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Cassava Biotechnology Network

Cassava in China in an Era of Change

A CBN Case Study with Farmers and Processors

Guy Henry
and
Reinhardt Howeler

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14 JAN 1997

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International Center for Tropical Agriculture

WORKING DOCUMENT
No. 155

Cassava Biotechnolgy Network

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Cover Photos:

Top: Cassava processing in Southern China

Bottom: Farmer participatory research in Southern China

All photos: Guy Henry (CIAT), July-August, 1994

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International Center for Tropical Agriculture
Apartado Aéreo 6713
Cali, Colombia

CIAT Working Document No. 155
Press run: 100
Printed in Colombia
June 1996

Correct citation: Henry, G.; Howeler, R. 1996. Cassava in China in an era of change. A CBN case study with farmers and processors. 31 July to 20 August, 1994. – Cali Colombia : Centro Internacional de Agricultura Tropical, 1996. 68 p. – (Working Document ; no. 155)

Cassava in China in An Era of Change

A CBN Case Study with farmers and processors in Guangdong, Guangxi and Hainan Provinces of Southern China

By: Guy Henry and Reinhardt Howeler

July 31 - August 20, 1994

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Funding Support:
CIAT, Cassava Program
Nippon Foundation, Japan
Special Project for Biotechnology and Development Cooperation, DGIS, The Netherlands

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INTRODUCTION

Since the late 1980's the Peoples Republic of China (further referred to as China) has been undergoing very significant political, economic and social changes. To a large extent this also has had implications on its cassava sector. In general, the cassava sector has slowly evolved from a semi-subsistence tradition to a market orientation. Especially the cassava starch processing industry is gaining significant importance.

In general, information on the cassava sector has been scarce. The little information that is available, mostly is in Chinese. A first holistic analysis of the cassava sector was annotated by Stone (1987). However, most data in the report was up to 1984-85. Given the lack of recent information and given the dynamics of the cassava sector during the 90's, Chinese scientists have expressed their interest in seeking collaboration in the collection and analysis of current cassava sector information.

During the First Chinese Cassava Workshop in Hainan, 1992, a Strategic Cassava Research Planning Exercise was proposed, discussed and agreed to (Henry, 1992). As a first activity, a Rapid Rural Appraisal (RRA) of the cassava sector was proposed. This and additional information was to serve as the basis to develop a cassava research agenda for a consortium of research institutes and universities involved in cassava research activities in South China. The RRA was an opportunity for CBN to get further involved in a client oriented research priority setting.

The general objective

To conduct a Rapid Rural Appraisal (RRA) with farmers and processors in the three major cassava growing provinces of China, in order to gain a better understanding of cassava production and utilization in the country and to analyze the major constraints and opportunities from the farmers and processors perspective.

Specific objectives:

(1) To obtain a first impression of the principal characteristics of the cassava sector in the main cassava growing & processing areas.

(2) To identify & prioritize the main limitations and opportunities of the sector.

(3) To identify specific areas and/or themes that will require additional formal in-depth analyses.

(4) To field-test and fine-tune a cassava RRA-methodology developed by NRI/CIAT, which was first tested in Tanzania. Once validated, the methodology can be formalized as a manual to serve national programs.

(5) To maximize the value of information collected and analyzed, while minimizing its costs in terms of expenses and human resources time.

METHODOLOGY

The RRA may be a catch-all for an information collection system and analysis that can vary significantly in length of time, intensity and detail. Some people consider talking to farmers and officials on a field trip an RRA. Others view that for certain objectives and conditions, living with a multidisciplinary team in a rural village for a week and interacting in most village activities is a necessity for a proper RRA. In the end one could argue that the type of RRA is entirely dependant on the objectives and the conditions.

It is the authors' opinion that the value of the information sought, is directly correlated to the resources invested to collect and analyze the information. It has been the challenge of the team to develop an efficient and effective method to gather information of high quality in a short time with a limited budget.

The resources constraints that guided the China RRA included (1) in-country total budget: US$10,000, (2) in-country time availability: 3.5 weeks, (3) minimum amount of time for training of Chinese nationals in RRA techniques, (4) team leaders, an agronomist and an economist who do not speak Chinese (mandarin), (5) each provincial team could rely on only 1-2 national participants with varying levels of English speaking capability.

Given the aforementioned, the method utilized for the 1994 Chinese cassava RRA included the following elements:

Stratification and Sampling Frame:

Prestratification of the area of interest aimed to reduce the number of visits to farms, villages, processing sites, etc. (sample size). While maintaining the representativeness of the sample. It also served as an ex-post basis for analysis.

Methodological inputs for the China RRA were: (1) the RRA case study in Tanzania with CBN in 1993; (2) a 2-day brainstorming of economists Guy Henry and John Cropley at NRI in July 1994; and (3) the Sasakawa Project FPR Workshop in Rayong, at the end of July 1994, which included RRA methods and practical training. A resulting RRA document served as the basic guideline for the China RRA. This was sent to our Chinese collaborators before the trip.

Theoretically, the selection of counties and villages to be visited was based on (a) the importance of cassava in the area; and (b) the representativeness of the production and/or processing system. Based on secondary information a pre-stratification was attempted. This boiled down to (i) lowland vs. highland areas; (b) near vs. far away from processing factories. For Hainan island an additional stratification included collective/state farm vs. "private" farm production. As such, a map prepared by CIAT showing cassava area distribution and processing sites was overlayed with soil types, elevation, rivers, roads and urban areas. This gave the team a first guide to sampling. These theoretical criteria were supplemented by practical constraints such as time, available funds, accessibility, etc.

Team make-up:

Depending on the specific objectives and themes of interest, theoretically the RRA team is made up of persons with different disciplinary backgrounds knowledgeable about the theme of interest, cassava, and with a good understanding of local conditions. As such, for the 1994 China RRA it was attempted to include in the teams: agronomy/production, processing, socio-economics as a minimum set of disciplinary requirements. This minimum team was then supplemented by extensionists with a good understanding of local conditions, traditions and languages. The latter served as the principal means to connect and integrate with audiences of interest. In addition, the team was supplemented by government officials, researchers and key informants.

Check list:

While most RRA guidelines suggest the use of a non-structured checklist, it was suggested that for this RRA some more structure for a checklist would be more efficient and effective. To a large extent the argument took into account the inexperience of most team members with RRA procedures. Hence, two 1-page checklists were developed. One for cassava producers and one for cassava processors. The basic feature of the checklists is that it starts very general and ends very specifically. It seemed to give good guidance and support to team members during interviews.

An important element of the checklist and subsequent interview was the discussion around the topic of "cassava problems" and the ranking of these. This topic attempted to capture the "user needs" that subsequently could be used, supplemented and validated by expert opinion, for the development of cassava research needs. The ranking of the most important problems was elucidated with the help of a white board whereby the farmers/processors were asked to put weights (of importance) on each problem. Sometimes this was done by assigning a maximum number of points (pebbles, seeds, coins, etc.) that could then be divided among the problems. At times this turned out to be a lengthy but very useful experience. A question that brought about a very useful discussion leading up to cassava problems was "why do you grow cassava?".

Program and Collaborators

In Guangdong the team was accompanied by Mr. Fang Baiping and Mr. Fu Guo Hui of UCRI, Mr. Xie Peijin (economist) of the South China Agric. Univ., Mr. Yin Shunyi (cassava processing specialist) of the Guangdong Food Industry Office, and Mr. Chen Ke Qiang of the Nanning Chem. Industrial Group Corp. The team traveled about 900 km. In Guangxi we were accompanied by Mr. Tian Yinong of GSCRI, Mr. Chen Ke Qiang, and Mr. Liu Yijun (senior economist) of the Guangxi State Farm Bureau. We traveled about 1600 km. In Hainan we traveled with Mr. Lin Xiong (cassava breeder), Mr. Zhang Weite (agronomist), Mr. Li Kaimian (breeder/agronomist) of SCATC and Mrs. Guo Jian Chun (economist) of the South China College of Trop. Agric. We traveled about 750 km.

Itinerary (see Figure 1)

Sunday,	July 31:	Bangkok-Hongkong-Guangzhou
	Aug 1:	Training session with RRA participants at UCRI; by car to Zhaoqing city, capital of Zhaoqing District
	Aug 2:	Visit MSG factory (1) in the city, by car to Guangning county, visiting the Guangning Glucose Factory (2) in Chunchui town along the way
	Aug 3:	Visit Shetian village (3) to talk to cassava farmers; by car to Huaiji county
	Aug 4:	Visit Fungta village (4) of Qiaotou town to talk to farmers; visit Huaiji Sorbitol Factory (5) in Huaiji city
	Aug 5:	Visit Shiyu village (6) to see a regional varietal trial and talk to farmers; return to Guangzhou
	Aug 6:	Data presentation and discussion at UCRI; evening flight to Nanning
Sunday,	Aug 7:	Training session with RRA participants; visit field experiments at GSCRI
	Aug 8:	Visit Yinle village (7) in Wuming county to talk to farmers; visit Luo Xun Starch Factory (8) in Wuming county; return to Nanning
	Aug 9:	Visit Mingyang Cathy Starch and Chem. Products Comp. (9) in Yongning county; by car to Guiping county

Aug 10: Visit small-scale private starch factory (10) and talk to farmers in Fuping village (11) of Guiping county; continue east to Tengcheng town of Teng county; talk to farmers in Jinji village (12); continue on to Wuzhou City

Aug 11: Visit the Wuzhou Starch-Alcohol-MSG Factory (13); continue to Chenxi county and talk to farmers in Xilan village(14); continue south to Yulin City

Aug 12: Talk to farmers in Sidi village (15) in Yulin City; continue south to Beihai City

Aug 13: Data presentation and discussion; by night ferry to Haikou

Sunday, Aug 14: Training session with RRA participants at SCATC; visit field experiments

Aug 15: Visit Bayi State Farm, Tongshan Branch, in Danxian county and talk to farmers of Production Team #2 (16); continue to Shifeng town in Baisha county

Aug 16: Visit private starch factory near Shifeng (17); talk to farmers in Shifeng Production Team #1 (18); talk to farmers in Hongba village (19); continue to the capital of Baisha county and from there across the mountains to Tongzha city

Aug 17: Talk to farmers in Maolu village (20) of Maoyang town, and visit Maoyang Starch Factory (21); talk to farmers in Zhatong village (22) of Maoqui town; continue north to Qiongzhong

Aug 18: Talk to farmers in Fongju village (23) of Hongdao town; see regional varietal trial; talk to farmers in Xinchi village (24) and visit Qiongzhong Starch Factory (25)

Aug 19: Visit Long Tang town of Dingan county and talk to farmers of various surrounding villages (26); see variety multiplication plot; continue north to Haikou

Aug 20: Data presentation and discussion; evening flight to Hongkong

Sunday, Aug 21: Hongkong-Bangkok

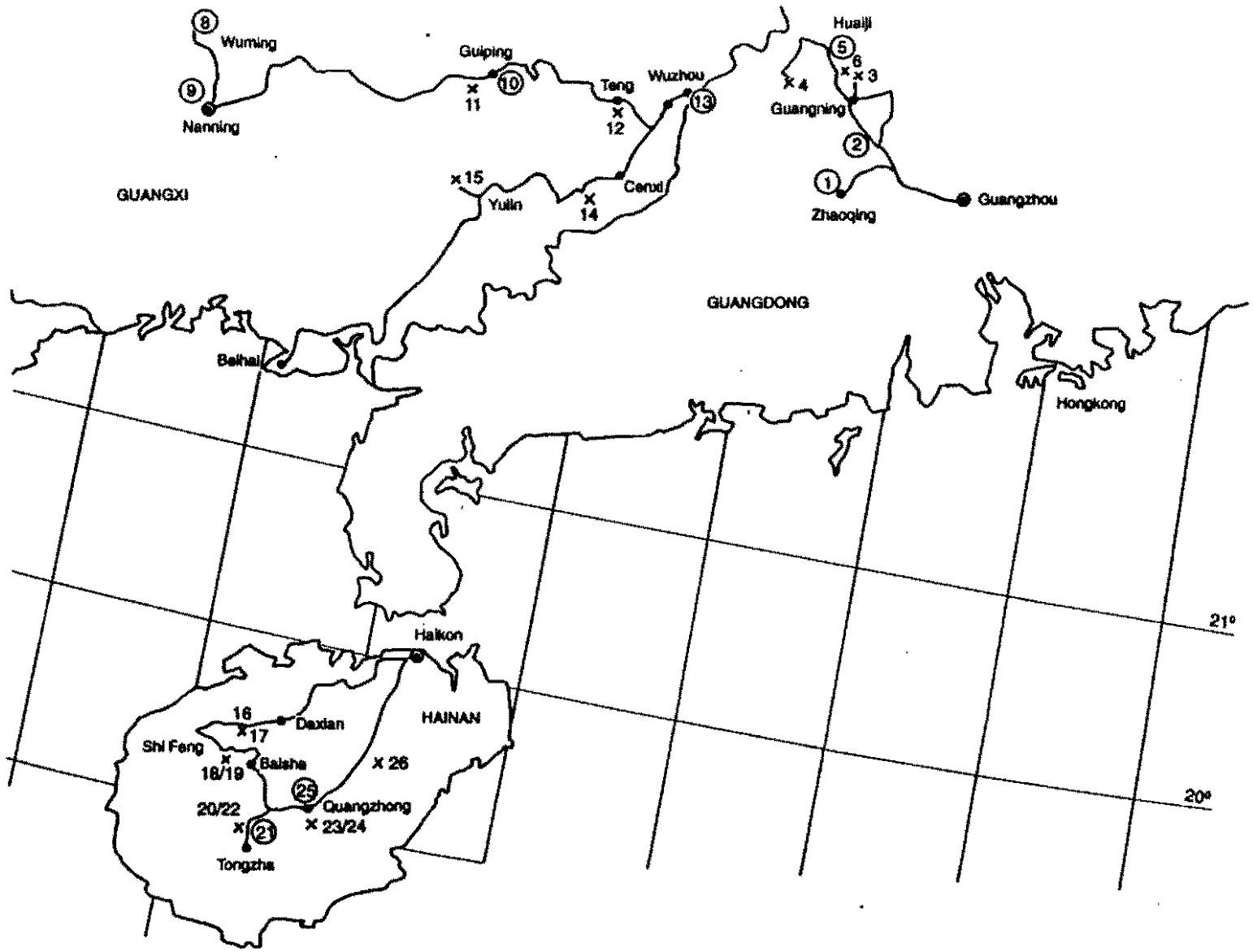

Figure 1. Route taken during Rapid Rural Appraisal in cassava growing areas of China, Aug 1-20, 1994. Numbers on map refer to villages or processing factories visited.

GENERAL OBSERVATIONS AND INSTITUTIONAL ASPECTS

In most districts or counties we first contacted the local government officials, mainly from the Agric. Bureau or the Agric. Committee, while in Guangxi they often belonged to the Science and Technology Committee. The Agric. Bureau is one of seven Bureaux under the Agric. Committee, and is organized at the provincial, district (or city), county and town level. The Agric. Committee is part of the city government. It plans agricultural activities, advises the local government and carries out government policies and strategies through extension. The Agric. Committee allocates land to each farm family: in Guangdong and Guangxi land is allocated according to the total number of members in the family, while in Hainan according to the number of labor force (about 18-60 years old) in the family. These land allocations are adjusted every 3-5 years. Farmers do not own the land, but can use the land permanently for 15-30 years; land can not be sold.

In most provinces, land with a slope of more than 45% is communal land and can not be cropped. The District Management Committee manages this land and makes farmers "volunteer" to plant trees. In some areas farmers are allowed to plant crops like cassava between the trees during the first 2-3 years. The District Management Committee decides where to plant and where to cut. Trees are usually cut after 20 years and farmers who planted the trees may get part of the wood for house building etc. China is one of the few Asian countries with an effective reforestation program with 58 million hectares to be replanted by the end of the century. Most mountains and hills in the three southern provinces are now covered with dense forests of pine, eucalyptus or medicinal trees, while the ground is covered with ferns, providing excellent protection against erosion. In Hainan, however, the law is less strictly enforced and farmers often extend their "legally" assigned land with "illegal" land by opening up steep land and planting cassava or sugarcane.

The district or county officials usually provided us with secondary data about climate, soils, landscape etc. and the production of the major crops. We also discussed the problems of cassava production, processing and marketing as well as future opportunities. Much of this information is summarized in Tables 5, 16 and 27. After talking with government officials, often over lunch or dinner, we were usually taken to a cassava growing village by local extension agents. Sometimes farmers had been asked to talk to us beforehand and they were waiting for us. In other cases we arrived unannounced and farmers had to be asked to join the discussion, often reluctantly, but after a while participating with great enthusiasm, often with heated discussions among themselves. The economist team member would usually discuss socio-economic issues and processing as well as problems and opportunities with one group of farmers, while the agronomist would discuss varieties and cultural practices with another. All questions and answers had to be translated from English to Chinese and vice-versa by one of our Chinese colleagues, and sometimes by a third person from Chinese into the local language; the latter was very cumbersome. While we tried as much as possible to interview "average" farmers, these would sometimes not be able to answer the questions or they would disagree among each other resulting in long and noisy debates in Chinese. Questioning village leaders would be much quicker and result in more reliable,

if somewhat biased, answers. This would be a bit of a trade-of. Most discussions were held in a farmer's house or in the courtyard in front of the house. Each session lasted about one and a half to two hours.

While it was sometimes difficult to persuade government officials to let us talk directly to farmers, or to ask them not to interject their opinions into the discussion, they could usually see the value in the proceedings. Talking to farmers rather than government officials is not the traditional "Chinese" way of doing things and sometimes caused some misunderstanding. Similarly, local officials usually wanted to show off the "model" farmers they had been working with for many years, or the biggest processing plants in the region, while we wanted to see both the good and the bad, the big and the small, in order to get a representative picture of the real situation.

RESULTS

Table 1 shows the cassava area, yield and production in the three major cassava producing provinces of China, i.e. Guangdong, Guangxi and Hainan, from 1954 to 1993. During that period the cassava area quadrupled, while total production increased about ten fold as a result of a marked increase in yield. In 1991 the total cassava area was 413 thousand hectares with an average yield of 10.81 t/ha. Guangxi and Guangdong accounted for 54 and 42% of the cassava area, and 44 and 49% of total production, respectively. Figure 2 shows the approximate distribution of cassava growing areas in China. In 1991 cassava yields were about equal (12-13 t/ha) in Guangdong and Hainan, while Guangxi had a lower yield of only about 9 t/ha. However, yields have increased recently in Guangxi, reaching 11.3 t/ha in 1993, and this province is now probably the greatest producer of cassava in China.

Guangdong

Tables 2 and 3 show data for the cassava area, production and yield in districts (or cities) and counties during the past two decades. Complete county-level data are available only for 1980 (Table 3), while we managed to uncover recent county level data only for Zhaoqing district (Table 4). This data does not seem to be available in a central location, but is only available in each district office. Since we visited only Zhaoqing District, which is the largest cassava growing district in Guangdong, accounting for about 25% of production, we have only recent data for that district.

