi	**8.9**	**9.9**	**11.5**	**12.3**	**13.7**	**13.7**	**14.2**	**14.2**
Nanning city	11.9	13.5	15.3	17.7	19.3	19.1	19.8	20.2
Liuzhou city	6.1	7.5	8.6	8.6	10.3	13.8	10.9	11.5
Guilin city	7.9	8.2	10.5	11.3	13.1	10.0	12.8	11.5
Wuzhou city	6.8	6.5	7.8	8.8	10.0	10.0	15.5	15.3
Beihai city	20.7	27.2	27.1	25.9	27.7	22.3	26.0	26.2
Guigang city[1)]	-	-	-	-	-	11.5	19.6	13.9
Nanning district	7.1	7.6	8.5	13.0	13.3	11.6	11.9	12.1
Liuzhou district	6.0	5.5	6.5	7.0	8.7	8.1	8.3	8.8
Guilin district	5.9	7.7	10.1	11.1	12.8	12.6	13.2	11.8
Wuzhou district	10.4	11.3	13.3	14.8	14.3	14.8	-	-
Yulin district	10.8	12.0	13.0	11.2	12.7	16.9	16.2	17.0
Bose district	8.5	9.0	10.5	10.8	13.4	12.1	12.7	13.4
Hechi district	6.7	6.3	7.9	8.0	10.1	10.0	10.2	10.7
Qinzhou district	10.1	11.7	11.7	13.0	15.6	13.9	13.9	14.7
Hezhou district[2)]	-	-	-	-	-	-	13.3	13.2

[1)]Guigang city is a new city previously part of Yulin district
[2)]Hezhou district is a new district, previously part of Wuzhou district
Source: *Guangxi Statistics Bureau, 1994-2000.*

Cassava processing in Guangdong is the most developed in China, mainly because the equipment and the technologies they developed are more advanced, and their management is more modern than in other provinces. But because of the shortage of raw material, total production is now smaller than in Guangxi. Also, the development of cassava-based chemical products in Guangdong has fallen behind that of Guangxi province (**Table 3**). In 1997, production of cassava starch in Guangdong province was about 100,000 tonnes, that of modified starch 40,000 tonnes, and sweeteners 10,000 tonnes (**Table 6**).

Table 6. Annual production of cassava starch and starch-derived products (tonnes) in China in 1997.

	Total	MSG	Modified starch	Sweeteners	Alcohol	Sorbitol	Organic acids
Guangxi	385,000	25,400	30,000	2,000	50,000	25,000	20,450
Guangdong	100,000	NA	40,000	10,000	NA	NA	NA
Hainan	>30,000				10,000		
Yunnan	10,000				NA		

Source: *Guangxi Starch Association, 2000.*

3. Hainan Province

Hainan is the southern most province of China and is completely surrounded by sea. The natural conditions are very good for agricultural production, having a relatively high temperature and rainfall; soils are also more fertile as compared to other cassava producing provinces; so, it is the best area for cassava production in China. But, because Hainan is a much smaller province compared with Guangxi and Guangdong, the cassava area of 30,000 ha and production of about 450,000 tonnes of fresh roots are relatively small, even though the yield is high. Hainan province accounts for about 7.5% of cassava area and production in China.

Before the 1990s, Hainan was very undeveloped and was part of Guangdong province. Most of the cassava was used for farmers' food and for animal feeding. In the early 1990s, Hainan became a separate province and a special economic zone, resulting in a very rapid development of the economy as well as agricutural production. The living standard of farmers increased a lot and the yield and total production of cassava also increased. In the late 1990s, many starch factories were established and the total production capacity is now about 30,000 tonnes of starch.

4. Yunnan and Other Provinces.

Yunnan is a new cassava producing province, which means that only in the past five years cassava roots have been used commercially on a large scale. In the past, farmers, in the mountainous areas also grew cassava, but very scattered in many small areas, using the fresh roots mainly for food. Since 1995, they have imported a thousand tonnes of cassava planting material from Guangxi and have greatly expanded the cassava area, which is presently concentrated mainly in the middle and southern parts of the province, in Shimao and Honghe districts. Since then, several starch factories as well as alcohol factories have been established in these districts. Now, the annual cassava planting area and production are estimated to be about 25,000 ha and 400,000 tonnes, respectively (Yunnan Animal Husbandry Bureau, personal communication). The provincial government is now disseminating to farmers a new technology of using cassava leaves and roots for making silage to be used for animal feeding (Liu Jianpin and Zhuang Zhongtong, 2001). With this technology, some farmers living in the mountains prefer to plant cassava.

