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Trends and Distribution of Chinese Cassava Production and Use 1820-1984
(A technological and economic examination of historical development and future potential)

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TRENDS AND DISTRIBUTION OF CHINESE CASSAVA PRODUCTION AND USE 1820 - 1984

Production trends and distribution

No official national data series for cassava in the Peoples Republic have been published by Chinese authorities It is possible to obtain estimated series from the Food and Agricultural Organization of the United Nations [1] Such series are based on assumed annual increments in harvested area for most years and somewhat less regular but a similar monotonically non-decreasing set of estimates for production Yields appear to be derived from the rough area and production estimates by calculation The only figure among these which appears to have come from a Chinese source is the 3 million ton production figure circa 1980 provided unofficially as an undated estimate to the 1982 CIAT delegation by one of the agricultural science institutes visited in Guangdong Earlier work [2] has concluded that the entire FAO series for root and tuber crops bears little relation to the aggregate series published since 1979 by Chinese statistical authorities [3] It is now also clear that the FAO

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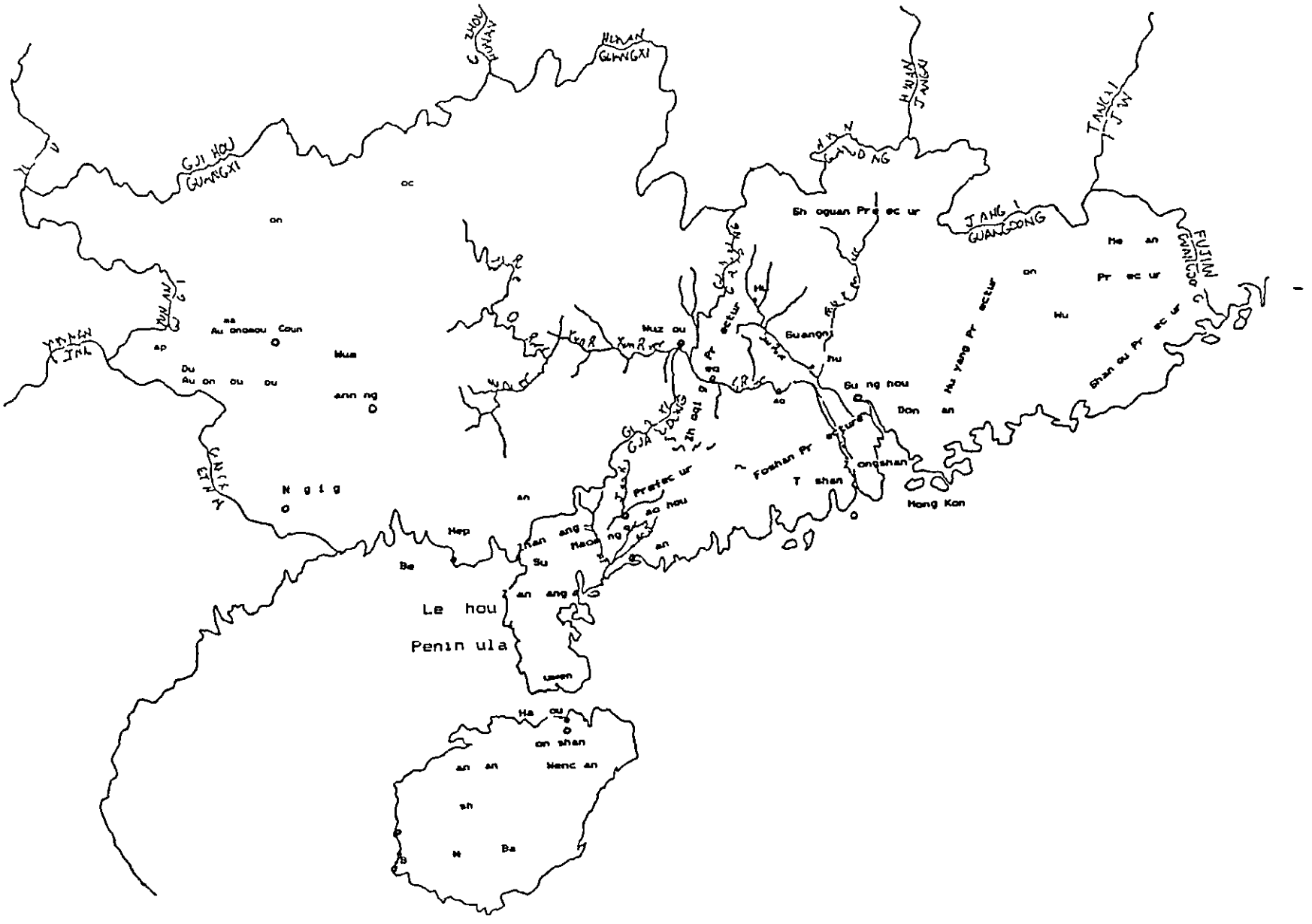
[1] e g FAO Supply Utilization Tapes 1984 Rome 1985 FAO Standardized Commodity Balance Tape 1984 Rome 1985 and FAO Production Yearbook Tape 1984 Rome 1985