Production aspects:

Table 1 shows that between 1954 and 1990 the cassava area in Guangdong increased about four times, reaching a peak of 187,000 ha in 1988, after which it decreased slightly to 173,000 ha in 1991. During the same period, yields increased from 3-4 t/ha to 12.7 t/ha in 1991. Figures 3 and 4 show the districts and counties in Guangdong and Figure 5 the

approximate distribution of cassava in the province. Cassava production is concentrated in the mountainous area bordering Guangxi and especially in the north and south of Zhaoqing district. Table 4 shows that in Zhaoqing district the cassava area decreased since 1980 in 8 out of 10 counties, but total production increased 81% due to a more than doubling of yields during the past decade. Table 5 and 6 show the relative importance of cassava and the main cropping systems. Increased yields, as shown in Table 4 are mainly due to the liberalization of agriculture since 1981, resulting in more intensive production, better varieties (mainly SC205 or SC201), higher plant populations and more fertilizer use (Tables 7 and 8). Although varieties have not changed much since the introduction of SC201 in the early 70s and SC205 in the early 80s, yields keep continuously increasing due to more widespread fertilizer use. The two counties we visited, Guangning and Huaiji, are the two most important cassava growing counties in Zhaoqing district and probably in Guangdong province, but the yields are the lowest in the district. In these mountainous and rather isolated areas, cassava is generally intercropped with young trees for 2-3 years. Since the land can not be permanently cropped, most farmers apply little manure or fertilizers; this, in addition to competition from the growing trees, result in low yields in the second and third year. In the flatter areas (such as Fungta village of Huaiji) or in the lower hills, cassava is usually grown on terraces and intercropped with maize, peanuts or cocoyam.

On the steeper slopes, land preparation is done by hoe, while on the flatter areas it is usually done by oxen or water buffalo (Table 7). During the 3-4 months of winter, with up to 50 days of frost, cassava stems are buried horizontally in 50-100 cm deep trenches, covered with rice straw and about 20 cm of soil. In late March the stored stems are uncovered, the dehydrated ends are discarded and the rest of the stems are cut into 10-20 cm stakes, which are planted horizontally at about 10 cm depth or inserted at a slight angle. In some years up to 50% of the stored stems are damaged due to frost, dehydration or termites.

When cassava is intercropped with food crops such as maize, peanuts or cocoyam, farm yard manure (FYM) and fertilizes are applied to the intercrops but will also benefit cassava. Sometimes cassava is also fertilized separately after the intercrops are harvested, usually with urea, calcium cyanamide (22% N) or single superphosphate (SSP, 18% P_2O_5). In Fungta village in Huaiji county where cassava is grown on flat, limestone derived soils and intercropped with maize, peanut, sweet potato and cocoyam, all crops are rather heavily fertilized, including with a 15-15-15 compound fertilizer imported from Norway. At 1-2 months after planting (MAP) and again at 4-5 MAP the fields are weeded with a hoe.

Cassava is harvested in Nov-Dec or little-by-little until Feb. Roots are pulled up and the outer peel and soil is removed by scraping with a bamboo stick or by rubbing the roots with the foot in a rough bamboo basket. Peeled roots are sliced by hand or by a knife mounted on a board, either in the field (if far away) or at the house. Chips are spread out to dry for about four days.

Utilization and benefits/costs:

In the two counties visited, about 60-70% of the cassava is sold to traders or local starch factories, mainly in the form of dry chips (Table 9). The remaining 30-40% is chipped and dried for on-farm use, mainly to feed pigs and chickens. In all locations visited, people commented that there exist a definite upward trend towards off-farm sales. Farmers explained that this is due to (a) need for cash; (b) existence of better demand for chips; and (c) for human consumption, rice is now more available and is preferred over cassava. There was some official's information relating that in the more remote areas, on-farm consumption was still very high due to the absence (distance) of processing factories. Due to the concentrated harvesting period in Nov-Dec, after the second rice harvest, cassava processors can buy fresh roots only during a short period of time (2-4 weeks), after which they process only dry chips. The fresh root price is about Y 220/ton ($26.-), while the dry chip price is Y 560 - 880/ton ($66-105). Chips must have at least 77% starch. Compared to the price of rice five years ago and now, cassava roots/chips have become relatively cheaper.

Labor requirements for cassava production range from 12-14 mdays/mu or 180-210 mdays/ha. Weeding, harvesting and chipping/drying are most labor intensive. Estimated gross income (labor not included) amounts to no more than Y 200-250/mu (US$ 375-568/ha). Virtually all labor is supplied by the farm family. Labor opportunity cost, especially near urban centers is Y 4,000/year (US$ 500). In many of the latter areas, most cassava activities are the responsibility of women and children. Male adult labor is available only for land preparation and harvesting. The marketing margin, depending on the distance, can be between Y180-300/ton.

Cassava starch processing:

In the starch-factory the chips are ground in a hammer mill, then soaked for 4-5 days to exclude HCN and protein and to cause a slight fermentation. The starch water is filtered and then sedimented in sedimentation channels. The wet starch is either dried to produce raw starch, or is further processed into glucose and possibly sorbitol. The solid waste is sometimes used for the production of alcohol. Liquid waste is dumped in the nearest river. Some report has it that this affluent is not toxic, because alternatively it could directly be used for carp production in fish ponds (?).

The major cassava processing factories in Guangdong are listed in Table 10 and their location is shown in Figure 3. In Zhaoqing district there are five cassava starch mills, of which three are more than 20 years old, and two are new factories. There is also a large MSG factory in Zhaoqing city, a glucose factory in Guangning and a brand-new sorbitol factory in Huaiji (Table 11). The total capacity for starch production is 100,000 t starch/year, but only 35,000 t is produced due to lack of raw materials. Competition between starch factories for raw materials has resulted in an increase in price from about Y 500/ton to Y 640 or even Y 800/ton. Dry chips (Y 1,200/t) or cassava starch (Y 2,100/t) are also brought in from Guangxi, since all five starch factories in Zhoaqing can not supply the 54,000 t dry

starch/year needed for the MSG factory alone The latter also supplements its starch requirement with corn starch imported from northern China, in times of cassava under supply. The glucose and sorbitol factories require an additional 15,000 and 20,000 t dry chips per year, respectively, out of a total production of 184,000 t dry chips in Zhaoqing district. These three factories combined require about 133,000 t dry chips/year or 72% of total production.

Discussions with officials on cassava problems mostly center on the crop's low profitability. Also, low labor availability is mentioned. It was also reported that small-scale family-run processing units were disappearing due to lack of technology and low product quality.

Constraints and opportunities:

Thus, in Guangdong the cassava area has remained stable or is slightly decreasing, while total production is steadily increasing due to a marked increase in yield. Farmers complain about the low profits of planting cassava, but continue to plant the crop because of few other alternatives, it is easy to grow and does not require much additional labor and very little inputs. Table 12 shows, however, that high labor requirements is the major constraint of cassava growing. In addition, the low chip price and chipping/drying activities are high priority problems.

Cassava provides a rapid return on labor, either through the direct sale of chips or through pigs. Due to competition for raw material among cassava processors, the price of chips is increasing, making the crop more attractive to farmers. The very aggressive reforestation program in Guangdong provides poor farmers, having only small land holdings, with an opportunity to plant cassava between the young trees, thus augmenting their income. If these plots are far from the home, the transport of fresh roots is cumbersome and roots are peeled, chipped and dried in the field before transport to the house. A portable chipping machine, made mainly from bicycle parts, could be developed (or transferred and adapted from other regions) to reduce the labor requirement for chipping and produce thinner chips that dry more quickly. Higher yielding varieties with high starch content, resistant to lodging and with short compact roots to facilitate harvesting, are required to increase yields and income. The availability of more appropriate and cheaper, locally-made fertilizers, as well as a better understanding of the nutrient requirements of the crop, would increase fertilizer efficiency and usage and thus increase yields and profitability. Although the land forms are highly unstable, resulting in massive land slides and high sediment loads in the rivers, the erosion losses as a result of agriculture do not seem to be very serious as steep slopes are not intensively cropped and are well-protected with trees and a dense undergrowth.

Guangxi

Table 13 shows the cassava area, production and yield in the various districts/cities of Guangxi in 1989 to 1993, while Table 14 shows the same data on a county level for 1992 and 1993. The cassava area increased in 9 out of 13 districts and increased about 4% for

the whole province since 1989. During the same four year period total production increased 45% due to a 39% increase in yield, from 8.13 t/ha in 1989 to 11.29 t/ha in 1993. This marked yield increase is probably due to intensification of production, higher fertilizer use, better weed control etc. in response to the increasing cassava price sparked by the rapidly expanding processing industry.

Figures 6 and 7 show the districts and counties in Guangxi while Figure 6 also shows the location of the major cassava starch factories. Figure 8 shows the distribution of cassava growing areas in the province. Cassava is produced throughout the province, but especially in the southeastern section bordering the main cassava growing area of Guangdong province. The main cassava producing areas are in Wuzhou and Yulin districts along the eastern border of the province. Total production in Wuzhou district increased nearly 50% since 1989; in Beihai City it tripled during the same period.

Production aspects:

Yields tend to be rather low in the colder and mountainous regions of northern Guangxi, such as in Guilin, Liuzhou and Hechi districts, but reach as high as 27 t/ha in the more fertile flat areas in the southern tip around Beihai City. The reason for these very high yields is not yet clear, as we did not have time to talk to farmers in this area.

Table 15 shows that in Guangxi province cassava is the fourth most important crop in terms of area, following rice, maize, and sugarcane. In Chenxi county the cassava area surpassed that of all other crops (Table 16). In the five counties we visited, cassava was generally grown on gentle slopes of 5-10% or on terraces made on the lower part of steep slopes, above the paddy fields, sweet potato and sugarcane, but below the fruit trees and pine trees grown on the higher and steeper slopes (Table 17). In Sidi village of Yulin city, cassava was grown on fairly steep slopes without terracing, but it was planted on contour ridges, with peanuts planted on either side of the ridge. In Teng county more than 50% of cassava is grown in the mountains, but we did not see any of this as the northern part of the county was inaccessible due to recent flooding. In the capital city of that county we were actually paddled by boat to the extension office as much of the city was up to 1 meter under water.

In most areas we visited, cassava was intercropped with peanut, maize, soybean or watermelon; the latter usually in plots near the road to facilitate transport. Cassava was often intercropped with peanut on the higher part of gentle slopes, with maize or soybean on the lower part, which was wetter and more fertile; cassava with watermelon or sugarcane in monoculture were found at the bottom of the slope. Sometimes cassava intercropped with peanut was rotated with cassava intercropped with maize. Cassava was grown in monoculture only in the mountainous areas of Teng county, in soils that are too poor or dry for other crops; in the second and third year cassava would be intercropped with trees. Table 18 shows that land preparation was done by oxen or water buffalo on gentle slopes or on terraces, except in Teng and Chenxi counties, where it was done by hand, either

because of steep slopes or because the soil was too hard for plowing. In Sidi village of Yulin city farmers plowed with oxen, but prepared contour ridges by hand.

Where cassava was intercropped with peanut or maize, these crops would usually be planted first (in March), followed by cassava once the intercrops had emerged. Farm yard manure (FYM) and chemical fertilizers, such as SSP, calcium cyanamide or urea, would often be applied to the peanut or maize, while cassava might receive some additional cyanamide, SSP or 15-15-15 compound fertilizers after the harvest of the intercrops. Cassava was always planted horizontally or at a slight angle, either in single rows of 1.0x1.0 or 1.0x0.6 m or in double rows of (1.50 + 0.60)x0.5 m. Thus, in spite of the presence of intercrops cassava was planted at very high populations of 10,000-20,000 plants/ha. Weeding was done usually twice with a hoe at 1-2 MAP and at 4-5 MAP, the latter after the harvest of the intercrops. In Fuping village of Guiping county, however, farmers were spraying a pre-emergent herbicide developed at the Agric. College in Nanning. This herbicide did not affect peanut or cassava growth and resulted in excellent weed control.

In Guangxi the most common variety is probably SC201, which is grown in the northern and central part of the province (Table 19). Where it is grown farmers like it because of its high yield and cold tolerance. However, in the eastern and southern districts the main variety is SC205, while SC201 was planted in Yulin city. The two varieties are seldom found together in the same area. Farmers planting SC205 preferred that variety because of its high yield and high starch content, while it is easy to harvest, peel and dry; they mentioned that SC201 had long thin roots which were more difficult to harvest, while having a low DM content. Many farmers had heard about SC124 but complained that buying stakes of this new variety was too expensive, while others said that it produced lower yields and was difficult to harvest. Similarly, Nanzhi 188 had been rejected because of low yield and low starch content.

Maize and peanut were usually harvested in July. Yields were reported to be quite high, ranging from 3-4 t maize/ha and 1.5-2.5 t peanut/ha. Maize was usually kept at home for pig feeding, while peanuts were used for the extraction of oil for home cooking. Part of the peanut harvest was also sold.

Utilization:

Cassava was generally harvested in Nov-Dec, but this might extend to January. Table 20 shows that in areas close to starch factories, such as in the villages visited in Wuming, Guiping and Teng counties, cassava was mostly sold to these factories, and usually as fresh roots; in Fuping village about half of the cassava was chipped and kept at home for pig feeding. In Chenxi and Yulin counties without nearby processing facilities, all cassava was chipped and dried, and depending on the price, variable amounts would be sold or kept at home for animal feeding. In Yulin both fresh root and dry chip prices were very low, but in other areas fresh roots were sold at Y 160-280/t ($19-33) and dry chips at Y 500-800/t ($60-95). In the eastern districts, bordering Zhaoqing district of Guangdong, cassava chips

would often be sold to traders for transport to Guangdong province. Except for Sidi village, most areas reported a continuing increase in off-farm cassava sales. The decision on selling fresh vs. chipped cassava depended on relative prices and cash needs. In addition, it was reported that in general, processing factories preferred fresh roots. Farmers try to play the market by selling chips during the off-season. However, this is constrained due to limited on-farm storage space and the fact that the low-quality chips will get moldy after 2 months. Supposedly, chip traders organize/rent storage facilities in villages or areas where there are significant supplies. Observed stored chips have a terrible quality. Price discounts are significant (up to 50%) for that reason.

Starch processing:

Table 21 shows the major cassava starch factories in Guangxi, their capacities and products. The largest cassava starch factory, Mingyang Cathy Starch and Chemical Products Co., located an hour south of Nanning, has just doubled its capacity from 21,000 to 50,000 t starch/year (Table 22) and is planning to double again by the end of the decade. Similarly, the Luo Xun Starch Factory near Wuming doubled its capacity this year from 10,000 to 20,000 t/year. Some of these factories not only produce raw starch but also various kinds of modified starches, MSG, potable alcohol, maltose etc., while the cassava waste is converted into animal feed. At present there are about 4-5 large processing factories and over 200 medium/small scale ones; the small ones are slowly disappearing, unable to compete with the bigger ones in terms of processing efficiency and quality. Most factories work significantly under their capacity. Months of actual processing ranges from 2-10. Fresh root to starch conversion rates are around 4:1. For chips this is 1.75-1.8 : 1.

Constraints and opportunities:

In general, cassava production in Guangxi is growing rapidly mainly due to the expansion and modernization of processing factories making starch and many starch-based products. Strong competition for raw material supply is pushing up the price of cassava, which in turn is stimulating more intensive production with increased fertilizer use, which has resulted in marked increases in yield. Production practices, such as cropping systems, varieties, planting patterns and fertilizer use are very diverse, reflecting on the one hand strong traditional influences and on the other hand adaptation to changing local economic circumstances, mainly the presence or absence of nearby processing factories. Like in Guangdong, farmers complain about low prices and profits, but still like the crop because of easy planting and low input requirements, as well as a rapid return on labor. They particularly like the flexibility in harvest time and the possibility to either sell or keep at home for animal feeding.

Only in Yulin city farmers did not really like to grow cassava because it required considerable labor (estimated at 315-375 mandays/ha) and produced little income. In this area all small-scale processing factories had gone broke because of low-quality products and inefficient processing technologies, while no new facilities had been built. Thus, chips were

sold mainly to outside traders and at a low price. Farmers continued to grow cassava because of a lack of other alternatives on poor soils. In many counties the government was paying little attention to cassava, but instead was promoting the planting of fruit trees like longan and lichee, as well as wood trees on steep slopes. In some areas farmers complained that they were not allowed to plant cassava as an intercrop between young fruit trees.

Economic data on the costs and profitability of various crops, shown in Table 23, indicate that cassava produces the lowest net profit. However, this may be misleading as cassava is seldom grown in monoculture and the combined income from cassava with the intercrops may still make it an attractive alternative to growing sugarcane or the long-term investment in fruit trees. Labor requirements range from 10-13 mdays/mu. Income from cassava, excluding (family) labor, ranged from Y 260-300/mu. It was mentioned that fattening of pigs is lucrative because over a nine month fattening period "net" gains are Y 200/pig.

Production problems centered mainly around lack of capital, and high labor requirements in weeding (esp. in Yinle village), chipping and drying (Yulin, Jinji, Sidi). A more efficient chipper could solve the latter problem. Diseases and pest problems were never observed or mentioned, but some farmers, esp. in Yinle village, had problems with rats damaging maize, peanuts and cassava roots in the ground. The higher cyanide variety SC201 may be preferred because it is probably more resistant to rat damage than SC205. Farmers problems and priorities are summarized in Table 24. The frequently mentioned problems of capital and labor seem difficult to solve, since fertilizers and herbicides require capital, which is hard to get.

Major problems cited at the factories include (1) lack of both investment and operational capital; (2) insufficient supplies of roots/chips at times; (3) high raw material price and faster increase of input than of output prices; and (4) little collaboration of the government. Also, although not cited, there may be a major problem with water pollution from factory affluents.

Hainan

Table 25 shows the cassava area, yield and production in each county or city in 1979 as well as in 1989, 1991 and 1992, while Figure 9 shows the distribution of cassava growing areas in Hainan in 1992. The cassava area increased about three fold from 1979 to 1989, reaching a peak of 29,000 ha in 1988 and declining to 19,000 ha in 1992. These data do not include cassava produced on State Farms, which accounts for 20-30 % of the total cassava area in Hainan. Yields by private farmers during the past 7-8 years have fluctuated between 10 and 14 t/ha, while those on State Farms are between 14 and 19 t/ha. Total cassava production also reached a peak in 1988 and declined to about 306,000 t in 1992; this corresponds to about 6% of total cassava production in China. The decline in cassava area and production is mainly due to the aggressive promotion of other more valuable crops like rubber and fruit trees as well as the absence of a significant expansion of cassava processing facilities. While in Guangdong and Guangxi cassava further-processing into

glucose, MSG, maltose, alcohol and sorbitol is being promoted, in Hainan the processing is still pretty well confined to production of raw starch, using rather antiquated processing facilities. Farmers reported that during the past couple of years the cassava area may have expanded again due to increasing prices and problems in the transport of competing sugarcane. In the counties visited, cassava was generally the third or fourth most important crop after rubber, rice and/or sugarcane (Table 26).

Production aspects:

In Hainan the total cropping area per family is similar or slightly larger than in Guangdong and Guangxi, except in Hongba village of Shifeng town where farmers cultivate rather large areas by planting crops also on illegal land with steep slopes. Moreover, in Hainan, most farmers also manage 0.5-1 ha of rubber trees. This means that they get up around 3:30 am, tap their trees until 7:30, go home to do house chores, and return to collect the rubber from 10 to 12 am. Thus, the cultivation of crops is limited to 4-5 hours a day, usually in the afternoon. This explains the prevalence of cassava monocropping, the less intensive management of the crop and the use of herbicides in some locations.

In Hainan cassava is grown between 18 and 20°N, without danger of frost but with occasional short-term cool temperatures of 4-7°C during the winter months in the northwestern region and the northern part of the central region; however, it does not affect cassava yield. Cassava planting is delayed to March-April in the western region due to drought, compared with Jan-March in most of the other regions.