Beside these four provinces, some cassava is also grown in Guizhou, Shichuan, Jiangxi and Hunan provinces. The roots are mainly used for on-farm animal feeding. In some areas farmers like to plant sweet varieties, as the roots are used mainly for production of snack food.

CONSTRAINTS IN CASSAVA PRODUCTION AND PROCESSING IN CHINA

1. Production Aspects

a. Lack of an effective organization and management system for developing cassava production

Cassava is an important upland crop in southern China, and plays an important role in many rural areas. Even though the price and income are not very high, farmers still like to grow cassava, maybe because the soil is too poor to grow any other crops. Looking back at the history of cassava planting, we can see that even when the price was very low, farmers still keep a certain area of land for cassava. But, surprisingly, the government

never paid any attention to cassava growing and processing; they did not show any interest in developing the cassava industry. Most considered that there was no need to use any inputs in cassava production as the crop is easy to grow and the economic value is low. They did not believe that the crop has a good potential, but requires some attention in order to develop. So, until now we have not yet developed a very successful working system, and the development of cassava is rather haphazard.

b. Lack of good varieties, poor management, low yield

Presently there are only 2-3 varieties farmers use in their fields, i.e. SC201, SC205 and SC124; these 2-3 varieties occupy about 99% of the total cassava area. Several new promising varieties developed by CATAS and GSCRI have not yet been extended over a large area. Also, some advanced cultural practices have not yet been adopted by farmers. Farmers are still not very concerned about obtaining high yields. Generally, the income of farmers from cassava is not high; therefore, farmers normally do not invest much in cassava production and don't care about the yield. In fact, for most farmers, cassava is not their main crop; they grow cassava only for feeding animals, but when the price is reasonably good, they sell to factories or to traders; otherwise, they use it themselves.

c. Serious soil erosion and decline in soil fertility

In China, cassava is mainly planted on hillsides while flat and fertile land is used for other kinds of economic crops, like fruit trees. Cassava grown on sloping land without proper cultural practices can cause very serious erosion problems. In China, farmers normally plant cassava from Feb to April. Soon after planting, the rainy season starts. As of May, rain water may wash out the top soil when the canopy of cassava has not yet covered the ground, so the soil's fertility decreases fast. At this moment, farmers don't realize this is a problem, and they do not take any measures to protect their soil from erosion. Experimental data indicate that soil losses due to erosion caused by cassava planting on a 15% slope without any erosion control practices may be ten times higher than those obtained with good management practices.

2. Processing Aspects

a. Confusing organization

There are about 200 cassava processing factories in China, and about 75% of these are in Guangxi province. Of all these cassava processing factories, more than 90% are small (with production capacity of less than 5000 tonnes/year). Some factories are owned by the central government, some by local governments and some by townships. Some factories are owned by the private sector, but they tend to be very small and very old; they work very independently.

b. Shortage of scientific and management talent

Up till now, scientists and skilled workers in the starch industry comprise less than 2% of the total staff, so the general level of competence of the staff is quite low. This is a main limitation for developing cassava processing.

c. Short processing period, high consumption of energy

In China, most factories process fresh cassava roots from the end of Oct to the end of Jan, only three months; from Jan to March they may use dry cassava chips, which results in lower efficiency and lower starch quality. Some factories operate even less then three months per year, use outdated equipment and have poor management. Hence, the production cost is very high and the products are not very competitive.

d. Shortage of funds and poor economic base

In many cases, the investment in fixed assets was too high, resulting in a high and long-term economic burden; this has affected the processing activity and profits. And, because profits are low, banks do not like to provide loans to so many small starch factories.

e. Serious pollution

As mentioned above, about 90% of the starch factories are small, they use poor equipment and have poor management. Their profits are very low and it is difficult for them to set aside money for resolving pollution problems. Several big processing factories have adopted some measures to reduce pollution, but the results do not seem as good as expected. The majority of factories are still causing heavy pollution when they process cassava roots.

