CASSAVA BREEDING AND VARIETAL RELEASE IN CHINA

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ABSTRACT

Cassava varietal improvement in China started in the beginning of the 1910s in Guangdong province; the main activity at that time was the selecting of varieties, character observation, determination of nutritive value and starch content, and the observation of growth habit. In the beginning of the 1940s some people did research on hydrocyanic acid content, which was published. Real cassava breeding work was started at the end of the 1950s by the Guangdong Agricultural Academy in Guangdong province. Since 1959, the South China Academy of Tropical Crops (now the Chinese Academy of Tropical Agricultural Sciences - CATAS) started cassava breeding and agronomy research in Hainan province. In 1985, a collaborative relationship was established between CIAT and CATAS, and later between CIAT and GSCRI, which started the introduction of cassava genetic resources from abroad. Every year hundreds of cassava hybrid seeds have been introduced from CIAT/Colombia and from Thailand. Now there are two institutes working on cassava breeding research, i.e. CATAS and GSCRI.

In 1980 the first cassava variety (SC6068) was released by CATAS. During the past 20 years cassava breeders in China have made considerable progress in cassava varietal improvement. Seven varieties have been released; they are: SC124, SC8002, SC8013, GR891, GR911, SC5 and SC6. In 1981 CIAT sent seven promising cassava varieties in tissue culture to Dr. Guo Jun Yan of the South China Academy of Botany in Guangzhou. One of these, CM321-188 was later released as Nanzhi-188. This variety spread quickly in Guangdong province, but was later rejected by farmers because of lack of cold-tolerance during stake storage. However, another variety, MPan 19 has recently been released as Nanzhi-199 and this variety seems to be high-yielding and well-adapted to conditions in Guangxi province. These new varieties are now being extended to the cassava growing areas and they will play a very important role in the cassava industry development in China, while at the same time increasing farmers' income from planting cassava. This year, the area of the above varieties is estimated at 30,000 ha, accounting for 8% of the total area. Following this trend the total area of these new varieties will probably reach 50,000 ha next year.

In China, cassava varietal dissemination usually occurs through the following channels: 1. the traditional government channel, i.e. the transfer of technology to the extension station of the Agricultural Bureau; 2. by recommendation of agricultural institutes (pictures and character descriptions) through the Bureau of Science and Technology at the county and city level; 3. propagation by cassava processing factories (in cooperation with institutes); 4. demonstration trials conducted by big farmers. From our experiences over the last ten years, the most successful extension channels are No. 2 and No. 4 (No. 3 is now being tried).

INTRODUCTION

Cassava is the fifth most important crop in the southern part of China, following rice, sweet potato, sugarcane and maize. It is used mainly as animal feed and for starch and alcohol manufacturing. Cassava is mainly concentrated in four provinces, i.e. Guangxi 243,750 ha (65%), Guangdong 60,000 ha (16%), Yunnan 37,500 ha (10%), and Hainan 22,500 ha (6%); the others are Jiangxi, Shichuan, Fujian, etc 11,250 ha (3%). During the mid-1990s, Guangxi became the most important cassava as well as cassava starch

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producing province in China (**Table 1**). The natural conditions of Guangxi gives this province a comparative advantage over other provinces. Moreover, the province already formed an advanced cassava starch processing base, which has been quite successful. During the last five years, at least one new cassava starch factories with a capacity of 20,000 tonnes of starch per year has been built every year. Now there are about 150 cassava starch processing factories in Guangxi with a total capacity of about 700,000 tonnes of starch. Since the market of cassava starch and starch derived products in China is very large (**Table 2**) the cassava industry will have very good prospects. Actually, in 2001, China produced about 350,000 tonnes of modified starch and imported at least 350,000 tonnes of modified starch from other countries.

Table 1. Production capacity and actual production of cassava starch by factories in Guangxi province from 1997 to 2002.