Table 27 shows that cassava is grown mainly on gentle slopes with some production on very steep slopes (up to 100%), especially in Tonzha city. Unlike in Guangdong or Guangxi provinces, cassava in Hainan is seldom grown on terraced fields; in contrast, rubber is often planted on narrow terraces in the mountains. In Hainan cassava is generally planted as a monocrop although some intercropping with maize or peanut or with maize plus sweet potato was found. In Baisha and Tongzha counties cassava is sometimes grown between young rubber or fruit trees.

Where cassava is grown on hillsides, the land is usually prepared only by making individual planting holes of 10x20 cm with a hoe, after slashing and burning the weed or bush vegetation (Table 28). On more gentle slopes the land is prepared by buffalo or oxen, usually 1-2 plowings followed by 1-2 rakings. Ten to twenty cm long stakes are planted horizontally 6-10 cm deep in each planting hole, spaced at random at 0.6x0.6 or up to 0.8x0.8 m. Plant populations are very high. Depending on the type of previous vegetation, land clearing, soil preparation and cassava planting may take up to 15 man-days/mu (225/ha). On the Bayi State Farm and in Hongba village, farmers spray with pre-emergent and/or contact herbicides after planting, followed by one hand weeding at 2-4 MAP. In other areas weeds are controlled with a hoe or knife, while in Longtang town fields are weeded using a buffalo and plow.

In the mountainous areas of Hainan, fertilizer and/or FYM are seldom applied to cassava, or are applied only after the second crop. Farmers often reported that yields increase from the first to the second year due to the slow decomposition of the previous vegetation, but decreases in the third and subsequent years due to nutrient extraction and erosion. Thus, 2-3 crops of cassava are rotated with (fertilized) sugarcane or are returned to fallow for 1-2 years. If cassava cultivation continues beyond two years, farmers usually apply some urea, SSP or 15-15-15 fertilizers, either at planting or at 2-3 MAP.

In Hainan cassava farmers plant basically only SC205 as well as very small areas of eating-type varieties, in Chinese called "Bread varieties" (Table 29). Only in Longtang town farmers plant the sweet variety SC102 with a little bit of a local variety called Red Stem. Farmers in this area prefer SC102 over SC205 because they claim that SC102 produces higher yields, has high starch content and is typhoon resistant. In this area SC205 may not grow tall enough to produce good stakes for replanting after a typhoon, or enough stems, which are used also as fuel for cooking. In Fongju, where a regional variety trial was located, farmers seemed to like ZM8002 (released recently in Guangdong) because of its high yield and starch content. No stakes, however, were available for multiplication.

Utilization and benefits/costs:

In most areas of Hainan, cassava is harvested in Nov-Dec, but in some cases this extends to Feb or even March. In the highland area of Tongzha City, some farmers leave cassava for a second cycle, harvesting only after about 18-20 months. If a starch factory is nearby, such as in Maoyang and Maoqui towns of Tongzha and Hongdao town of Quongzhong, cassava is mainly sold as fresh roots (Table 30). But in the absence of a nearby factory, cassava is chipped and dried; in the Bayi State Farm and in Shifeng most of this is sold to traders, while in Longtang town the chips are ground to a powder in a local mill and fed mainly to own pigs or sold at the local market. Some of the chips are taken to the animal feed mill in Wenchang county. In Hainan, on the average, 80-90% of cassava is sold off-farm. In many areas, especially near urban areas or main roads, on-farm pig feeding is highly lucrative. It was estimated that a cassava-based pig-feed (mixed on-farm) is 15-25% cheaper than commercial pig feed. With the current strong economic development, especially of the larger industrialized cities, demand for pork is very strong. In China, pork is the animal protein most highly consumed.

In various areas of Hainan farmers have developed their own chipping machines. These range from a knife mounted on a board for hand slicing to produce 5 mm thick oval-shaped chips; a hand or bicycle-mounted rotating slicer, which could also be driven by a tractor; or a hand-operated chipper, which produces small stick-shaped chips. The latter is commercially available, probably for grating coconuts, but is rather slow. Hand operated chippers can be purchased in the market in several areas at Y 12-30. A more efficient hand or bicycle operated chipper would greatly reduce the time required for chipping and drying.

In Xinchi village, farmers make cassava alcohol (similar to that in Vietnam). Each family makes some 20 liters, which are consumed mainly at Spring Festival celebrations. This process involves a pottery distiller and requires about 4 kg of roots for making 1 liter of alcohol (depending on the alcohol content: 25-45%). Most probably, similar practices exist in the more remote mountain areas elsewhere (again, similar to Vietnam).

Table 30 also shows that fresh root prices paid by starch factories are similar or lower than in Guangxi and Guangdong, while dry chip prices also tend to be lower, probably due to lack of serious competition among cassava processors.

Table 31 indicates the major cassava starch and animal feed factories in Hainan, while Figure 10 shows their location. The small private starch factory in Shifeng town is modernizing its equipment and expanding its processing capacity to 2500 t starch/year (Table 32), but can operate only for 3 months of the year, Nov-Jan, due to the unavailability of fresh roots during the other months. This factory will start making contracts with farmers and pay a guaranteed price of Y140/ton. The factory is obviously making money, but farmers were complaining about low prices and price discounts. The state-run starch factories in Maoyang and Quongzhong also process mainly fresh roots, operating only from Nov to March. The latter has rather modern equipment and an installed capacity of 10,000 t starch/year, but due to lack of raw materials it produces only 3,000-4,000 t/year. The starch factory in Baisha county has a capacity to produce 3,000 t/year, but actually produces only 300 t/year. Most of these State-or County-owned starch factories use old equipment, have too much personnel, and, in general, are poorly managed, resulting in high production costs and financial losses. While all are producing below capacity due to lack of raw material, they do not seem to compete aggressively with each other to secure this raw material; this is resulting in stagnating prices and a reduction in cassava area. Hainan needs about 15,000 t starch/year, mainly for the food, candy and card board industries. Besides the large factory in Qiongzhong there are another 20 starch factories in Hainan, but with a total capacity of less than 10,000 t starch/year.

Economic data in Table 30 show that labor requirements for cassava production in Hainan are higher than on the main land. It ranges between 12-20 mdays/mu. To a large extent this can be explained by the fact that cassava fields are on steeper slopes, further away from the village and because of climatic conditions, chip drying takes longer. Cassava income (labor not accounted for) ranges from Y 250-300/mu. Although sugarcane is often used as a crop alternative, and has a higher income (Y 300-400/mu), in several areas there were demand problems. Also, cane, once harvested needs to be factory processed at once. Cassava, on the other hand can be chipped and stored, and has more utilization alternatives. As such, these are typical criteria entering farmer's decision-making process regarding crop choices.

Cassava problems and opportunities:

In Hainan most farmers had mixed feelings about cassava. On the one hand they like the crop because it is well-adapted to soil and climatic conditions, it is easy to grow with a

minimum of inputs and it gives a quick return on labor; the harvest and transport of the roots is also more flexible and thus more easily organized than that of sugarcane. But, as summarized in Table 33, farmers complain that yields and profits are low, that it requires more labor than sugarcane, which is harvested three times before replanting, that the transport of fresh roots from far-away fields is hard work and that drying of chips is a problem during the rainy season. They also mentioned that cassava cultivation reduces the productivity of the soil, either through nutrient extraction or erosion. Thus, they either had to apply fertilizers to cassava or return the plot back to fallow for 1-2 years, after which it would require considerable labor again to slash and burn the fallow for further cropping. On the relatively fertile soils and under the favorable climatic conditions, an abundant fallow vegetation is generally produced in a short time. However, farmers in the upland area still prefer to first plant cassava after opening up new (often illegal) land.

Erosion was also recognized as a serious problem, but besides digging diversion channels to prevent water from entering the cassava fields, very little was done to prevent erosion. This is because of lack of labor or because they do not own the land, as in State Farms or Township Communal Farms, where crop land is rotated among farmers or can be used any time for rubber planting. Erosion was found to be very severe on the steep slopes in Tongzha City, as well as on gently slopes at CATAS.

Farmers also mentioned that transport of fresh roots to the factory was expensive (with a recent 60% increase in gasoline prices) and that factories did not always receive their roots immediately, but that this was still preferable to the problems encountered in harvesting sugarcane, which depended on factory trucks to pick up the harvest.

Without exception, all managers of starch factories ranked lack of raw material and lack of capital as the top two constraints (similar to those in Colombia, Brazil and Ecuador). Regarding the first problem this seems rather a cat-and-mouse-game, since factories are reluctant to increase root prices, with the result that farmers are unwilling to increase supplies, etc. Factories blamed farmers and vice versa. Typically, state-run factories face worse problems than private-run factories, especially regarding technology, working capital, and labor. However, this seems to be a phenomenon applicable to the majority of Chinese state-run enterprises.

In Hainan cassava is still an important crop, but cassava has suffered a downward trend due to inefficient processing facilities and government interest mainly in rubber, sugar and fruit trees. It remains an important crop mainly in the foothills of mountains in central Hainan, especially in those areas close to starch factories. Although cassava yields are slightly higher (esp. on State Farms) than in Guangxi and Guangdong, they could still increase considerably by planting better varieties with more intensive management, including more and more appropriate use of fertilizers. Since farms tend to be larger than in the other two provinces and farmers are partially occupied with rubber production, they plant cassava mainly as a monocrop with a minimum input of labor. Soils are relatively more fertile, but fertility declines if cassava is grown continuously without fertilizer inputs, due to nutrient extraction

and severe erosion. According to government policy, crops can not be grown on slopes of more than 45%, but cassava is still being planted on slopes of over 100%.

CONCLUSIONS AND RECOMMENDATIONS

1. The three-week case study in China provided a good insight into the actual situation of cassava production and processing. It showed clearly the great diversity of production practices, in contrast to the use of only two dominant varieties (Table 34); it showed that fertilizer use is widespread in Guangdong and Guangxi provinces, but less so in Hainan, and that cassava is predominantly sold to processing factories, either as dry chips in Guangdong and eastern Guangxi, or as fresh roots in central Guangxi and in Hainan. On-farm use for pig feeding was usually less than 30-40%, but was as high as 80-90% in two of the 16 villages visited. Cassava for human consumption has decreased significantly over the last decade.

2. It is clear that the future of the cassava sector is driven by the strong domestic (and international) demand for native and modified starches. It is hard to quantify this demand. But given the 1.2 billion Chinese population and the strong (urban) economic growth, potential demand is extremely large. Current domestic MSG demand could be between 0.8-1.5 million ton annually. The majority of current supplies is still being imported or domestically produced from maize and/or sugarcane.

3. Except in the direct vicinity of the R&D institutions that are already known, almost no cassava research and extension products arrive at their users. Cassava, although its image improving, is still in the minor league compared to rice, rubber, fruit trees, etc. Government officials were really amazed that "foreign experts" would come all the way just to talk about cassava. Virtually no funds are available to test and transfer new technologies. In addition, there exist little communication (or collaboration) between research institutes and local Agricultural Bureau or Extension offices. Basically, there are no priorities for cassava and hence no money. The bright side is, that there is a technology transfer system in place!

4. It is expected that in time, state processing factories will either go broke or go private (and survive). Some factories are already soliciting foreign (Thai, Taiwanese) private capital for technology infusions. The future of small-scale (family run) starch processing units seems to be bleak or at least uncertain. However, more and better information needs to be collected on this particular sector. It may even be a future opportunity for CIAT with local collaborators to target post-harvest technology in the form of an Integrated Cassava Research and Development Project.

5. The team did not visit more isolated highland cassava growing areas. As such our current information is far from being complete. This is another area that needs to be targeted for future surveys.

6. Another area for concern is cassava processing waste pollution. Although the Chinese historically are well known for their ability to fully utilize by-products, including wastes, at the same time there seems to be a high disregard to natural resources when it affects profits. Again, better, more detailed, and quantitative data is needed to analyze the extent of pollution and opportunities for technology intervention.

7. The few cassava varieties that make up the present portfolio in southern China is a cause for alarm regarding bio-diversity. This is one more reason to actively advance the introduction, selection (through FPR) and transfer of improved varieties.

8. There seems to be an excellent opportunity to involve the private sector (processing factories) in future cassava R&D and TT. Cassava starch producers are to some extent organized through provisional Cassava Starch Processing Organizations. In Guangxi they even publish a technical journal. In Hainan, there seems to be much discussion between processors to start an association.

9. Research should continue to emphasize the development of high yielding, high starch varieties with short and thick roots, and cold, drought and typhoon resistance; better fertilizer practices and better training of researchers and extensionist in fertilizer use; and better erosion control practices, especially in Hainan. The development of a short-duration variety might help to escape problems of low temperatures, drought and/or typhoons; it could also provide for a longer harvesting period, which would benefit starch factories. In Hainan a wider spread in planting dates is also possible and would help provide a more continuous supply of cassava roots. Finally, the development or adaptation and transfer of a more efficient, portable and cheap chipping machine would reduce labor in chipping and drying and probably produce better quality chips.

10. It is recommended that the information of this report will be fed back to all cassava stake holders in the 3 provinces. Subsequently a workshop can serve to discuss current cassava sector problems and opportunities and formulate high priority research activities. Research and technology transfer responsibilities can be divided, according to comparative advantages, between state research institutes and universities, and the private sector.

11. The RRA framework that was developed and tested in South-China served its purpose and was considered efficient and effective. Nonetheless, as was concluded earlier, the time and financial constraints prove to be too limiting. As such, several cassava areas and themes were not sufficiently addressed. Furthermore, Chinese conditions and traditions in general pose a major challenge to accomplish a strict itinerary and workplan with hardly any flexible time available. It is believed however, that this exercise generated a satisfactory return (of information) on the (relatively small) investment.

Table 1. Cassava area, yield and production in China, 1954-1993.

Year	Area ('000ha)				Yield (t/ha)				Production ('000t)			
	Guangdong	Guangxi	Hainan	Total	Guangdong	Guangxi	Hainan	Total	Guangdong	Guangxi	Hainan	Total
1954	40.45	67.45			7.43	1.89			300.5	127.6		
1955	27.53	62.65			4.27	1.69			117.7	106.1		
1956	60.07	93.01			2.19	1.88			131.8	174.8		
1957	89.01	104.32			3.55	2.62			316.3	273.0		
1958	109.07	132.57			7.52	3.74			820.8	495.6		
1959	131.70	118.84			6.22	3.54			819.7	421.0		
1960	86.27	127.91			2.77	2.07			238.8	264.1		
1961	117.27	104.35			2.82	3.33			331.1	347.6		
1962	-	183.55			-	3.09			-	567.8		
1963	-	153.43			-	2.98			-	457.0		
1964	110.07	154.31			3.12	3.11			343.5	480.7		
1965	98.38	158.52			3.57	3.18			351.8	503.5		
1966	106.86	102.22			3.35	2.48			358.2	253.3		
1967	-	70.30			-	7.41			-	521.1		
1968	-	73.67			-	6.60			-	486.4		
1969	126.47	124.73			4.72	5.21			597.1	650.2		
1970	164.49	145.60			5.09	4.86			837.2	708.0		
1971	-	129.61			-	4.89			-	633.9		
1972	167.54	124.48			3.79	6.32			635.0	786.8		
1973	152.47	107.90			3.89	5.74			593.9	619.6		
1974	134.00	100.85			3.98	5.08			533.7	512.3		
1975	135.15	131.90			3.79	5.92			512.3	781.3		
1976	102.23	110.47			3.82	5.08			390.3	561.2		
1977	90.75	74.57			4.57	5.70			415.2	425.6		
1978	175.16	131.02			5.08	5.91			890.4	774.8		
1979	185.90	155.99			5.51	6.01			1,025.2	937.9		
1980	177.58	207.76			6.15	6.95			1,092.6	1,443.6		
1981	173.17	190.39			7.06	7.63			1,223.6	1,452.8		
1982	167.27	175.17			8.07	8.02			1,349.3	1,404.8		
1983	131.27	120.64			8.03	8.12			1,054.1	980.0		
1984	127.07	94.00			10.81	7.70			1,373.7	723.5		
1985	125.07	100.75			9.71	7.78			1,146.5	783.6		
1986	148.79	134.15	15.33	298.27	10.20	9.06	10.68	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	1,990.0	275.9	4,471.5
1992		213.32	19.17			9.92	12.55			2,115.8	305.9	
1993		219.06	24.90			11.29	13.05			2,473.4	324.9	

Table 2. Cassava area, production and yield in districts and cities of Guangdong province of China in 1989, 1990 and 1991.

District/city	Area (000 ha)			Production (000 t)			Yield (t/ha)		
	1989	1990	1991	1989	1990	1991	1989	1990	1991
Guangzhou	9.10	8.45	8.54	107.23	107.63	114.57	11.78	12.74	13.42
Shenzhen	0.30	0.28	0.26	5.65	4.35	4.46	18.83	15.53	17.15
Zhuhai	0.57	0.61	0.57	8.87	11.52	9.54	15.56	18.88	16.74
Shantou	5.91	5.94	5.94	107.76	118.64	115.49	18.23	19.97	19.44
Shaoguan	4.28	4.36	4.96	32.14	36.37	43.23	7.51	8.34	8.71
Heyuan	8.13	8.39	9.84	73.34	76.33	93.35	9.02	9.10	9.49
Meizhou	21.73	21.68	21.32	184.42	196.93	190.43	8.49	9.08	8.93
Huizhou	6.17	6.06	5.54	68.29	66.14	57.97	11.07	10.91	10.46
Shanwei	0.83	0.78	0.71	10.98	11.03	10.02	13.23	14.14	14.11
Dongwan	1.28	1.12	0.99	22.89	22.30	18.57	17.88	19.91	18.76
Zhongshan	0.23	0.20	0.17	3.82	3.29	2.39	16.61	16.45	14.06
Jiangmen	15.00	14.53	14.41	261.74	261.02	268.72	17.45	17.96	18.65
Fushan	2.59	2.19	2.12	38.75	36.50	40.76	14.96	16.67	19.23
Yangjiang	12.08	11.58	11.01	115.65	127.86	123.41	9.57	11.04	11.21
Zhangjiang	10.64	10.11	9.90	163.25	144.17	138.79	15.34	14.26	14.02
Moaming	13.58	14.15	13.58	194.94	206.37	202.97	14.35	14.58	14.95
Zhaoqing	44.20	43.11	42.43	520.89	509.39	546.83	11.78	11.82	12.89
Qingyuan	21.04	20.81	21.07	193.90	200.80	224.09	9.21	9.65	10.64
Chaozhou	2.10	1.91	1.60	18.65	16.73	14.29	8.88	8.76	8.93
Total Guangdong	179.77	176.30	174.94	2,133.16	2,157.37	2,219.88	11.87	12.24	12.69

Source : Guangdong Agric. Bureau in Guangzhou.

Table 3. Cassava Area, yield and production in counties within districts of Guangdong province of China. Data are average from 1971 to 1980 and for 1980 alone.