FUTURE OPPORTUNITIES IN THE CHINESE CASSAVA MARKET

In 2000, total starch production in China is about 4,000,000 tonnes, 82% of which is maize starch, and about 12%, or 470,000 tonnes, is cassava starch (Guangxi Starch Assoc., 2000; Zhao Jixiang, 2000) (**Table 1**); this just meets the demand of several industries (**Table 7**). Actually, China imports a lot, more than 100,000 tonnes of cassava starch from Thailand, and dry chips from Vietnam for making starch.

Some of this starch is used for the production of modified starch, or other chemical products (**Tables 8** and **9**); the rest is used for other purposes, for example, for making noodles, enzyme products, etc. In the future, this demand will further increase in line with economic development and improvements in the people's living standards (**Table 10**).

Table 7. Annual production ('000 tonnes) of various starch-based products and their starch requirements in China in 2000.

	MSG	Sweeteners	Modified starch	Pharma-ceuticals	Noodles	Paper	Total
Production	520	400	200				
Starch requirement	1,400	400	200	800	800	400	4,000

Source: *Guangxi Starch Association, 2000.*

Table 8. Annual consumption of modified starch (tonnes) in China in 1997 and expected consumption in the year 2000.

	1997	%	2000*	%
Paper	80,000	38	400,000	58
Textile	55,000	26	80,000	11.5
Feed	50,000	24	100,000	14.5
Food	18,000	8.6	100,000	14.5
Others	5,000	3.4	10,000	1.5
Total	**208,000**	**100**	**690,000**	**100**

* includes imported starch.

Source: *Guangxi Starch Association, 2000.*

Table 9. Various cassava-derived products produced in Guangxi in 1997.

	Production (t)	% of national production	Remarks
Starch	385,000	72	of cassava starch
Alcohol	50,000	70	of cassava alcohol
Modified starch	30,000	15	includes maize modified starch
Sorbitol	25,000	24	includes maize modified starch
Sorbitol acid	450	60	
Citric acid	10,000	5.5	
MSG	25,400	4.5	
Acetic acid	10,000	2.0	

Source: *Guangxi Starch Association, 2000.*

Table 10. Potential future markets for starch in some industries in China.

	Production (tonnes/year)	Starch consumption (tonnes/year)
Citric acid	300,000	400,000
Modified starch	500,000	500,000
Candy	800,000	16,000
Feed	4,000,000	200,000
Bakery products	600,000	30,000-60,000
Pastry	1,000,000	50,000-100,000
Meat products	2,000,000	200,000
Plastic products	1,400,000	70,000
Enzyme products	140,000	
Total		**> 1,500,000**

Source: *Guangxi Starch Association, 2000.*

FUTURE PLAN OF CASSAVA PRODUCTION DEVELOPMENT IN GUANGXI

After a long disscusion and evaluation regarding the present situation and future potential of cassava, the Guangxi government has recognized that Guangxi has a comparative advantage for the development of cassava production, and that cassava-based industries have a bright future. But, how important this industry is in comparison to other industries is still not clear.

In 1997, the Guangxi government organized a working group of specialists to work out a future cassava development plan, to discuss, evaluate and compare the cassava situation both inside and outside the country. After almost three years, the plan is about finished (**Table 11**); it is the only such provincal development plan for cassava in China, as other cassava producing provinces have not yet made any similar plans.

This plan has gained the government's interest, and they have taken the first steps to implement the plan by making some initial investments in the dissemination of new cassava varieties, as well as in improving the processing equipment and technologies. To meet the various targets, there are many things that have to be done. For the government, shortage of money (funds) is the major problem. Hence, their strategy is to find any channels to raise money; they especially recommend that private enterprises invest in the industry. In other words, any measures and methods that will benefit the development are encouraged and supported.

In order to meet these targets, the following should be done first:

a. Adopt advanced technologies and equipment to improve the cassava processing efficiency and product quality

Compared with the past, the level of cassava processing in Guangxi province has improved a lot, but there is still a way to go compared with other countries. So, both better technologies and advanced equipment should be developed and adopted in order to improve the quality of the products and to reduce energy and water consumption; this will reduce the costs, increase the profit of the various products and improve their competitiveness.

b. Develop various products

There are many people with a lot of experience who have obtained good results in developing many types of cassava processing products in Guangxi. The advanced level of technologies developed in other parts of China can also be taken advantage of and utilized in further developing the industry.

c. Cassava processing factories need to be modernized and developed to a larger capacity

Presently, there are only 5-7 starch factories with a capacity of more than 10,000 t starch/year in Guangxi, while the remaining small ones have not been able to modernize and develop any further. The government has already initiated a policy to limit the setting up of small factories, and at the same time has encouraged the further development of the big ones; this is going to be the future trend.

d. Comprehensive utilization of resources, reduction of pollution and protection of the environment

In Guangxi, the annual production of cassava-based products is 350,000 tonnes; this is producing at least 10,500,000 tonnes of waste water. The appropriate disposal or

Table 11. Cassava production and processing parameter estimates in Guangxi province during the next 20 years.