	Production capacity ('000 t)	Actual production ('000 t)	% of national production
1997	300	260	68
1998	350	270	70
1999	430	296	69
2000	450	300	70
2001	470	310	70
2002	500	329	72

Source: *Estimated by Guangxi Starch Association.*

Table 2. Size of various industries and their potential requirements for modified starch in China.

Industry	Production ('000 t)	Requirement for modified starch ('000 t)	Observation
Paper	36,000	600	mainly cassava mod. starch
Textile	250	175	mainly cassava mod. starch
Food	9,300	100	
Feed	400	100	
Building material		100	mainly cassava mod. starch
Pharmaceutical		50	
Petroleum prospecting		50	
Total		**1,175**	

Source: *Estimated by Chinese Tuber Crops Starch Association.*

HISTORICAL REVIEW

The history of cassava breeding and varietal improvement can be traced back to the second decade of the twentieth century when cassava varieties were collected, evaluated and the roots analyzed for nutritive value at the Guangdong Agriculture and Sericulture Experimental Farm. Later, these activities were continued by Li You Kai of Xinxing farm in Liuzhou city of Guangxi province. This laid a very good foundation for subsequent

cassava breeding research, but it was discontinued during the civil war of 1945-1949. In the early 1950s, cassava varietal improvement research was reinitiated, first in Guangdong province and then in Hainan (a that time a district of Guangdong) and in Guangxi provinces. But systematic and intensive research on cassava cultivation was not conducted until 1959 when the South China Academy of Tropical Crops (SCATC) was founded on Hainan island. Cross breeding began in 1980, and the first variety named "SC6068", selected from hybrid seed of local cassava varieties was released. After that, several agricultural research institutes established their own cassava breeding programs and started the cooperation with CIAT, as well as with other national cassava breeding programs.

PRESENT SITUATION AND PROGRESS

Before the 1990s, the cassava processing industry developed only slowly in China. Cassava research on breeding was not considered of any importance, but only in SCATC a reasonable amount of human and financial resources were spent on cassava research, with limited support from the central government. As such, little progress was made, and average national cassava yields remained low at about 10 t/ha. In the late 1980s and the early 1990s, many new cassava-based products were developed successfully and their utility was recognized by people, which resulted in a great increase in cassava processing output, and the supply of raw material of cassava roots fell short of demand. Being a big country, with a large domestic market, China soon became an importer of cassava. From then on, people became interested in cassava and governments at various levels started to recognize the importance of cassava breeding and the extending of new varieties with high yield and high starch content. As they realized the benefits they received from the cassava processing industry, government funds started to be used for cassava breeding programs and farmers started to increase their input in growing cassava. Many starch factories became very active and initiated their cooperation with the government and research institutes to extend the promising cassava varieties as well as advanced cultivation practices. New cassava varieties with high yield and high starch content were warmly welcomed in the countryside.

During the 1990s, several research institutes, such as CATAS, UCRI and GSCRI, established their own cassava breeding programs. However, at present only CATAS and GSCRI are spending human and financial resources to continue this program because in the agricultural economic development cassava has become relatively important only in Hainan and Guangxi provinces. The Guangdong Academy of Agricultural Science used to be a key cassava breeding center, but since the cassava growing area in the province decreased year by year, they closed the program by the end of the 1990s. Because cassava flowers only in Hainan, we can make crosses and produce hybrid seeds only in that province. Thus, this type of activities is mainly conducted at CATAS, while GSCRI can bring their promising clones (varieties) to CATAS to be used as cross parents to make crosses there in cooperation with CATAS. Presently, the two principal cassava programs in China are capable of annually producing more than 3,000 hybrid seeds from 80-100 cross combinations.