District and counties	Area (ha)		Yield (t/ha)		Production (000t)	
	1971-80	1980	1971-80	1980	1971-80	1980
Guangzhou district	8432	11401	5.70	7.00	48.04	79.75
1. Guangzhou	1051	662	5.57	5.33	5.85	3.53
2. Conghua	2455	3836	5.14	5.72	12.62	21.93
3. Huaxian	574	503	6.25	7.55	3.59	3.80
4. Panyu	752	957	8.43	10.98	6.34	10.51
5. Zhengcheng	3600	5443	5.46	7.35	19.64	39.98
Shantou district	6179	8744	7.47	7.27	46.17	63.64
6. Shantou	9	7	9.60	11.43	0.09	0.08
7. Chenghai	38	10	13.20	22.00	0.50	0.22
8. Raoping	1377	1505	8.16	8.57	11.24	12.88
9. Nanao	7	2	14.43	15.00	0.10	0.03
10. Chaoyang	315	407	10.46	10.42	3.30	4.24
11. Huilai	213	252	5.00	4.25	1.06	1.07
12. Puning	931	1770	6.69	5.53	6.23	9.78
13. Jiexi	1059	1487	6.80	7.51	7.20	11.17
14. Jeiyang	532	593	10.49	12.39	5.58	7.35
15. Chaoan	1698	2711	6.40	6.20	10.87	16.82
Shanwei district	569	710	5.98	5.92	3.40	4.20
16. Lufeng	440	619	5.86	5.82	2.58	3.60
17. Haifeng	129	91	6.38	6.59	0.82	0.60
Huizhou district	3688	3230	4.62	5.68	17.03	18.36
18. Huizhou	94	85	4.65	7.06	0.44	0.60
19. Huiyang	527	362	4.68	6.33	2.47	2.29
20. Huidong	852	565	5.10	5.54	4.34	3.13
21. Boluo	1134	1281	5.15	6.51	5.84	8.34
22. Longmen	1081	937	6.35	4.27	3.94	4.00
Dongguan district	3266	3327	9.41	9.90	30.74	32.93
23. Dongguan	3266	3327	9.41	9.90	30.74	32.93
Heyuan district	4897	4016	3.00	4.07	14.70	16.36
24. Heyuan	982	660	3.53	3.82	3.47	2.52
25. Heping	407	482	3.06	2.84	1.24	1.37
26. Longchuan	925	653	3.40	4.82	3.14	3.15
27. Zijing	2397	2063	2.62	4.18	6.29	8.62
28. Lianping	186	158	2.99	4.43	0.56	0.70
Meizhou district	15697	26076	4.18	5.00	65.69	130.50
29. Meizhou	12	13	10.58	4.62	0.13	0.06
30. Meixian	2040	3196	4.53	5.34	9.25	17.06

Table 3. (con't)

District and counties	Area (ha) 1971-80	Area (ha) 1980	Yield (t/ha) 1971-80	Yield (t/ha) 1980	Production (000t) 1971-80	Production (000t) 1980
31. Wuhua	2499	5361	5.34	5.12	13.33	27.45
32. Xingning	2041	3699	6.72	8.04	13.71	29.73
33. Jiaoling	905	1264	2.78	2.87	2.51	3.63
34. Dapu	2800	2615	2.75	3.13	7.69	9.11
35. Fengshun	4720	8844	3.55	4.56	16.77	40.36
36. Pingyuan	680	784	3.38	3.96	2.30	3.10
Shaoguan district	2012	2871	3.88	5.10	7.80	14.65
37. Shaoguan	15	19	4.80	2.63	0.07	0.05
38. Renhua	12	39	4.14	6.58	0.09	0.25
39. Naxiong	1	-	4.00	-	0.01	-
40. Shixin	58	153	2.50	2.05	0.14	0.31
41, Wenyuan	210	476	3.92	4.45	0.82	2.12
42. Xingfeng	1230	1719	4.41	6.06	5.43	10.43
43. Qujiang	290	283	2.31	2.97	0.67	0.84
44. Ruyuan	155	136	2.57	3.90	0.40	0.53
45. Lechang	32	47	5.47	2.55	0.17	0.12
Qingyuan district	12907	16260	4.08	5.81	52.63	94.48
46. Zingjiao	4955	4900	3.72	5.25	18.42	25.71
47. Lianxian	433	273	2.85	3.66	1.23	1.00
48. Lianshan	553	949	3.07	3.18	1.69	3.02
49. Liannan	472	510	2.26	2.12	1.07	1.08
50. Yangshan	1310	2234	3.00	4.82	3.93	10.76
51. Yingde	3932	5381	4.97	6.75	19.54	36.35
52. Fugang	1252	2013	5.39	8.23	6.74	16.56
Fushan district	1364	1395	6.17	6.85	8.41	9.55
53. Fushan	1	-	5.00	-	0.01	-
54. Nanhai	481	502	8.76	8.45	4.21	4.24
55. Shunde	42	1	8.76	10.00	0.37	0.01
56. Sanshui	320	532	4.49	6.00	1.44	3.19
57. Gaoming	520	360	4.59	5.86	2.39	2.11
Zhongshan district	488	328	8.79	11.38	3.94	3.73
58. Zhongshan	488	328	8.79	11.38	3.94	3.73
Jiangmen district	8180	7975	5.05	7.57	41.28	60.34
59. Jiangmen	79	37	8.63	9.19	0.68	0.34
60. Heshan	503	360	4.78	5.86	2.40	2.11
61. Xianhui	1591	1625	9.00	12.97	14.32	21.08
62. Taishan	1901	1745	3.89	5.92	7.40	10.32
63. Kaiping	1864	2623	4.86	7.42	9.05	19.47
64. Enping	2242	1585	3.31	4.43	7.43	7.02

Table 3. (con't)

District and counties	Area (ha) 1971-80	Area (ha) 1980	Yield (t/ha) 1971-80	Yield (t/ha) 1980	Production (000t) 1971-80	Production (000t) 1980
Zhoaqing district	44969	51892	4.12	5.88	185.10	305.06
65. Zhaoqing	34	30	3.68	7.00	0.12	0.21
66. Gaoyao	3081	3896	4.69	5.64	14.44	21.98
67. Guangning	9546	10369	3.01	3.53	28.75	36.60
68. Sihui	1711	2432	4.36	6.59	7.45	16.02
69. Xinxing	2582	3452	5.48	7.85	14.14	27.10
70. Luoding	4452	4882	6.20	9.32	27.61	45.52
71. Yunfu	4040	5528	5.60	8.25	22.63	45.61
72. Deqing	1632	2129	4.99	8.31	8.14	17.70
73. Yunan	3223	7970	5.18	6.76	32.23	53.87
74. Fengkai	1673	2430	5.42	7.40	9.07	17.99
75. Huaiji	9995	8774	2.05	2.56	20.50	22.45
Zuhai district	425	60	11.38	7.83	4.84	0.47
76. Zuhai	425	60	11.38	7.75	4.84	0.47
Shenzhen district	1015	833	8.75	8.12	8.88	6.76
77. Shenzhen	1015	833	8.75	8.12	8.88	6.76
Yangjiang district	7688	8520	5.03	6.23	30.87	33.03
78. Yangchun	6469	7000	4.90	5.34	31.72	37.38
79. Yangjiang	1219	1520	5.73	10.34	6.99	15.72
Zhangjiang district	5191	4905	5.95	6.73	30.87	33.03
80. Zhangjiang	364	366	6.55	5.27	2.38	1.93
81. Wuchuan	374	433	7.28	7.21	2.72	3.12
82. Xuwen	1477	1076	6.28	5.37	9.27	5.78
83. Haikang	586	457	5.11	5.25	3.00	2.40
84. Suixi	446	489	7.47	7.94	3.33	3.88
85. Liangjiang	1944	2084	5.23	7.64	10.16	15.92
Maoming district	13210	13357	4.69	6.88	62.01	91.95
86. Maoming	76	33	7.20	8.18	0.55	0.27
87. Gaozhou	2754	2172	2.40	4.06	6.60	8.81
88. Xingyi	7089	7638	4.73	7.46	33.51	57.00
89. Dianbai	1918	1676	6.98	7.51	13.38	12.58
90. Huazhou	1373	1838	5.81	7.23	7.97	13.29
Total Guangdong Province	140,137	165,900	4.78	6.14	670.23	1018.86

Source: Agricultural Statistics, Guangdong Statistics Bureau, 1971-1980.

Table 4. Cassava area, yield and production in various counties of Zhaoquing district Guangdong province of China in 1991 and as compared to 1980.

County	Area (ha)	Change since 1980 (%)	Yield (t/ha)	Change since 1980 (%)	Production (t)	Change since 1980 (%)
Gaoyao	4,509	+16	18.57	+229	83,732	+280
Guangning	6,893	-33	7.75	+119	53,421	+46
Sihui	2,437	-1	14.05	+113	34,240	+114
Xinxing	2,592	-25	15.06	+92	39,035	+44
Luoding	4,721	-3	15.52	+66	73,270	+61
Yunfu	3,924	-29	18.74	+127	73,536	+61
Deqing	2,519	+18	15.09	+81	38,012	+115
Yunan	4,986	-37	9.60	+42	47,866	-11
Fengkai	2,066	-15	19.33	+161	39,936	+122
Huaiji	7,145	-18	8.38	+227	59,875	+167
Duanzhouqu	48		19.45		934	
Dinghuqu	580		14.91		8,648	
Total Zhaoqing	2,420	-18	13.02	+112	552,505	+81

Table 5. Supplementary data on climate, soils, and agriculture in Guangdong Province, China.

	Zhaoqing district	Guangning county	Huaiji county
Latitude (° N)	23° 5'	23° 40'	23° 50'
Altitude (masl)			
Soils		rocky Paleustult	rocky Paleustult
Landscape			
-general		70% hilly	
-cassava	on gentle slopes or on terraces	on hills	40% upland 60% hilly
Climate			
Average temperature (°C)		21	20.5
Absolute minimum temp.		-4.2	
Mean minimum temperature			
Absolute maximum temp.		39.4	
Mean maximum temperature			
Rainfall (mm)			1,700
No.of frost-free days		313	310
Main crops (mu) 1/			
rice (crop land)	2,400,000	200,000	320,000
cassava	636,000	103,000	107,000
maize			40,000
peanut		50,000	45,000
sugarcane	130,000		20,000
sweet potato		50,000	40,000
vegetables	1,000,000		
fruit trees	1,000,000		
bamboo			400,000
forest			3,220,000
Cassava yield (kg/mu)			
-fresh	868	517	559
-dry			
Total farm size (mu/pl)	4		
-upland	2		
-irrigated	0.6		
Annual income (Y/person)			

1) 1 ha = 15 mu

Table 6. Land use, crops and cropping systems in Guangdong province, China.

	Zhoaging district	Guangning county	Huaiji county	Qiaotou town	Guangning Shetian village	Huaiji Fangta village	Huaiji Shiyu village
Main crops	rice fruit trees vegetables cassava	rice cassava peanut sweet pot.	forest bamboo rice cassava	rice maize cassava peanut	bamboo C, upl. rice CY, ginger medic. trees	cassava maize peanut	bamboo trees cassava some P,M,CY
Land use - cassava		mainly mountain C in hills	mountain 60% upland 40% C in hills	mainly flat C in flat	irrig. <5% upland 95% C in hills	mainly flat C in flat	mainly mountain C in hills
Cropping systems 1/		C+trees C+P C+CY	C monocult. C+P, C+M C+S	C+M, C+P C+S, C+T	C+trees C+M or P	C+M+P+CY+SP	C+trees
Crop area (mu/fam.)-total 2/	14-15			2-3		8	
-Cassava (mu/fam.)	2-3	5-6		2-3	15	8	14-15
-Irrigated (mu/person)	0.50-0.75			0.2-0.3	0.1-0.2	0.2	0.2
-Upland (mu/person)	2-3				3	1.1-1.5	3-4
Yield (kg/mu)							1st year:
-Cassava -fresh roots	700-1,000		640	600-650	750	945	700-1,000 -->500-->400
-dry chips	200-400			200-250		300-350	200-400
-Rice					40		
-Maize				200-250		<330	
-Peanut						112	

1) C = cassava, M = maize, P = peanut, S = soybean, SC = sugarcane, CY = cocoyam, SP sweet potato
2) 1 ha = 15 mu
3) Note: in Guangdong province land is assigned according to the total number of people in the family.

Table 7. Cassava varieties and agronomic practices in Guangdong province, China.

	Zhaoqing district	Guangning county	Huaiji county	Qiaotou town	Guangning Shetian village	Huaiji Fungta village	Huaiji Shiyu village
Varieties	SC205 some SC201	SC205 (95%)	SC205 (90%)	SC205	SC205	SC205	SC205
Fertilizer use (kg/mu)	some FYM + cyanamide <50% farmers apply fert.	10 cyanamide	only in lowland when intercropped 7-10 urea 15-20 SSP little K or ash		none	50 cyanamide or 20 urea or 15 (15-15-15)	no fert. with trees 500 FYM 30 SSP C+P:10 urea
Stake storage					in holes (50-100 cm deep)		
Land preparation			oxen or hand		hand	oxen	hand
Plant spacing (m)	1.0x0.8				1.0x0.8	1.0x0.8	0.6x0.8
Planting method					hor. in triangle	inclined	inclined
Weed control					hand	hand	
No.of weeding					2	2-3	2
Time of planting intercr.						mid. Feb-Mar	
Time of planting C			late March		late March	late March	late Mar-Apr
Time of fertilizer apply							
Time of weeding					1-2 MAP 4-5 MAP	0 MAP 2 MAP	2 MAP 5 MAP
Time of harvest:							
-intercrops						July-August	
-cassava			November		Nov.- Feb.	November	Nov-Dec
Intercropping system					C between trees during the first 2-3 years	C + M with P or SP between rows or after M harvest	C between trees during the first 2-3 years C+P on lower slopes

Table 8. Principal cassava varieties in Guangdong province, China and their characteristics

	Zhaoqing district	Guangning county	Huaiji county	Guangning Shetian village	Huaiji Fungta village
Main variety	SC 205 (50%)	SC 205 (90%)	SC 205 (90%)	SC 205	SC 205
Secondary varieties	SC 201 (50%) SC 124	SC 201 (10%) SC 124	SC 201 (10%)	SC 124	
Characteristics:					
SC 205		Introduced: 1981-'91		Easy harvest Wind tolerant	High yield Easy harvest Easy peel Fast to dry
SC 201		1971-'80	Long roots Difficult to harvest		Introd.: 1970 Big short roots Rough skin Lower DM
SC 124	High yield Medium DM	1988	Not adapted	High yield Easy lodging Difficult to harvest	
SC 102					
ZM 8002			High yield		
Nanzhi 188	High yield Low DM Med. cold tolerance	High single-plant yield Poorly adapted Drought + cold sensitive Sometimes difficult harvest	Not adapted		

Table 9. Cassava utilization and associated labor use, prices, costs, and income in Guangdong province, China.

	Zhaoqing district	Guangning county	Huaiji county	Qiaotou town	Guangning Shitian village	Huaiji Fungta village	Huaiji Shiyu village
Utilization (%)							
Sold -factory	mainly chips	mainly chips		mainly chips	mainly chips	mainly chips	chips
	>60	60-70		>60	70	70	80-90
-export	10						
On-farm -pigs	10-20	30-40		30-40	25	30	10-20
-human		little			5	in past only	
Chipping	by hand				by hand	chipping board	
Labor use (mandays/mu)							
land preparation			2			5-6 (hand)	
						0.7 (oxen)	2-3
plant intercrop						0.5	
stake prep.+ planting			2			1.0	3
weeding			2			3	4
harvest intercrop						2	4
harvest C + peeling			1		6-7	2	
chipping			5		3-4	2	
drying			2		5 (1-2)	1	2
Total			14			12-17	15-16
Prices and costs (Y)							
fresh roots/t	220						
dry chips/t	660-760	660-880	560-700	660	480-560	500-620	560-640
starch (grade 1)/t	2,100						
MSG/t	14,000						
SSP/50kg							
urea/50kg						76	
cyanamide/50kg						32	
15-15-15/50kg (import)						110-120	
Cost of labor/day							
Total cost of fert./mu		6-8	0-22		<5	33	0-18
Source of income					bamboo > med. trees > C	C > M	bamboo > C > trees
Net income (Y/mu)							
vegetables	2,000-2,500						
fruits	1,600-2,000						
rice	700						
sugarcane	500						
cassava	200						
Net income (Y/fam.)							
-cassava							600
-bamboo							2,000

1 US $ = 8.4 Y ; 1 ha = 15 mu

Table 10. Major cassava starch and starch-based product factories in Guangdong province.

Factory	Location 1/	Main Products	Production (t/yr)
1. Guangdong MSg Factory	Guangzhou city	MSG	16,000
2. Haitian Flavouring Factory	Foshan city	soya suace, MSG	no details
3. Xinghu MSG Company Ltd.	Zhaoging city	MSG	15,000
		pharm. prod.	450
4. Guangzhou MSG Factory-Fogang Branch	Fogang county	MSG	no details
5. Xingning MSG Factory	Xingning county	MSG	< 5,000
6. Jiangmen MSG Factory	Jiangmen city	MSG	< 5,000
7. Kaiping MSG Factory	Kaiping city	MSG	< 5,000
8. Chaozhou MSG Factory	Chaozhou city	MSG	< 5,000
9. Jieyang MSG Factory	Jieyang city	MSG	< 2,000
10. Heping Farm MSG Factory	Huazhou county	MSG	< 2,000
11. Xinhui Duyuan MSG Factory	Xinhui city	MSG	< 2,000
12. Zhujiang Food Factory	Guangzhou city	liquid glucose	no details
13. Huiyang Citric Acid Factory	Huiyang county	citric acid	2,000
14. Guangning Glucose Factory	Guangning county	glucose	7,600
15. Huaiji Sorbitol Factory	Huaiji county	sorbitol	6,000
16. Yunfu Starch Factory	Yunfu city	starch	2,200
17. Haufeng Starch Prod. Co., Lt	Foshan city	starch	18,000
18. Fengshun Starch & Chem. Fa	Fengshun county	starch	no details
19. Yunan Starch Factory	Yunan county	starch	no details
20. Yangshan Starch Factory	Yangshan county	starch	no details
21. Dongguan Starch Factory	Dongguan city	starch	no details

1/ see Figure 3

Table 11. Cassava processing in three counties of Guangdong province, China.

	Zhaoqing city	Guangning county	Huaiji county
Manufacturer	Xinghu MSG Comp. Group	Guangning Glucose Factory	Huaiji Sorbitol Factory
Ownership	private	Guangning county	Huaiji county
Products	1) MSG 2) pharmaceutical prod.	1) starch 2) anhydrous glucose 3) monohydrate glucose 4) edible glucose 5) alcohol	1) starch slurry and dry 2) glucose 3) sorbitol
Production capacity (t/yr)	1) 15,000 actual prod. 30,000 in future (5% of Chinese dom.demand) 2) >450 (= 80% of Chinese-domestic demand)	1) 7,000 2) 3,000 3) 3,600 4) 1,000 5) 400	1) 17,500 dry starch 2) 1,000 20% liquid-sorbitol
Actual production (t/yr)	1) 15,000	1) 7,000	not yet operational
Production period	year round		
Raw material needs (t/yr)	50,000 starch (now 20% is corn starch)	15,000 dry chips from Guangning+Guangxi	20,000 dry chips or fresh root equiv.
Price raw material (Y/t)	2,100 cassava starch from Guangxi 2,100 corn starch	660-880 chips 1,200 chips from Guangxi	560-700 chips
Conversion ratio	1.9 starch = 1 MSG 10 starch = 1 pharm.prod.	1.8 dry chip = 1 starch 1.4 starch = 1 glucose	1.5 dry chips = 1 starch 1.1 glucose = 1 sorbitol
Technology	fermentation of starch -->liquification-->sacch. -->crystalization-->MSG	dry chips --> starch fermentation-->glucose starch residue-->alcohol	dry chips --> starch fermentation-->glucose -->sorbitol
Price products (Y/t)	MSG 14,000	anhydr.glucose 6,000-7,000 monohydrate 4,600-5,000	sorbitol 6,000 dry starch 2,200
Economics (Y/yr) -output	370 million	45 million	
-profit	34 milion (including tax)	4.5 million	
Problems	starch supply	dry chips supply	

Table 12. Guandong cassava farmers problems, ranking and solutions mentioned (average of 3 villages).