	1997	2000	2005	2010	2020
1.Cassava planting area('000ha)	273	300	350	400	500
% of new high-yielding varieties	5	10	25	50	80
Yield (t/ha)	14.2	15	20	25	30
Total production ('000t)	388	450	700	1000	1500
2.Starch					
production ('000t)	385	400	600	800	1200
water consumption (m^3/t starch)	40	35	30	25	20
coal consumption (t/t starch)	0.12	0.1	0.1	0.1	0.1
electricity consumption (KWH/t starch)	200	180	170	160	150
3.Alcohol					
production ('000t)	50	100	300	600	1200
processing days (days/year)	75	100	200	250	300
4.Modified starch					
production ('000t)	30	70	150	300	600
-for paper making		32	66	130	250
-for textile making		16	24	40	70
-for feed		10	20	40	60
-for food		10	30	70	150
-for other purposes		2	10	20	70
5.Sweeteners					
production ('000t)	2	20	30	100	200
-fructose			15	50	100
-glucose-syrup			12	35	70
-others			3	15	30
6.Fermented products					
production ('000t)			100	180	360
-MSG	25.4	26	40	50	80
-citric acid	10	12	20	50	100
-lactic acid		5	20	50	100
-others			20	30	80
7.Various chemical products					
production ('000t)		27	57	140	250
-sorbitol	25	25	30	55	100
-sorbic acid	0.45	2	10	20	40
-feed additive (lysine)			5	20	30
-hygroscopic agent			2	5	10
-others			10	40	70
8.Other chemical products					
production ('000t)			320	640	960
-acetaldehyde			50	100	150
-ethylane oxide			50	100	150
-acetic acid			50	100	150
-ethyl acetate			50	100	150
-acetic acid			50	100	150
-butyl alcohol			50	100	150
-others			70	140	210

Source: *Guangxi Starch Assoc., 2000*

utilization of this is a serious problem for the industry and could become a strong limitation for its future development. So ,we must spare no effort to try to reduce the pollution and protect the environment by a more comprehensive utilization of all resources and by-products.

REFERENCES

Stone, B. 1987. Trends and distribution of Chinese cassava production and use, 1820-1984. *In*: J. Lynam. The Cassava Economy of Asia: Adapting to Economic Change. Global Cassava Research and Development. Paper prepared for TAC Nairobi meeting, June 21-July 1, 1987. pp. III: 1-79.

Guangdong Statistics Bureau. 1980. Agricultural Statistics. Guangzhou, Guangdong, China.

Guangxi Starch Association, 2000. Cassava Status and Future Plans for Guangxi, 1998-2020. Report submitted to Guangxi Provincial Government.

Guangxi Statistics Bureau. 1994-2000. Agricultural Statistics, Nanning, Guangxi, China.

Henry, G. and R. Howeler. 1996. Cassava in China in an Era of Change (A CBN Case Study of Farmers and Processors). CIAT Publication No. 155. CIAT, Cali, Colombia. 68 p.

Liu Jianpin and Zhuang Zhongtong. 2001. The use of dry cassava roots and silage from leaves for pig feeding in Yunnan province of China. *In*: R.H. Howeler and S.L. Tan (Eds.). Cassava's Potential in Asia in the 21st Century: Present Situation and Future Research and Development Needs. Proc. 6th Regional Workshop, held in Ho Chi Minh city, Vietnam. Feb 21 -25, 2000. (this Proceedings)

Zhao Jixiang. 2000. The present situation and prospects for further development of starch-based industries in China. *In*: R.H. Howeler (Ed.). Cassava, Starch and Starch Derivatives. Proc. Intern. Symp., held in Nanning, Guangxi, China. Nov 11-15, 1996. pp. 12-19.