In close cooperation with CIAT and other national cassava breeding programs, from the early 1980s the South China Academy of Botany in Guangzhou, CATAS and GSCRI made considerable progress in cassava varietal improvement. Every year, several

thousand cassava hybrid seeds from CIAT/Colombia and the Thai-CIAT program, as well as promising clones in the form of tissue culture were introduced into China. At present, from these hybrid seed recourses from CIAT, three breeding lines were selected and released under the names of "GR891", "GR911" and "SC6" in 1997, 1998 and 2001, respectively. Four other varieties were selected from locally produced hybrid seeds and released under the names of SC124, SC8002, SC8013, and SC5 during 1990-2000 (**Table 3**). In 1981, CIAT sent seven promising cassava varieties in tissue culture to Dr. Guo Jun Yan of the South China Academy of Botany; one of these, CM321-188 was later released as "Nanzhi 188". This variety spread quickly, first in Guangdong province, then to Guangxi and Yunnan provinces from the mid-1980s to the mid-1990s. With this variety, farmers can obtain good yields in fertile soils, but usually get low yields in poor soils. Moreover, the cold-tolerance of this variety during stake storage in winter is rather poor, so finally the variety was rejected by farmers. However, another variety introduced by tissue culture from CIAT/Colombia, MPan 19, has only recently been released as "Nanzhi 199" and is now grown on a large scale. This variety seems to be not only high-yielding but also has a high starch content in the root, and is well-adapted to conditions in Guangxi province. The above-mentioned varieties have been widely tested in regional trials (**Table 4**) and are now being extended to the cassava growing areas in Guangxi, Guangdong, Hainan and Yunnan provinces. They will play a very important role in the development of the cassava industry in China, while at the same time increasing farmers' income from planting cassava. In 2002, the area of these varieties is estimated at about 30,000 ha (**Table 5**), accounting for 8% of the total cassava area in the country. Following this trend the total area of these new varieties will probably reach 50,000 ha next year. Materials from CIAT/Colombia or the Thai-CIAT program have not only played an important role in cassava breeding but are also a useful genetic resource in China. Now, a cassava germplasm bank has been established at CATAS with presently more than 120 accessions, and at GSCRI with more than 40 accessions.

Table 3. Origin and principal characteristics of released varieties in China.

Variety	Parents	Year released	Origin	Principal characteristics
SC6068	SC201	1980	Local seed	high starch content
SC124	SC205	1990	Local seed	high yield, low starch content
Nanzhi 188	=CM321-188	1992	CIAT/Colombia tissue culture	high yield, low starch content, poor cold tolerance
SC8002	SC124×SC205	1994	Local cross	high yield
SC8013	SC124×SC205	1995	Local cross	high starch content
GR891	MCol 2215	1997	CIAT/Colombia seed	high yield, high starch content, early harvestability
GR911	MBra 35×CM523-7	1998	CIAT/Colombia seed	high yield
Nanzhi 199	=MPan 19	1999	CIAT/Colombia tissue culture	high yield, high starch content, good cold tolerance
SC5	ZM 8625xSC8013	2000	local cross	high yield, high starch content
SC6	OMR33-10-4	2001	Thai-CIAT seed	high starch content, typhoon resistance, good germination

Table 4. Root yield and starch content of 12 cassava varieties evaluated in China in 2002[1)].

Variety	Evaluated area (ha)	Yield (t/ha)	Starch content (%)
SC124	2	30.0	24.5
SC8002	few	27.8	27.0
SC8013	few	25.3	28.9
GR891	2	26.5	30.9
GR911	15	33.0	26.4
Nanzhi-199	4	28.9	28.7
SC5	4	33.0	28.5
SC6	few	25.2	28.5
KU50	very few	32.0	28.5
Rayong 72	very few	33.4	28.9
SC201 (local check)		24.5	27.0
SC205 (local check)		29.0	28.5

[1)]Average of five regional trials conducted in Guangxi, Hainan and Yunnan provinces.

Table 5. Estimated areas planted with new cassava varieties in China in 2002.