Problem/issue	Relative importance (H.M.L)	Frequency mentioned	Farmers suggested solutions
1. Cassava production needs too much labor	H	3/3	?
2. Cassava chip price is too low; income is low	H	3/3	Need better varieties to increase yields and incomes
3. Capital/credit needed	M/L	1/3	?
4. Weeding labor too much	H	2/3	Buy herbicides; but this needs capital
5. Much labor needed for chipping/drying	H	2/3	Find better tools; try to sell fresh
6. Wild pig damage	L	1/3	?
7. Some insect damage	L	1/3	?

Source: 1994 China RRA, primary data.

Table 13. Cassava area, production and yield in districts and cities of Guangxi province of China in 1989, 1991, 1992 and 1993

District/city	Area ('000 ha)				Production ('000 t)				Yield (t/ha)			
	1989	1991	1992	1993	1989	1991	1992	1993	1989	1991	1992	1993
Liuzhou district	29.30	28.30	26.65	24.97	155.70	169.40	146.74	157.71	5.31	5.98	5.51	6.32
Liuzhou city	7.82	6.05	4.94	4.59	54.33	36.97	36.88	39.47	6.95	6.11	7.46	8.60
Qinzhou district	14.31	15.53	15.56	15.26	127.63	153.99	167.90	177.34	8.92	9.91	10.79	11.62
Beihai city	4.81	6.74	7.73	8.45	73.64	139.73	209.70	229.95	15.30	20.73	27.13	27.21
Bose district	8.82	11.07	11.21	11.91	67.41	94.54	100.62	124.85	7.64	8.54	8.97	10.48
Hechi district	17.19	18.33	17.03	18.91	114.33	122.96	106.91	146.88	6.65	6.71	6.28	7.77
Wuzhou district	32.50	34.21	34.49	34.52	309.40	354.79	389.05	460.49	9.52	10.37	11.28	13.34
Wuzhou city	3.20	3.94	3.76	3.50	23.38	26.79	24.62	27.14	7.31	6.80	6.60	7.76
Nanning district	34.47	34.13	31.84	34.74	247.16	240.27	242.18	296.42	7.17	7.04	7.61	8.53
Nanning city	11.70	13.32	12.39	14.15	104.60	158.81	167.17	216.42	8.94	11.92	13.49	15.30
Yulin district	36.69	38.81	37.06	37.56	375.64	419.10	444.63	489.61	10.24	10.80	12.00	13.03
Guilin district	6.81	8.06	7.56	7.71	36.11	47.15	58.56	77.98	5.30	5.85	7.75	10.11
Guilin city	2.99	3.24	3.10	2.79	22.61	25.54	25.54	29.17	7.55	7.88	8.24	10.47
Total Guangxi	210.62	221.73	213.31	219.06	1,711.94	1,990.02	2,120.70	2,473.43	8.13	8.98	9.94	11.29

Note: production and yield calculated by multiplying data on dry slices by three.
Source: Guangxi Agric. Bureau in Nanning.

Table 14. Cassava area, yield and production in counties within districts or city in Guangxi province of China in 1992 and 1993.

		Planted area (ha)		Yield* (t/ha)		Production* ('000t)	
		1992	1993	1992	1993	1992	1993
	Liuzhou District	26,653	24,967	5.50	6.32	146.72	157.71
1.	Heshan county	340	266	2.68	1.97	0.91	0.52
2.	Luzhai county	7,007	5,599	6.98	7.70	48.90	43.09
3.	Xiangzhou county	1,934	1,666	5.10	6.50	9.86	10.84
4.	Wuxuan county	3,275	3,606	5.99	7.38	19.62	26.61
5.	Laibin county	3,309	3,304	3.87	5.58	12.82	18.44
6.	Rongan county	2,033	2,011	5.22	6.53	10.61	13.13
7.	Sanjiang county	1,732	1,585	5.66	6.15	9.81	9.74
8.	Rongshui county	3,201	3,417	5.36	4.77	17.14	16.32
9.	Jinxiu county	2,084	1,774	4.84	6.15	10.09	10.92
10.	Xincheng county	1,738	1,739	4.00	4.65	6.96	8.09
	Liuzhou City	4,941	4,590	7.46	8.60	36.87	39.47
11.	Liujiang county	2,656	2,678	6.84	9.23	18.16	24.71
12.	Liucheng county	1,748	1,560	6.56	6.63	11.46	10.34
13.	Linzhou suburb	537	352	13.50	12.54	7.25	4.41
	Qinzhou District	15,564	15,263	10.79	11.62	167.89	177.34
14.	Qinzhou county	2,920	3,271	12.25	12.24	35.77	40.04
15.	Shangsi county	524	417	6.49	7.00	3.40	2.92
16.	Fangcheng county	1,066	999	15.18	12.74	16.18	12.73
17.	Lingshan county	5,688	5,995	9.70	11.11	55.20	66.59
18.	Pubei county	5,366	4,581	10.69	12.02	57.34	55.06
	Beihai City	7,727	8,451	27.14	27.21	209.70	229.95
19.	Beihai suburb	989	1,039	28.40	24.04	28.09	24.98
20.	Hepu county	6,738	7,332	26.95	27.63	181.61	202.59
21.	Fangcheng port suburb	-	80	-	29.70	-	2.38
	Bose District	11,208	11,913	8.57	10.48	96.10	124.85
22.	Bose city	1,476	1,664	6.17	10.56	9.10	17.57
23.	Tianyang county	1,136	1,187	10.08	12.89	11.45	15.30
24.	Tiandong county	3,435	3,485	7.87	8.50	27.05	29.63
25.	Pingguo county	2,784	3,303	11.93	13.50	32.77	44.59
26.	Debao county	439	388	3.82	4.93	1.68	1.91
27.	Jingxi county	78	73	5.19	8.14	0.40	0.59
28.	Napo county	384	467	6.55	6.65	2.51	3.10
29.	Lingyun county	1,099	979	7.53	8.77	8.27	8.58
30.	Leye county	34	54	4.94	4.94	0.17	0.27
31.	Tianlin county	143	123	7.45	12.88	1.06	1.58
32.	Longlin county	119	88	7.86	10.98	0.94	0.97
33.	Xilin county	117	102	5.97	7.29	0.70	0.75

Table 14 (con't)

		Planted area (ha)		Yield* (t/ha)		Production* ('000t)	
		1992	1993	1992	1993	1992	1993
	Hechi District	17,028	18,905	6.28	7.77	106.91	146.88
34.	Hechi city	764	833	5.73	7.97	4.38	6.64
35.	Yishan county	1,657	1,748	5.63	6.53	9.34	11.42
36.	Luocheng county	1,213	1,390	7.16	11.81	8.68	16.42
37.	Huanjiang county	1,493	1,488	6.36	6.73	9.50	10.02
38.	Nandan county	361	115	7.81	9.08	2.82	1.04
39.	Tian'e county	638	707	5.13	7.95	3.27	5.62
40.	Fengshan county	1,113	1,028	5.67	7.44	6.31	7.65
41.	Donglan county	1,143	1,289	4.77	7.29	5.46	9.39
42.	Bama county	4,491	6,005	6.77	9.22	30.39	55.39
43.	Duan county	2,174	2,268	4.35	4.61	9.45	10.45
44.	Dahua county	1,981	2,034	8.74	6.31	17.31	12.84
	Wuzhou District	34,488	34,519	11.28	13.34	389.06	460.49
45.	Chenxi county	10,112	10,892	17.53	18.88	177.31	205.60
46.	Teng county	10,965	10,360	9.64	12.02	105.67	124.59
47.	Zhaoping county	3,822	3,358	7.68	8.67	29.34	29.12
48.	Mengshan county	2,771	2,655	8.51	12.23	23.58	32.47
49.	He county	4,295	4,728	8.05	9.80	34.58	46.35
50.	Zhongshan county	1,859	1,848	7.10	7.64	13.21	14.11
51.	Fuchuan county	664	678	8.09	12.17	5.37	8.25
	Wuzhou City	3,756	3,497	6.61	7.76	24.82	27.14
52.	Cangwu county	3,581	3,302	6.58	7.77	23.58	25.64
53.	Wuzhou suburb	175	195	7.11	7.69	1.24	1.50
	Nanning District	31,845	34,740	7.60	8.53	241.90	296.42
54.	Pingxiang city	777	759	6.03	6.30	4.69	4.78
55.	Heng county	4,668	4,613	10.62	10.11	49.57	46.66
56.	Binyang county	3,412	3,650	6.66	7.45	22.72	27.21
57.	Shanglin county	1,687	1,820	4.62	5.67	7.79	10.32
58.	Longan county	2,486	2,605	7.67	12.65	19.07	32.97
59.	Mashan county	2,452	3,080	4.90	5.61	12.02	17.26
60.	Fushui county	3,491	4,201	7.83	9.00	27.33	37.81
61.	Chongzuo county	4,226	5,087	6.64	8.38	28.08	42.62
62.	Daxin county	2,343	2,552	7.67	7.71	17.98	19.68
63.	Tiandeng county	1,070	1,117	4.11	4.33	4.40	4.84
64.	Ningming county	2,779	2,482	8.56	9.16	23.80	22.74
65.	Longzhou county	2,454	2,774	9.96	10.64	24.45	29.52
	Nanning City	12,387	14,148	13.49	15.30	167.16	216.42
66.	Nanning suburb	2,716	2,973	11.95	13.16	32.45	39.14
67.	Yongning county	3,011	3,698	10.27	11.52	30.91	42.61
68.	Wuming county	6,660	7,477	15.59	18.01	103.80	134.67
	Yulin District	37,065	37,563	12.00	13.03	444.63	489.61
69.	Yulin city	5,395	5,629	12.97	14.74	69.96	83.00
70.	Gui county	3,274	2,805	7.73	19.89	25.31	55.79
71.	Guiping county	6,600	7,021	8.45	8.53	55.80	59.88
72	Pingnan county	5,737	5,650	11.28	9.94	64.74	56.15
73.	Rong county	3,378	3,224	17.40	17.28	58.40	55.72
74.	Beiliu county	4,905	5,035	13.91	13.40	68.22	67.48
75.	Luchuan county	3,880	4,001	13.13	13.32	50.96	53.29
76.	Bobai county	3,896	4,198	13.05	13.89	50.84	58.32

Table 14 (con't)

		Planted area (ha)		Yield* (t/ha)		Production* ('000t)	
		1992	1993	1992	1993	1992	1993
	Guilin District	7,556	7,715	7.75	10.11	58.55	77.98
77.	Lingchuan county	350	360	5.49	6.86	1.92	2.47
78.	Quanzhou county	205	188	11.84	14.15	2.43	2.66
79.	Xing'an county	256	342	8.61	10.53	2.20	3.60
80.	Yongfu county	812	816	5.27	7.16	4.28	5.85
81.	Guanyang county	13	24	5.31	11.87	0.07	0.28
82.	Longsheng county	564	603	3.58	6.22	2.02	3.75
83.	Zhiyuan county	14	15	9.00	8.80	0.13	0.13
84.	Pingle county	1,778	1,673	10.71	9.00	19.04	15.07
85.	Lipu county	2,361	2,519	7.57	12.44	17.88	31.33
86.	Gongcheng county	1,203	1,175	7.13	10.93	8.58	12.85
	Guilin City	3,100	2,786	8.24	10.47	25.54	29.17
87.	Lingui county	1,491	1,339	8.61	12.53	12.84	16.78
88.	Yangshuo county	960	893	5.28	7.50	5.07	6.70
89.	Guilin suburb	646	554	11.81	10.26	7.63	5.68
Total Guangxi Province		213,318	219,057	9.92	11.29	2,115.85	2,473.43

* Yield and production of fresh roots estimated by multiplying production data of dry slices by three.

Source: Guangxi Statistics Bureau, 1992, 1993.

Table 15. Area, production and yield of crops in Guangxi province, China, in 1990.

Crop	Area (ha)	Production (ton)	Yield (kg/ha)
Rice	2,543,733	12,390,000	4,875
Maize	536,867	1,188,000	2,220
Sugarcane	319,867	15,020,000	46,950
Cassava (fresh roots)	217,338	1,956,525	9,000
Soybean	213,400	136,000	630
Peanut	167,267	242,036	1,440
Fruit	154,000	916,094	
Tobacco	30,600	40,777	
Tea	23,600	16,410	

Note : cassava production and yield calculated by multiplying data on dry slices by three.

Table 16. Supplementary data on climate, soils, and agriculture in Guangxi province, China.

	Wuming county	Guiping county	Teng county	Cengxi county	Yulin city
Latitude (°N)	23° 10'	23° 25'	23° 20'	22° 50'	22° 40'
Altitude (masl)	80	42	54	99	82
Soils	rocky Paleustult	Paleustult	Paleustult	dark-red Paleustult	Paleustult
Landscape					
-general					
-cassava	66% flat 33% hilly		18% flat 23% upland 60% hilly	70% upland 30% hilly	
Climate					
Average temp. (°C)	21.9	21.4	21.0	21.3	21.8
Absolute minimum temp.	-0.8	-3.3	-4.1	-3.0	-2.1
Mean minimum temp.	13.1	12.4	11.7	12.4	13.2
Absolute maximum temp.	40.7	39.2	39.6	38.7	38.0
Mean maximum temp.	28.7	28.6	28.3	28.2	28.4
Rainfall (mm)	1242.3	1789.7	1403.9	1470.2	1541.9
No.of frost-free days	333	337	305-330	327	334
Main crops (mu) 1/					
rice (crop land)	450,000	780,000	350,000	130,000	630,000
cassava	100,000	105,000	155,000	163,000	84,000
maize		70,000			
peanut	190,000	120,000		53,000	20,000
sugarcane		160,000			14,000
sweet potato					
vegetables					
bamboo					
forest					
Cassava yield (kg/mu)					
-fresh	1,039	568	801	1,258	980
-dry	346	189	267	419	327
Total farm size (mu/p)	2-3				
-upland					
-irrigated	0.8-0.9				
Annual income (Y/person)	875			1,200	

1) 1 ha = 15 mu

Table 17. Land use, crops and cropping systems in Guangxi province, China.

	Wuming county	Guiping county	Teng county	Wuming Yinle village	Guiping Fuping village	Teng Jinji town	Chenxi Xilan village	Yulin Sidi village
Main crops 1/	rice maize sugarcane cassava peanut	rice fruit trees sugarcane peanut maize cassava	rice cassava sugarcane fruit trees	rice cassava maize sugarcane peanut	rice sugarcane peanut cassava fruit trees	rice fruit trees cassava peanut	rice cassava peanut fruits pine	rice cassava peanut fruit trees soybean
Land use - cassava	mostly on gentle slopes (5-10%)	60-80% in uplands 10-20% flat 10-20% hills	50-60% in mountains 25% uplands 20% flat	C 66% on flat+rolling 33% on steep land	C on gentle slopes	C in uplands 10-20% in steep land	C+P on terraces low slopes	C on contour ridges on low slopes
Cropping systems	C+P C+M or C+WM	C 1 year —>trees in mountains C+P or M in uplands or flat	C+P in flatland C monocr. or C+trees in mountains	C+M rotation with C+P C+WM near the road	C+P in rotation with SC	C+P also C+S, C+WM	C+P C+S C+MB	C+P C+S, C+M C+MB
Crop area (mu/fam.)-total 2/	20	7	4-6	8-15	12	7-16	8-13	10.0-10.5
-Cassava (mu/fam.)	7	2	1	4-9	1.5-3.0	1-2	5	1.2-1.5
-Irrigated (mu/person) 3/	1	0.5	0.40-0.45	1	0.8-0.9	0.35-0.42	0.5	0.5
-Upland (mu/person)	4	0.6	0.8-1.0		0.90	0.35-0.42	0.7	0.6-0.7
-Forest (mu/person)								
Yield (kg/mu)								
-Cassava -fresh roots	1,039 †	568 †	642 †	1,500 †	1,250	800-2,000		
-dry chips	346	189	214	500	420-670		650	380-440
-Rice				350	500	450	550	
-Maize				250-300				
-Peanut				150	135	150-170	100	40
-Watermelon				2,000-2,500				

1) C = cassava, M = maize, P = peanut, WM = watermelon, SC = sugarcane, MB = mungbean
2) 1 ha = 15 mu
3) Note: in Guangxi province land is assigned according to the total number of people in the family.

Table 18. Cassava varieties and agronomic practices in Guangxi province, China.

	Wuming county	Guiping county	Teng county	Wuming Yinle village	Guiping Fuping village	Teng Jinji town	Chenxi Xilan village	Yulin Sidi village
Varieties	SC 201 (100%)	SC 201 (70-80%) some sweet varieties	SC 205	SC 201	SC 201	SC 205 some SC 124	SC 205 Bread var.	SC 201 Bread var.
Fertilizer use (kg/mu)	increasing	increasing						
-peanut				200 FYM 20 (15-15-15)	300-350 FYM 15-20 cyanamide 25 SSP	FYM+25 SSP	50 SSP 25 (15-15-15) 15 lime,5 urea	5 urea
-cassava					little	50 cyanamide + 25 SSP	10-20 cyanamide 15 (15-15-15)	400 FYM 40 (15-15-15)
Stake storage				in ditch (30-50 cm deep)				in ditch (50-60 cm deep)
Land preparation				oxen	oxen 1 plow+1 raking	hand + ridging up	hand + ridging up	oxen + hand ridging
Plant spacing (m)	1.0x1.0 1.0x1.2			1.0x1.0 0.6x1.0	1.0x1.0	double row (1.5+0.6)x0.5	0.6x0.9	0.6x0.8
Planting method				hor.15-20 cm deep	hor.-inclined	horizontal	horizontal	hor.10 cm deep
Weed control				hoe or oxen	Pre-E herbicide hoe	hoe	hoe	hoe
No.of weedings				2-3	0-1	2-3		2
Time of planting intercr.				early Febr	mid Mar	late March		late March
Time of planting C				late Febr	late March	late March	early Mar	mid March
Time of fertilizer apply				plant P	plant P	plant P	plant P July-August	plant C
Time of weeding: -1st				1 MAP	2 DAF peanut	1-2 MAP		1 MAP
-2nd				5 MAP	5 MAP	5 MAP		4-5 MAP
Time of harvest:								
-intercrops				July	July	early July	July	July
-cassava		Oct-Dec		late Nov-Jan	late Nov	mid Nov	late Dec-Mar	Nov-Dec
Intercropping system				M or P —> C 1 row M or 2 rows P between C rows	P —> C 3 rows P between C rows	P —> C 3 rows P between double row C	P —> C 2 rows P between C rows	C —> P P on side of cassava ridges

Table 19. Principal cassava varieties in Guangxi province, China and their characteristics

	Wuming Yinle village	Guiping county	Teng Jinji village	Yulin Sidi village
Main variety	SC 201 (100%)	SC 201	SC 205	SC 201
Secondary varieties		Some SC 205 Bread var.	SC 201 SC 124	SC 205
Characteristics:				
SC 205	Short plants –> not enough planting mat. Same yield as SC 201		Introd: 1980 High yield Easy peel Fast to dry	Low yield High DM Easy harvest
SC 201		Introd: 1980	Introd: 1950 Long thin roots Low DM	High yield
SC 124	Stakes too expensive Easy harvest Low starch	Stakes too expensive	Low yield Long thin roots –> difficult to harvest	
SC 102				
ZM 8002				
Nanzhi 188	Low yield Low starch			

Table 20. Cassava utilization, socio-economics, labor use, prices, costs and income in Guangxi province, China.

	Wuming county	Guiping county	Teng county	Wuming Yinle village	Guiping Fuping village	Teng Jinji town	Chenxi Xilan village	Yulin Sidi village
Utilization (%)				fresh	fresh	fresh	chips	mainly chips
Sold to factory		70 !		100	50	100	20	60
On-farm use		30		-	50	-	80	40
Chipping				-	chipping board			hand
Labor use (mandays/mu)								
land preparation				>1	1	3	6	2
plant intercrops						5-6	2	
stake prep. + planting				2	1-2		2	2
fert. application				2				4
weeding				4-7	1-2	1-4		
harvest intercrop				2	7	2	3	3-4
harvest C + peeling								4-6
chipping				(2)	1-2	-		6-7
drying				-	2	-		
Total				11-14	13-16	8-12		21-25
Prices and costs (Y)								
fresh roots/t				200-280	160-200	180-200	220	120-140
dry chips/t			400-600	510-800	700-800	-	560-970	380-440
starch (grade 1)/t			2,000	2,000-2,100		2,200-2,600		
maize/t				1,000				
peanut/t				2,000-3,000				
urea/50kg							80	80
SSP/50kg					18		30	28
cyanamide/50kg					25			28
KCl/50kg								68
15-15-15/50 kg (imported)								120
compound/50kg (local)				43			50	55
herbicide/box					2.5			
stakes of SC 124/stake				0.3				
Cost of labor/day								
Total cost of fert./mu				40-70	16	63	86	104
Net income (Y/fam.)								
-cassava	>300			>300	300	1,000-1,1000		140
-peanut				500	300		400	200-250
-maize				300				
-sugarcane				highest	600			

1 US $ = 8.4 Y ; 1 ha = 15 mu

Table 21. Major cassava starch factories in Guangxi province.

Factory	Location 1/	Products	Capacity (t/yr)
1. Ningming Overseas Chinese Starch Factory	Ningming county	starch	10,000
2. Luoxun Starch Factory	Wuming county	starch	20,000
3. Wuming Overseas Chinese Starch Factory	Wuming county	starch	8,000
4. Ningwu Starch Factory	Wuming county	starch	15,000
5. Mingyang Starch Factory	Nanning city	starch modified satrch alcohol animal feed	45,000
6. Liuzhou Glucose Factory	Liuzhou city	glucose	5,000
7. Luoyang Starch Factory	Liuzhou city	starch	8,000
8. Guiping Starch Factory	Guiping county	starch	10,000
9. Southern Starch Factory	Teng county	starch	10,000
10. Chenxi Light Indistry and Food Factory	Chenxi county	starch	5,000
11. Wuzhou Starch Factory	Wuzhou city	raw starch edible starch modified starch MSG alcohol maltose	10,000
12. Beihai Starch Factory	Beihai city	starch	4,500

1/ see Figure 6

Table 22. Cassava processing in four counties of Guangxi province, China.

	Wuming county	Nanning city	Guiping county	Wuzhou city
Manufacturer	Luo Xu Starch Factory	Minyang Starch Chemical		Wuzhou Starch, Alcohol
Ownership	Luo Xu township	State Farm Bureau	private	Wuzhou city
Products	1) starch	1) starch 2) alcohol (potable) 3) animal feed 4) modified starch	1) raw starch	1) raw starch 2) edible starch 3) modified starch 4) MSG 5) alcohol (potable) 6) maltose
Production capacity (t/year)	1) 20,000	1) 50,000 2) 15,000 3) 10,000	50	1) 15,000 2) 8,000 3) 6,000 4) 1,500
Actual production (t/year)		1) 45,000		
Production period	Nov-end June	Nov-end Aug	45-50 days (Nov-Dec)	Nov-end Sept
Raw material needs (t/year)	100,000 fresh roots (Nov-Jan) or dry chips (Apr-June)	30,000 fresh roots (Nov-Feb) + 30,000 dry chips	250 fresh roots .	15,000 fresh roots (Nov-Jan), 15,000 t chips (mid Jan-Oct)
Price (Y/t) -fresh roots	200-260	200-320	160-180	260-280
-dry chips	510-800	600-970		600-1,000
Conversion ratio	4 fresh roots = 1 starch 1.7 dry chips = 1starch	4 fresh roots = 1 starch	5 fresh roots = 1 starch	3.8 fresh roots = 1 starch 1.8 dry chips = 1 starch
Technology	Grated roots kept under water until processing (Feb-Mar)		Wash + peeling in drum, mill, settle (>10hrs), dry (>7 days)	
Price products (Y/t)	starch -grade 1 2,000 -grade 2 1,950 -grade 3 1,900 -export 2,150	mod. starch 3,200-13,500	starch 1,200	raw starch 1,800-2,700 mod. starch 3,000-10,000 alcohol >4,000
Raw material cost/total cost	65-70%	70%	85	
Economics (Y/yr) -output			60,000	
-profit	600,000		<10,000	
-tax	> 1 million			

Table 23. Costs, Income and profits/ha of various crops in Guangxi, province of China in 1990.

Crop	Average yield (t)	Income (yuan)	Goods and materials cost (yuan)	Labor (man-days)	Labor costs	Total cost (yuan)	Profit
Rice	5.74	3,057	816	493	1,433	2,250	734
Sugarcane	67.45	7,994	1,699	604	2,466	4,166	3,778
Maize	2.53	1,272	356	157	422	778	483
Peanut	2.00	3,987	1,570	457	1,576	3,145	788
Orange	18.25	18,177	6,689	1,113	4,592	11,190	5,648
Cassava	9.20	1,411	556	210	577	1,132	279

Note: 1 US$ = approx. 4.7 yuan in 1990; cassava yield calculated by multiplying data on dry slices by three.
Source: Guangxi Economic Year Book

Table 24. Guangxi cassava farmers problems, ranking and solutions mentioned (averages of 5 villages).

Problem/issue	Relative importance (H.M.L)	Frequency mentioned	Farmers suggested solutions
1. Drying and chipping needs much labor	H	4/5	Sell fresh to the market
2. Drying chips is difficult	H	3/5	Maybe other variety is better
3. Much capital needed	H/M	2/5	?
4. Much labor needed	H	3/5	Get capital to buy fertilizers and herbicides
5. Chip price sometimes is too low	M	2/5	Increase yields with better varieties
6. Government wants us to grow fruit trees instead of cassava	H	1/5	Smaller cassava area; need for better varieties to increase yield
7. Cassava growing is very hard on sloping areas	H/M	2/5	?
8. Government does not pay attention to cassava, only to rice	M	1/5	?
9. Problems with rats	M/L	1/5	?

Source: 1994 China RRA, primary data.

Table 25. Cassava area, yield and production in the various districts of Hainan province, China in 1979, 1989, 1991 and 1992.

County/City	Area (ha)				Yield (t/ha)			Production (t)		
	1979	1989	1991	1992	1989	1991	1992	1989	1991	1992
Wenchang	307	355	359	373	7.87	7.54	8.18	2,796	2,708	3,050
Qiongshan	1,407	1,584	1,771	1,960	7.64	8.82	9.72	12,094	15,616	19,052
Chengmai	493	866	807	1,093	18.75	7.42	7.60	16,238	5,989	8,305
Lingao	40	720	340	437	14.51	12.68	10.61	10,447	4,310	4,637
Danxian	413	1,532	887	668	12.87	11.72	12.71	19,717	10,396	8,490
Qionghai	553	920	896	951	9.09	10.63	12.68	8,363	9,522	12,058
Wanning	280	499	696	728	9.36	9.13	9.43	4,671	6,358	6,862
Linshui	266	1,858	715	637	9.24	6.71	7.85	17,168	4,799	5,002
Sanya	266	965	565	382	13.56	3.14	3.83	13,085	1,775	1,462
Ledong	87	1,524	1,943	2,111	9.82	6.49	5.21	14,973	12,613	11,002
Baoting	340	1,563	1,186	1,071	11.91	3.51	3.35	18,615	4,162	3,585
Dongfang	87	1,346	335	541	13.41	7.59	6.18	18,044	2,543	3,346
Baisha	933	1,533	2,367	2,308	20.13	19.37	19.83	30,859	45,848	45,760
Changjiang	153	788	195	168	12.31	10.61	7.50	9,697	2,070	1,261
Dingan	480	979	1,187	1,001	10.69	10.61	9.96	10,470	12,592	9,968
Tunchang	213	631	861	716	15.95	13.46	21.46	10,064	11,590	15,364
Qiongzhong	807	2,537	2,247	2,696	15.39	14.59	15.46	39,044	32,785	41,694
Tongzha	-	2,145	1,237	1,322	12.32	10.98	10.95	26,426	13,588	14,481
Total districts	7,125	22,345	18,594	19,163	12.65	10.72	11.24	282,771	199,264	215,379
State farms	-	9,754	5,320	5,198	19.25	14.41	17.41	187,765	76,673	90,495
Total for Hainan	-	32,099	23,917	24,361	14.66	11.54	12.56	470,536	275,937	305,874

Table 26. Supplementary data on climate, soils, and agriculture in Hainan province, China.

	Bayi State F. Tongshan branch	Bayi State F. Production team #2	Baisha county	Tongzha city	Qiongzhong county	Dingan county Longtan town
Latitude (°N)	19° 30'	19° 30'	19° 20'	18° 45'	19° 5'	19° 25'
Altitude (masl)	<100	<100	100-500	300-500	250-500	100-200
Soils	Hapludult	Hapludult	yellow-red Hapludult	rocky Paleustult	rocky Paleustult	dark Hapludult
Landscape						
-general	hilly	hilly	hilly	mountains	hilly-mount.	60% upland 40% irrig.
-cassava	on flat and steep slopes	on flat and steep slopes	on flat and gentle slopes	on steep slopes	on gentle slopes	on flat and gentle slopes
Climate						
Average temperature (°C)	23.0-23.5	23.0-23.5	23.5-24.0	22.5	22.0-22.5	22.0-23.0
Absolute minimum temp.						
Mean minimum temperature	5-7		5-7	4-5	4-5	5-7
Absolute maximum temp.						
Mean maximum temperature						35
Rainfall (mm)	1,600-1,800		1,600-1,800	1,600-1,800	>2,400	2,000-2,400
No.of frost-free days	365	365	365	365	365	365
Typhoon incidence	medium	medium	low	low	medium	high
Main crops (mu) 1/						
rice -irrigated	1,416			30,500	72,773	15,600
-upland				4,032	3,097	
cassava	2,500	300	36,778 (#3)	15,748	42,012	4,100
maize				9,382	904	
peanut				2,866	6,738	4,600
sugarcane	5,136	100	(#2)		8,182	14,000
fruit trees	410				10,300	4,200
vegetables				5,023	11,303	
rubber		1,000	(#1)			4,800
sweet potato	239		62,937	8,050		4,500
bamboo	1,000					
pineapple					14,167	
Cassava yield (kg/mu)						
-fresh			1,419		988	
-dry		500-750 v				
Total farm size (mu/lf) 2/						
-upland	5.0					
-irrigated	0.5					
Average income (Y/person)	3,200					

1) 1 ha = 15 mu
2) lf = labor force

Table 27. Land use, crops and cropping systems in Hainan province, China.

	Danxian city	Qiongzhong county						Dingan county
	Bayi State F. Production Team #2	Shifeng Production Team #1	Shifeng Hongba village	Maoyang Maolu village	Maogui Zhatong village	Hongdao Fongju village	Hongdao Xinchi village	Longtang various villages
Main crops 1/	rubber sugarcane forest cassava rice	rubber sugarcane cassava rice	rubber sugarcane rice cassava	rubber rice, maize cassava sugarcane fruit trees	rubber cassava rice maize soybean	rubber rice cassava bamboo beetle nut	rubber rice cassava beetle nut	sugarcane rice cassava rubber fruit
Land use - cassava	on steep slopes Rotate with SC	on gentle slopes with R or SC	in hills Rotate with SC or fallow	on very steep slopes	on gentle and steep slopes	on lower slopes	on gentle slopes	on flat C 1 yr --> SC 2 yrs
Cropping systems	C monocult. some C + M or C + P in fertile soil	C monocult. R + C intercr. 1 yr C--> 3 yrs SC	C monocult. some C + M or 2-3 yrs C--> fallow	C monocult. 3 yrs C --> 2 yrs fallow	C + M + SP R + C intercr. for 2 yrs 2 yrs C --> 2 yrs fallow	C monocult. no R+C	C monocult. no R+C 4-5 yrs C -->1-2 yrs fallow	C monocult. some C+P
Crop area (mu/fam.) -total 2/	8-10	3-7	40-50	20	15-18	10-12	6-8	12-20
-Cassava (mu/fam.) 3/	2-5	1-3	30-40 (legal-20)	4-6	5-10	4-7	2-4	1-5
-Irrigated (mu/labor force)	0.5		1.9	2.5-3.0	2.5-3.0	2.0-2.5	1-4	
-Upland (mu/labor force)	5.0		15-17	4-5	5	2.0-3.5	2-4	
-Rubber (mu/labor force)	11-12	8-9	7-8	5-10	8-12	0-8	7-8	10-12
Yield (kg/mu)								
-Cassava -fresh roots	1,500-2,000	500-1,000	1,000-2,500	1,000-2,000	750-2,000	1,500-2,500	750-1,500	1,000-1,500
-dry chips	500-750							
-Sugarcane		3,000-5,000						
-Maize					150-250			
-Sweet potato					400			

1) C = cassava, M = maize, P = peanut, SC = sugarcane, SP = sweet potato.
2) 1 ha = 15 mu
3) Note: in Hainan province land is assigned according to the number of labor force in the family.

Table 28. Cassava varieties and agronomic practices in Hainan province, China.

	Bayi State F. Production Team #2	Shifeng Production Team #1	Shifeng Hongba village	Maoyang Maolu village	Maoqui Zhatong village	Hongdao Fongju village	Hongdao Xinchi village	Longtang various villages
Varieties	SC 205 SC 6068	SC 205	SC 205	SC 205 Hainan narrow leaf	3 from SCATC	SC 205 Bread var.	SC 205	SC 102 Red stem
Fertilizer use (kg/mu)	very little FYM 15 (15-15-15) 4 urea	250 FYM no fert. for SC : 20-25 urea 5 (15-15-15)	In 3rd yr: 25 SSP 17 (15-15-15)	none	none	0-250 FYM 0-20 SSP	In 3rd yr: 50 SSP	250 FYM or 50 SSP 12 urea
Land preparation	slash/burn planting holes 10x20 cm	slash/burn planting holes 10x20 cm	slash/burn planting holes	slash/burn planting holes	slash/burn hoe all area	buffalo 2 plow + 2 rake	buffalo 1-2 plow 1-2 rake	buffalo 1-2 plow 1-2 rake
Plant spacing (m)	0.6x0.6 0.8x0.8 at random	0.8x0.8 1.0x0.6 at random	0.5x0.5 0.6x0.6	0.6x0.6	0.6x0.6 0.8x0.8 at random	0.6x0.7	0.5x0.6 0.7x0.7	0.6x0.6
Planting method	horizontal	horizontal		horizontal	horizontal	horizontal	horizontal	horizontal
Planting depth (cm)	6-10				10	10	10	15
Stake length (cm)	10-20	10-15			10-15	15-20	15-20	
Weed control	PreE herbicide + hand	hand	PreE herbicide contact + hand	hoe/knife	hoe/knife	hoe/hand-pulling	hoe	buffalo + ridging up
No.of weeding	1 + 1	2	2 + 1	2	2	2	1-2	1-2
Time of planting	Feb-Mar	Feb-Mar	Feb-Mar	Mar-Apr	Mar-Apr	Jan-Feb	Jan-Feb	Jan-Mar
Time of fert. applic.	at planting urea 2-3 MAP							at or after planting
Time of weeding: -1st	1-4 DAP	2 MAP		2 MAP	2 MAP	2 MAP	1-2 MAP	2 MAP
-2nd	2 MAP	4-5 MAP		4 MAP	4 MAP	5-6 MAP	5-6 MAP	
Time of harvest:								
-intercrops					June-July			
-cassava	Nov-Feb	Nov-Dec	Nov-Jan	Nov-Apr	Nov-Jan	Nov-Dec	Oct-Jan	Nov-Jan
Intercropping system				sometimes 2 yrs C cycle	C + M with SP in between			

Table 29. Principal cassava varieties and characteristics in Hainan province.

	Bayi State F. Production Team #2	Maoyang Maolu village	Hongdao Fongju village	Longtang various villages
Main variety	SC 205	SC 205		SC 102
Secondary varieties	SC 6068 2 local var.	Hainan narrow leaf		Red stem
Characteristics:				
SC 205	High yield	High yield Short stem--> typhoon resist. Lack of plant material	High yield High DM	
SC 201				
SC 124	Not typhoon resistant			
SC 102				High yield High starch Typhoon resist.
ZM 8002			High yield High DM Cold resist. Typhoon susc.	

Table 30. Cassava utilization and socio-economics in Hainan province, China.

	Bayi State F. Production Team #2	Shifeng Production Team #1	Shifeng Hongba village	Maoyang Maolu village	Maoqui Zhatong village	Hongdao Fongju village	Hongdao Xinchi village	Longtang various villages
Utilization (%)	chips	chips	chips	fresh	fresh	fresh	fresh	chips/flour
Sold -factory	80-90	80	90	90-100	90-100	80-90	70-80	
Local market								10-30
On-farm use	10-20	20	10	0-10	0-10	10-20	20-30	70-90
Chipping	Chip. machine	hand or chipper					chipper	chipping board or chipper
Labor use (mandays/mu)								
land preparation	6-9 (new land)	2-5	15	5	4-5 (new land)	3-6 (new land)	2-3	0.5-1.0
stake prep. + planting	2-3 (old land)			6-7	3 (old land)	1-3 (old land)	< 1	1
						0.5-1.0		
fert. application					4-5	1.5		1
weeding	3-6	3-6		4	2-4	2-4	2-6	1
harvest transp.	3-6	2-3		3-4	6-9	> 2	2	3
chipping	0.5-1.0	1-2		-	-	-	0.5-1.0	1-2
drying	2-3 (1)	1		-	-	-	-	2 (1)
Total	11-23	9-17		18-20	15-23	7-15	8-13	8-10
Prices and costs (Y)								
fresh roots/t	240	180	160-180	140	160	180	150-160	
dry chips/t	500-600	500-600	500-600					500-800
starch (grade 1)/t		1,600-1,700						
maize/t	1,300				1,000			
sweet potato/t					300-400			
rubber/kg	14							
urea/50kg								80
SSP/50kg			23-32			30	30	30-38
15-15-15/t (imported)	80-100		100-120			> 80		130
compound/50kg (local)								60
Cost of labor/day	12-15		5-10					
Total cost of fert./mu	30-36	0	0-15	0	0	0-14	0-30	20-50
Net income (Y/fam.)								
-cassava	100-300	100-200		150-300	220-300	200-250	100-250	240
-sugarcane	100-380	100-300						

1 US $ = 8.4 Y ; 1 ha = 15 mu

Table 31. Major cassava starch and animal feed factories in Hainan province.

Factory	Location 1/	Capacity 2/
1. Qiongzhong Starch Factory	Qiongzhong county	6,000
2. Dazhipo Starch Factory	Qiongshan county	6,000
3. Baisha Starch Factory	Baisha county	3,000
4. Maoyang Starch Factory	Tongzha city	3,000
5. Nankun Starch Factory	Tunchang county	3,000
6. Baoting Starch Factory	Baoting county	2,000
7. Dingan Starch Factory	Dingan county	2,000
8. Lixiegu Private Starch Factory	Baisha county	1,000
9. Xishui Satrch Factory	Baisha county	500
10. Longjiang Satrch Factory	Baisha county	500
11. Wanchong Starch Factory	Ledong county	500
12. Fenglai Satrch Factory	Wenchang county	500
13. Shishan Starch Factory	Qiongshan county	500
14. Songtao Satrch Factory	Qiongzhong county	500
15. Yangjiang Starch Factory	Qionghai county	500
16. Heshe Starch Factory	Lingao county	500
17. Nanfeng Feed Factory	Qiongshan county	80,000
18. Qiongzhou Feed Factory	Qiongshan county	50,000
19. Huaxin Feed Factory	Haikou city	50,000
20. Baoli Feed Factory	Wenchang county	10,000
21. Fushan Feed Factory	Chengmei county	10,000
22. Yangjiang Feed Factory	Qionghai county	10,000
23. Xiangshan Feed Factory	Tunchang county	10,000

1/ see Figure 10
2/ * = indicates that factory is still processing

Table 32. Cassava processing in three counties of Hainan province, China.