Variety	Estimated planted area (ha)	
SC124	2,000	mainly in Guangxi, Yunnan and Fujian provinces
Nanzhi-188	100	mainly in Fujian province
SC8002	8,000	mainly in Guangdong province
SC8013	2,000	mainly in coastal areas of Guangdong province
GR891	400	mainly in Guangxi province
GR911	8,000	mainly in Guangxi province
Nanzhi-199	4,000	mainly in Guangxi province
SC5	4,000	mainly in Hainan province
SC6	200	mainly in Hainan province
Others	1,000	
Total	**29,700**	

Cassava Varietal Release

Since the economic value of cassava is still low, and the crop is planted in relatively small areas as compared to other crops, the extending of high-yield or high-starch varieties still meets many difficulties. But, contrary to the factories' requirements, farmers are more interested in high yield than in high starch content varieties. This is due to a lack of communication between farmers and processing factories, and due to the fact that factories do not pay a differencial price for cassava roots according to their starch content. But, in areas where the cassava processing industry is well developed, it is much easier to extend new cassava varieties, and there are many "big farmers" in such areas.

Cassava release of new varieties in China is still mainly through traditional channels, which means the need for the local governments to join in. We have different levels of agricultural extension stations at the provincial, district, county, and town levels. Their main job is to disseminate new technologies and information from the research institutes to

the farmers by the introduction of materials or posters or through wall newspapers. They have some special extension activities, sometimes held in villages (we call it "technologies service in countryside") and sometimes held in town-centers during the market days (once every three days). During the 1990s, the economic situation of China has changed a lot. Many farmers benefited by adopting new technologies, and once they realized how important a role the new technologies are playing in their farming enterprise, some of these farmers buy new agricultural technologies directly from the agricultural institutes. The characteristics of this kind of farmers are: 1. works very hard and is smart; 2. farms at a large scale; 3. they do mostly before the others do, and obtain benefits. These are the ones we now call "big farmers" even though in the past they were also small farmers. Although they are few, these "big farmers" are playing a very important role in the course of rural economic development, and they also play a positive role in extending modern agricultural technologies in rural areas.

The great economic achievement of China is not only due to the reform of the economic system, but also from the reform of the management system. In the past, the only function of the institute was research, and again research, while people did not need to pay attention to other things. It had no influence on your future development whether you made progress or not in your research, and oftentimes many of the results obtained at the research institutes were laid aside and neglected. Now it is very different. The government's policy encourages research institutes to join in the development of "new markets", so most research institutes are now also doing extension work based on the results of their research on the one hand, and to speed up the transfer of technologies to increase productivity and to promote the development of the local agricultural economy. On the other hand, the institutes or the researchers themselves can benefit from their own activities. CATAS and GSCRI have greatly benefited from the expansion of their new cassava varieties.

In the southern part of China, cassava, like sugarcane, is a very important raw material for the processing industry. The difference is that due to government intervention, sugarcane was developed very fast and is now in a situation of over-production. The opposite is true for cassava. Every year there are not enough cassava roots to be used as raw material for the starch processing factories. In the past, the owners of cassava starch factories (private or state) paid very little attention to the development of cassava cultivation. There were many reasons for this; for instance, they could always get some benefit from their processing, while the market demand for cassava starch was small and they could not have predicted that it would develop so fast during the 1990s. Presently, most owners of starch factories (private and state), especially the bigger factories, are recognizing the importance of raw materials' supply. They start to support cassava cultivation by signing buying contracts with farmers and by introducing new cassava varieties with high yield or high starch content to farmers. Although this practice has not yet produced such good results, it seems to be an effective way and which could be further improved to be more satisfactory.

The above description indicates that in China there are presently four channels for the release of cassava varieties, the first one is a traditional government channel, i.e. the transfer of technology to the extension station of the Agricultural Bureau or the Bureau of Science and Technology; the second one is by recommendation of the agricultural research institutes (with pictures and varietal character descriptions) through the Bureau of Science and Technology at the county and city level; the third one is by cassava processing factories

(in cooperation with the institute) to disseminate new technologies of cassava to farmers and then help farmers to cultivate cassava; the fourth one is to conduct demonstration trials with big farmers, who then contribute their experiences to others in the area.

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