	Baisha county	Tongzha city	Qiongzhong county
Manufacturer	Lixiegu Starch Factory	Maoyang Starch Factory	Qiongzhong Starch Factory
Ownership	private		state
Products	raw starch	starch	starch
Production capacity (t/year)	2,500	3,000	10,000
Actual production (t/year)	700		3,000-4,000
Production period	3 months (Nov-Jan)		Nov-March
Raw material needs (t/year)	12,500 fresh roots		45,000-50,000 fresh roots (Nov-Mar) or dry chips equivalent (Apr-May)
Price (Y/t) -fresh roots	180		200
-dry chips			800
Conversion ratio	5 fresh roots = 1 starch		5 fresh roots = 1 starch 1.6 dry chips = 1 starch
Technology	wash + peeling in drum, mill, sediment. in channels dry in sun + flash dryer		
Price products (Y/t)	starch 1,600-1,700		starch 2,000
Raw material cost/total cost			
Economics (Y/year) -output			
-profit			
-tax			
Problems	raw material supply	raw material supply	raw material supply

Table 33. Hainan cassava farmer problems, ranking and solutions mentioned (averages of 7 villages).

Problem/issue	Relative importance (H.M.L)	Frequency mentioned	Farmers suggested solutions
1. Cassava prices are too low	H	4/7	?
2. Chip drying is difficult because of weather	H	3/7	Sell fresh roots to factory
3. Chip drying takes a lot of labor	H	3/7	Maybe some better tool/machine?
4. Low soil fertility; cassava saps nutrients; steeplands; erosion	H	6/7	Fertilizers needed; contour plowing (too much labor); closer planting
5. Herbicides and fertilizers are too expensive (but we need them); too much labor for weeding	H	5/7	?
6. Too much labor for harvest and transport from hillsides plots	H/M	4/7	?
7. Problem with rats in the fields	L/M	1/7	?
8. Lack of market at times	M	1/7	Try to store some of the chips, but get moldy; feed more pigs

Table 34. Summary of agronomic practices for cassava in China

	Guangdong	Guangxi	Hainan
Cropping systems	C + trees C+P, C+M Monoculture	C+P, C+M C + watermelon	C monoculture C + rubber
Cropping pattern	C 2-3 years with trees	C + P rotated C + M	2-3 years C rotated wit SC or fallow
Varieties	SC201, SC205	SC201, SC205	SC205, SC102
Land use	C on steep hills with trees C on gentle slopes or terraces	C on gentle slopes or terraces	C on gentle slopes C on steep slopes
Land preparation	Hoe or water buffalo	Water buffalo or hoe	Planting holes with joe water buffalo
Planting time	Late March-April	Febr.- March	Jan.-March/April
Harvest time	Nov.-Dec.	Nov.-Dec.	Nov.-Dec (to MArch)
Fertilizer use	None in C + trees FYM+NPK to intercrops NPK to cassava	FYM+NPK to intercrops NPK to cassava	FYM+NPK to SC in rota FYM+NPK in 3d yr. of C monoculture
Planting method	Horizontal	Horizontal	Horizontal
Planting distance (m)	1,0x0,8 - 1,0x0,6	1,0x1,0 (1,5+0,6)x0,5	0,6x0,6; 0,8x0,8
Weeding	2-3 times by hoe	2-3 times by hoe some herbicides	2-3 times by hoe some herbicides
Stake storage	Underground	underground	aboveground

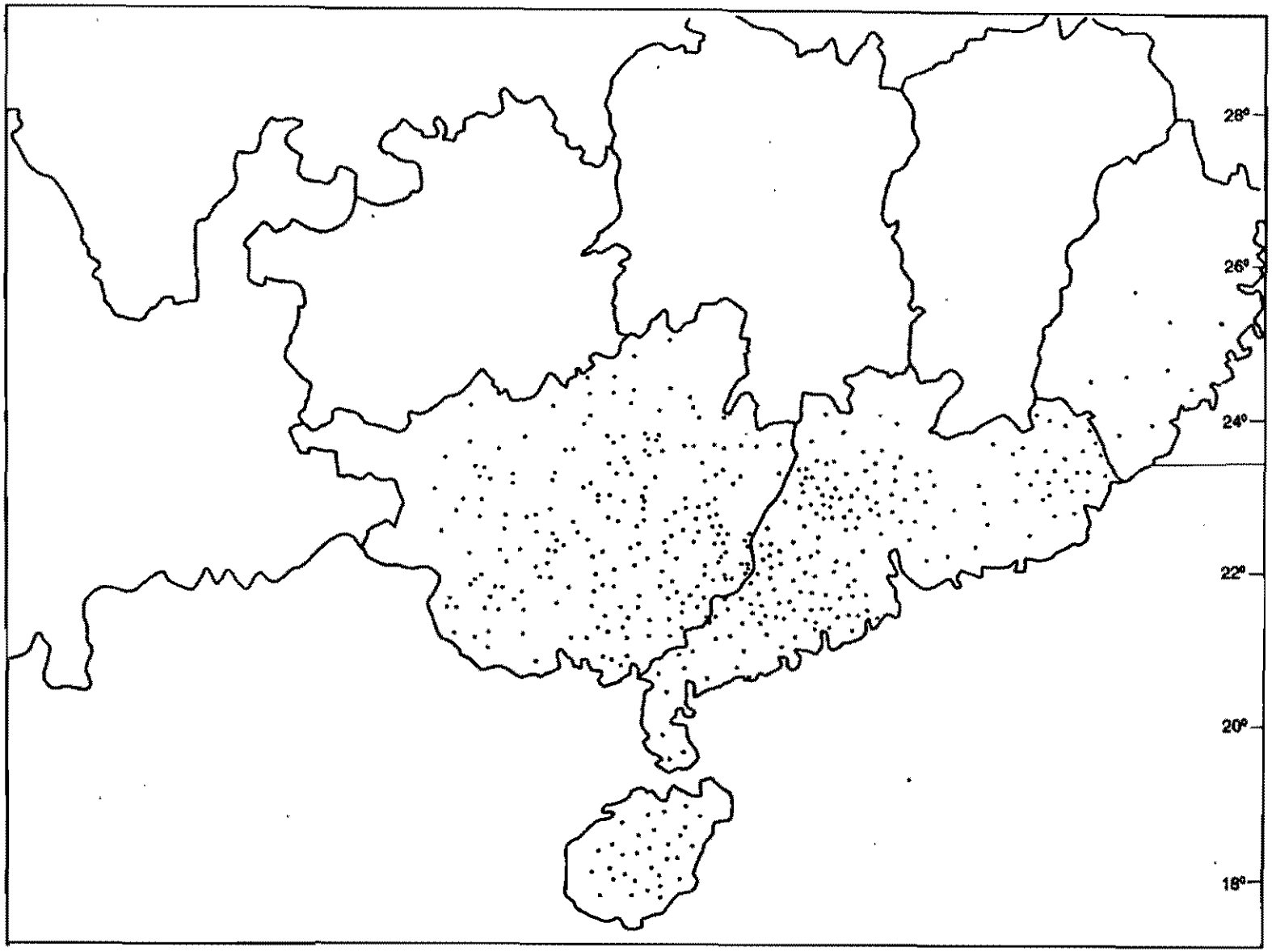

Figure 2. Cassava growing areas in China in 1989. Each dot represents 1000 ha of cassava.

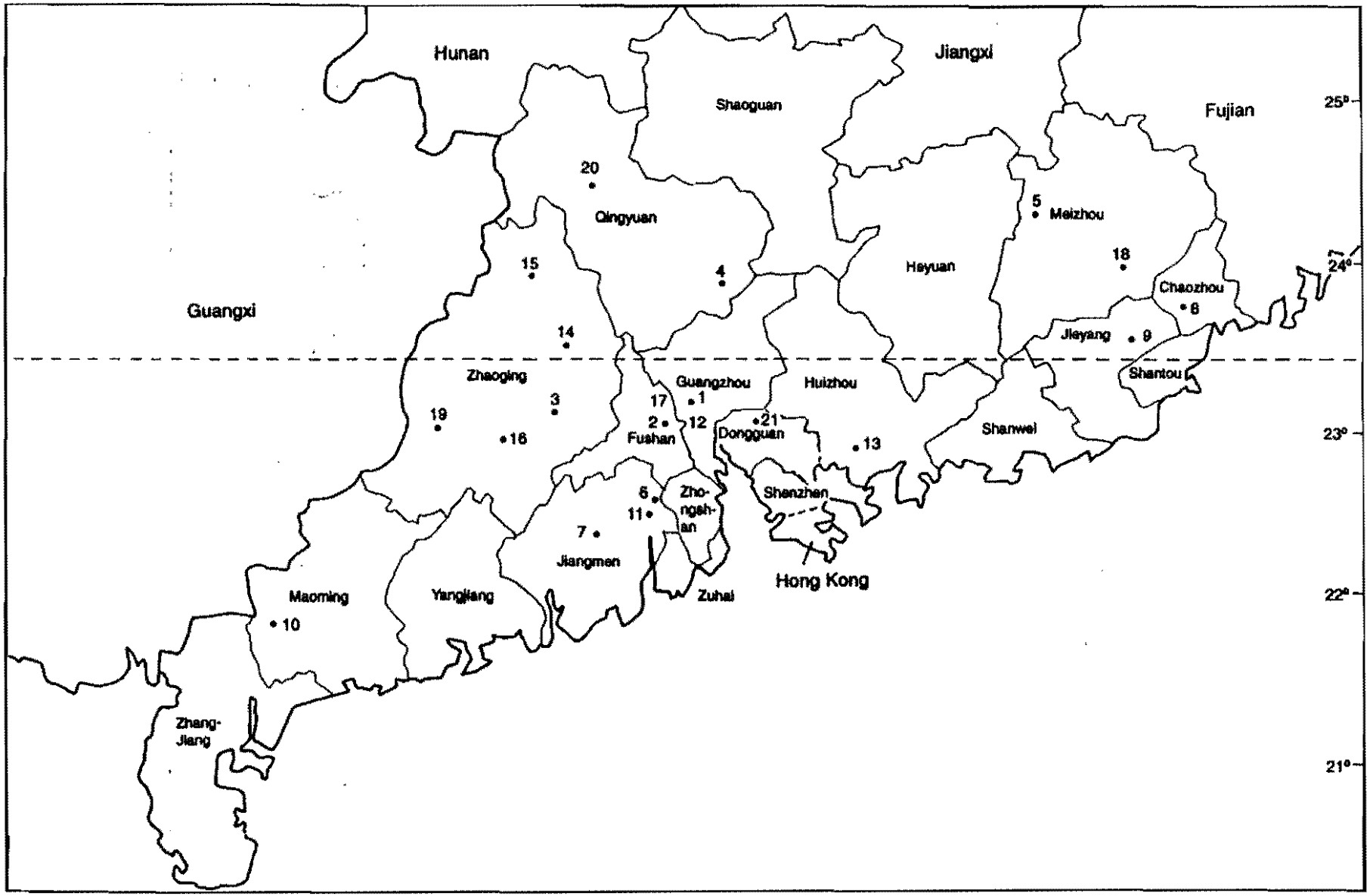

Figure 3. Districts (or cities) in Guangdong Province of China. Numbers indicate the location of the principal cassava processing factories (see Table 10).

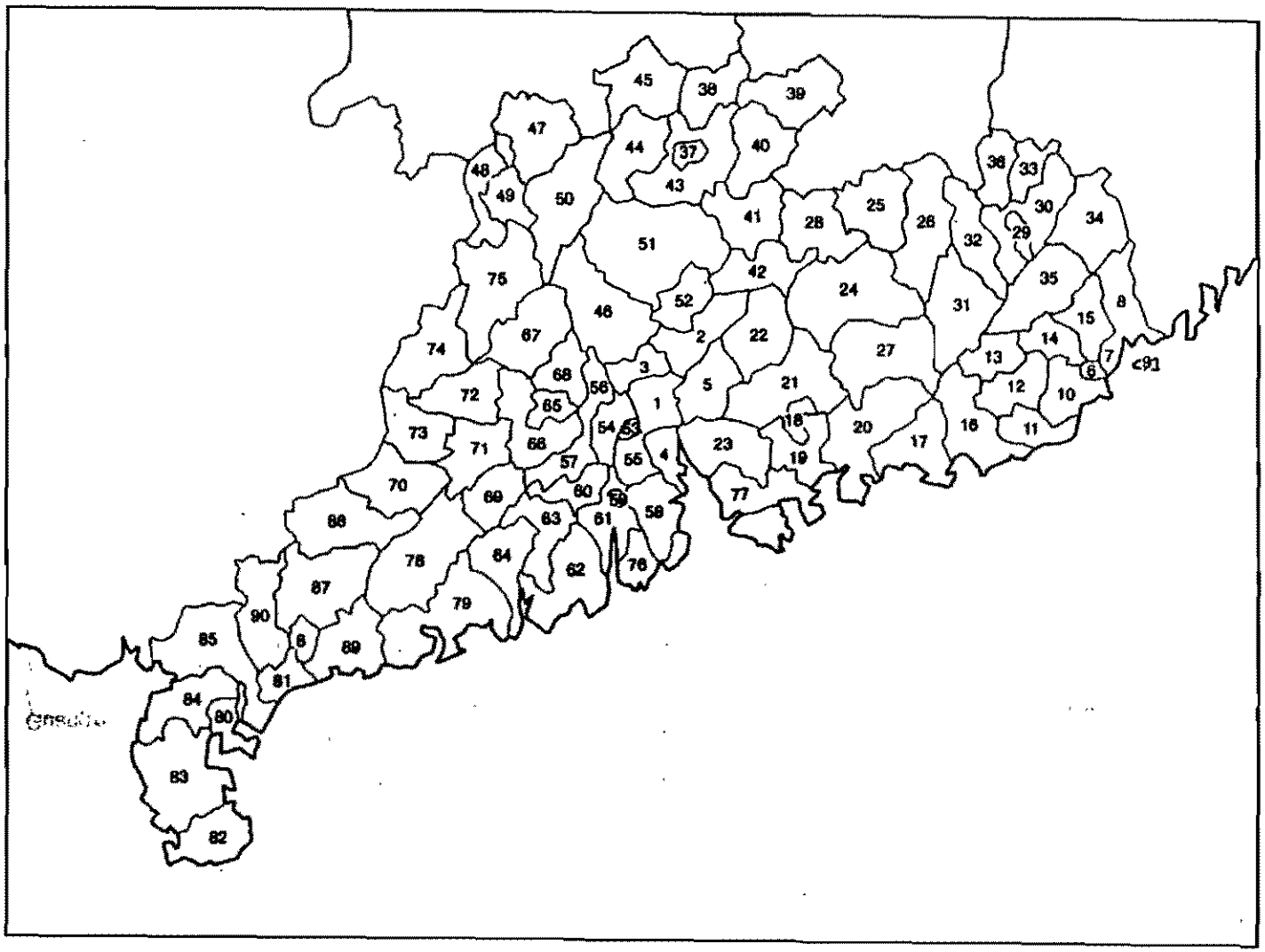

Figure 4. Counties in Guangdong Province of China. The names of counties are shown in Table 3.

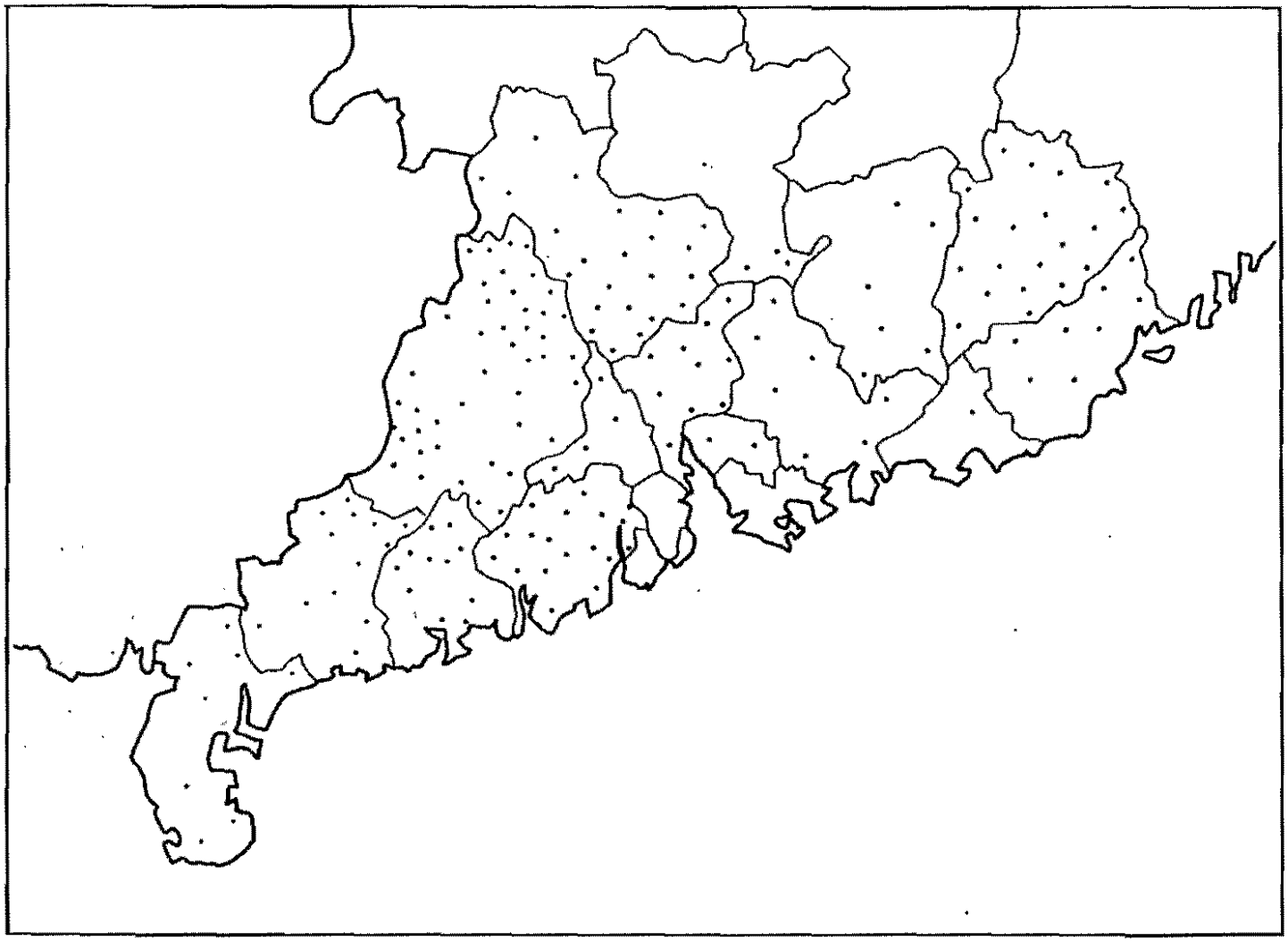

Figure 5. Cassava production zones in Guangdong Province of China in 1987. Each point correspond to 1000 ha.

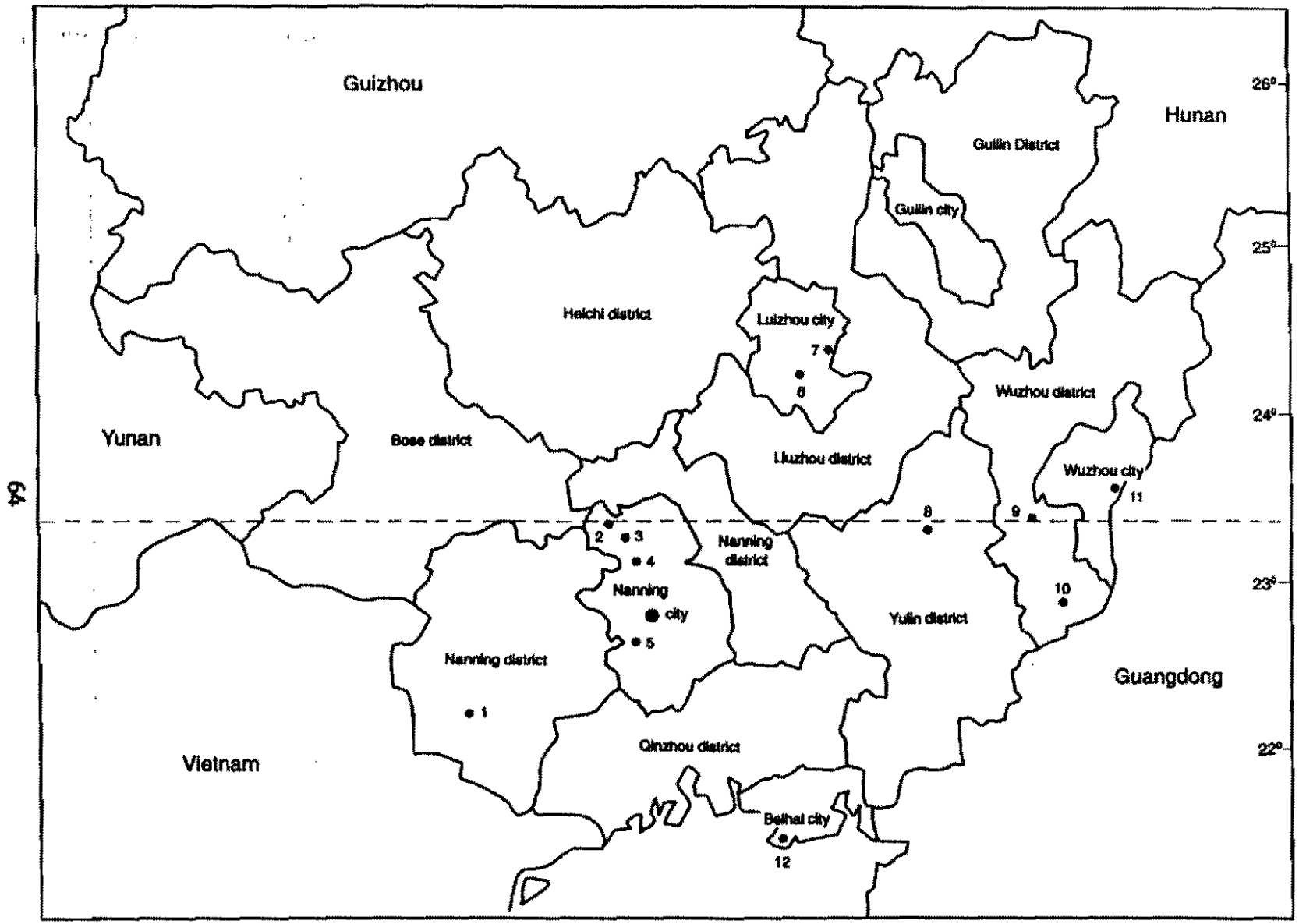

Figure 6. Districts and cities of Guangxi Province of China. Numbers indicate location of major starch factories.

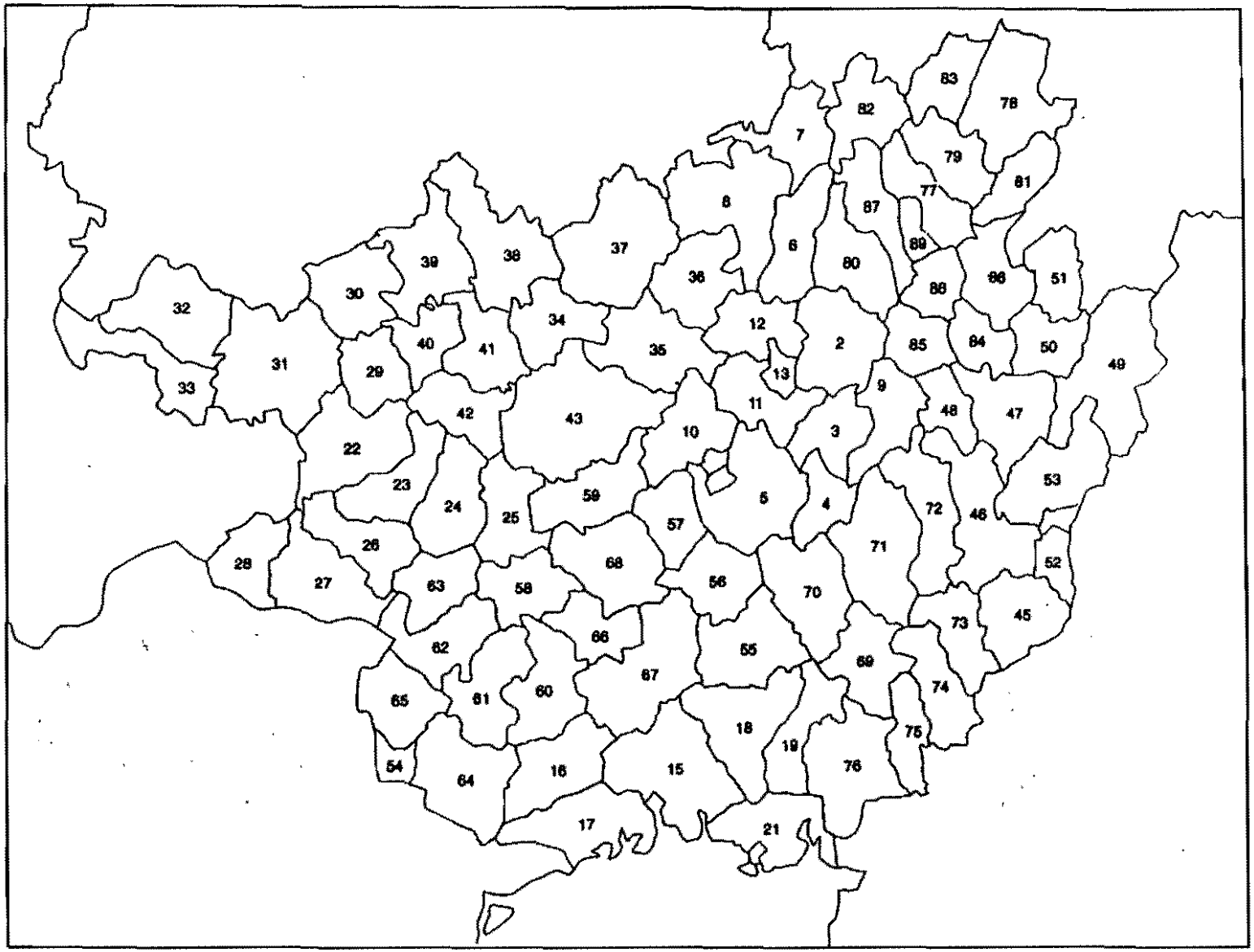

Figure 7. Counties, cities and suburbs in Guangxi Province of China. See Table 11 for names.

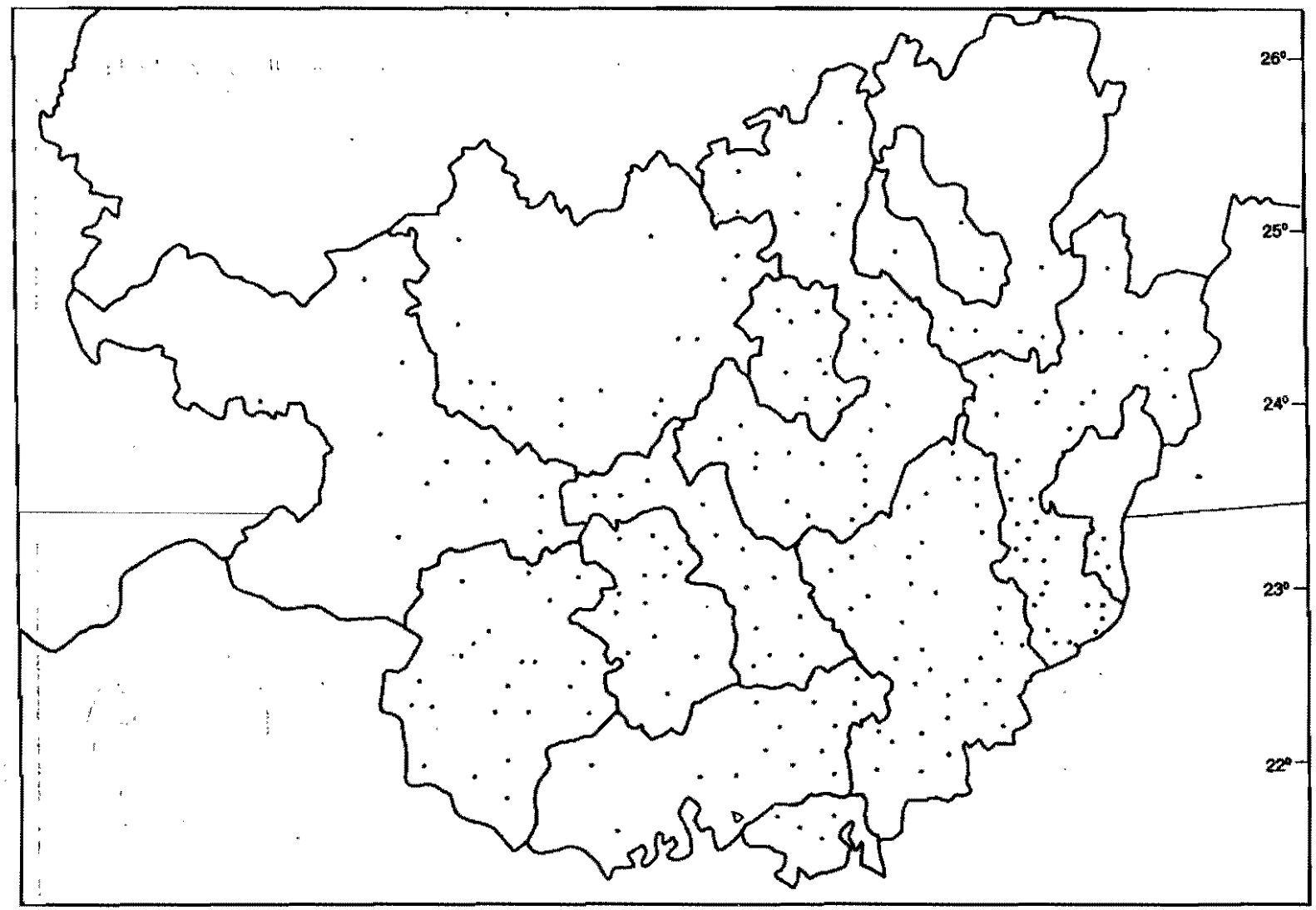

Figure 8. Cassava growing areas of Guangxi Province of China in 1989. Each dot represents 1000 ha of cassava.
Source: Guangxi Statistics Bureau, 1989.

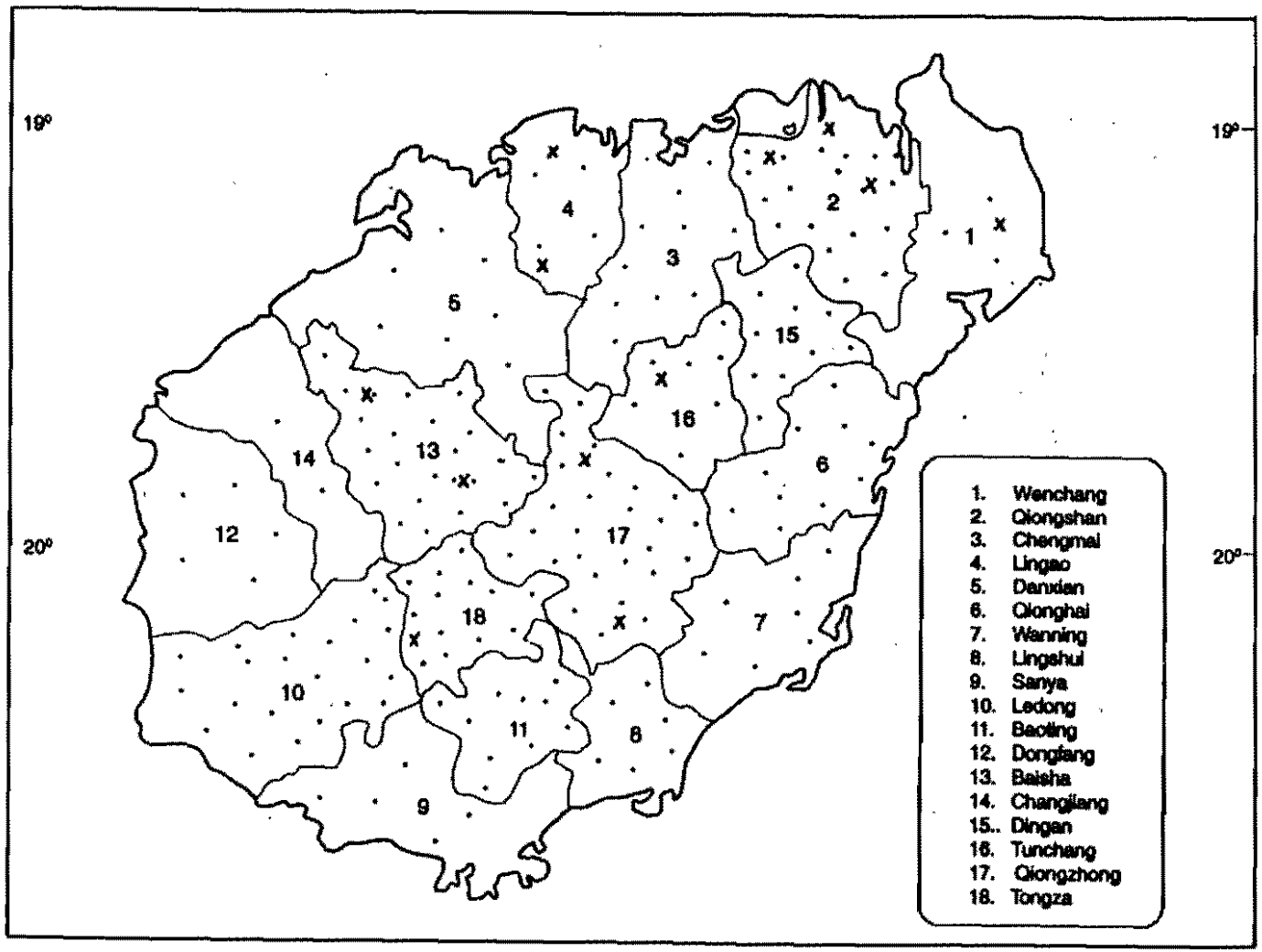

Figure 9. Cassava production area in the various districts of Hainan Province of China in 1992. Each dot indicates 100 ha of cassava.

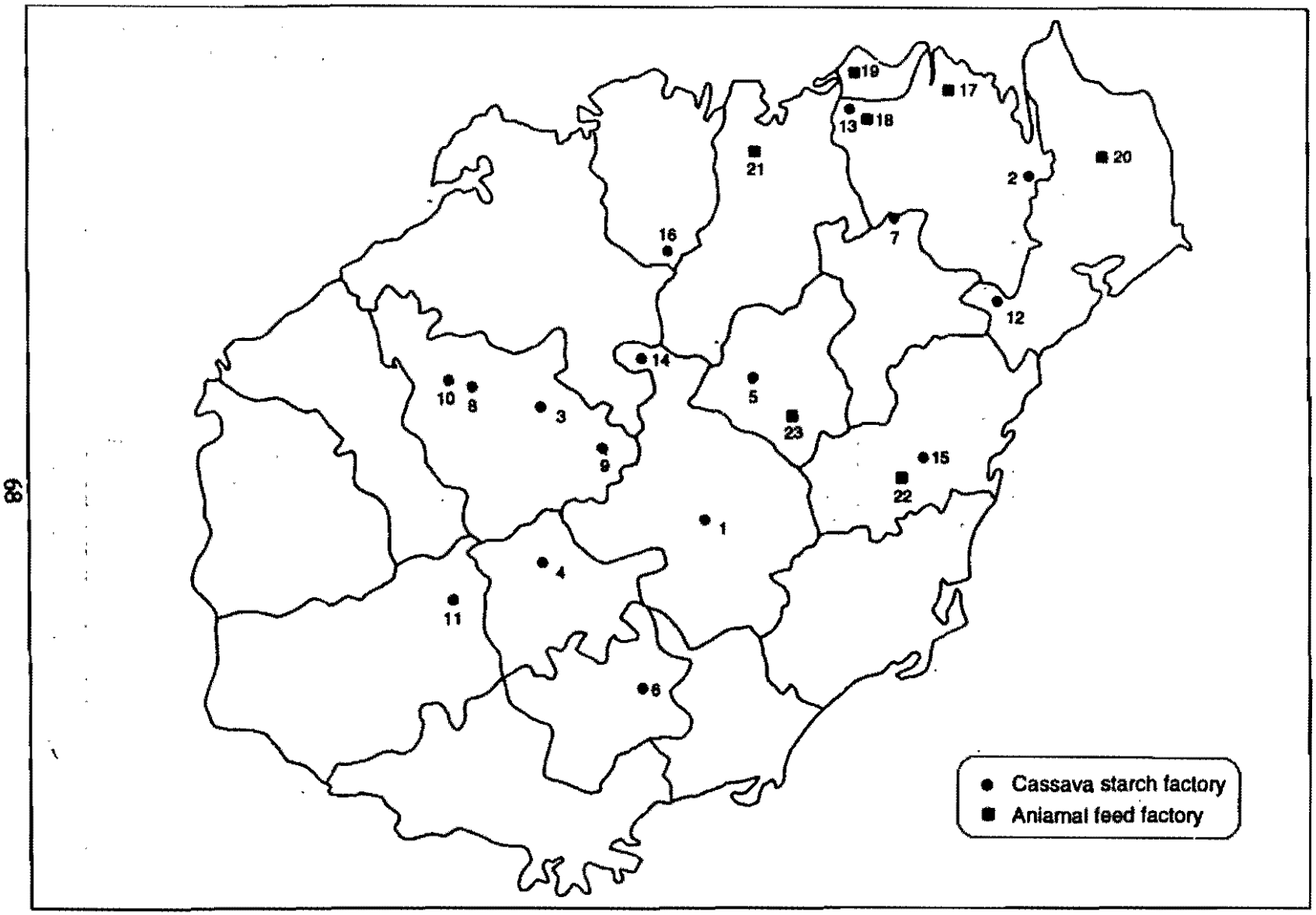

Figure 10. Location of cassava starch and animal feed factories in Hainan Province (see Table 31).