[2] Bruce Stone An Examination of Economic Data on Cassava Production Utilization and Trade a paper prepared for the International Center for Tropical Agriculture (CIAT) International Food Policy Research Institute Washington D C August 1983

[3] e g He Kang et al Zhongguo Nongyebu [Ministry of Agriculture of China] (eds) Zhongguo Nongye Nianjian 1980 [Agricultural Yearbook of China 1980] (Beijing Nongye Chubanshe [Agricultural Publishing House] 1980) and Zhongguo Guojia Tongjiju [State Statistical Bureau] Zhongguo Tongji Nianjian - 1983 [Statistical Yearbook of China 1983] (Beijing Tongji Chubanshe [Statistical Publishing House] 1983)

Known Cassava Growing Regions of the People s Republic of China (see text for details)



*Location as described by CIAT delegation 1982 as the most southwestern tip of Hainan Island

series for cassava *per se* conflict with officially published series for one of the two principal growing regions and with scattered national estimates for individual years found elsewhere in Chinese publications Since 1984 the FAO has taken account of some of the recent information in formulating current root and tuber crop estimates for publication in FAO Production Yearbooks But much recent information has not been reflected in FAO series and additional work is required to obtain a reliable impression of long term trends for individual crops including cassava

According to Chinese sources [4] cassava had been introduced into China from South America via nanyang [the South Seas or Pacific Ocean] by 1820 although it is not clear whether it entered Guangdong Province directly from the West or whether it was introduced indirectly following regional cultivation in Sri Lanka India or Indonesia By far the main Chinese producing area is the extreme south below the Tropic of Cancer (23 5°N) especially Guangdong

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[4] Liang Guangshang (ed) Mushu Zaipei yu Liyong [Cassava Cultivation and Use] (Guangzhou Guangdong Keji Chubanshe [Guangdong Scientific and Technical Publishing House] 1981) author s preface and p 4 Cassava is confirmed to have been grown in China for more than 100 years in Zhongguo Kexueyuan Dili Yanjiusuo Jingji Dili Yanjiushi [Chinese Academy of Sciences Institute of Geography Economic Geography Research Room] Zhongguo Nongye Dili Zonglun [A General Treatise on China s Agricultural Geography] (Beijing Kexue Chubanshe [Scientific Publishing House] 1980) p 129 1820 was also the introduction date mentioned during a spring 1982 delegation from the International Center for Tropical Agriculture (CIAT) and recorded in James H Cock and Kazuo Kawano Cassava in China unpublished trip report CIAT Palmira Colombia June 1982 p 1 However Mushu Zaipei yu Liyong clearly indicates that 1820 is the earliest record of cassava cultivation so far uncovered the introduction date may well have been earlier

Province and Guangxi Zhuang Autonomous Region Of the two production has typically been greatest in Guangdong Cassava is also cultivated in Fujian Yunnan Hunan Guizhou and Taiwan Provinces but much less extensively and to a very minor extent in Hubei Jiangxi Zhejiang and Sichuan Some estimates of provincial cultivated area gleaned from Chinese sources are arranged in Table 1

While cassava had been introduced into Guangdong and Guangxi by the first half of the 19th century and a book devoted to cassava planting methods had been published as early as 1900 the first cultivation record in Fujian is 1920 and in Taiwan 1929 Introduction dates for most other provinces were considerably later Hunan 1941 Guizhou 1942 Zhejiang 1954 and Jiangxi 1959 Cultivation of cassava in Yunnan though potentially beginning earlier was estimated at only two thousand hectares in 1960 Most farmland in these provinces fall within what is described in Chinese sources as the expansion area north of the Tropic of Cancer and south of 30°N There is experimental cultivation of cassava even north of 30°N with the northernmost plantings at the Hebei Forestry Science Institute at 39°20 N These experiments began during the famine years in 1960 and 1961 in Hubei Anhui Jiangsu Shaanxi Shandong Liaoning Sichuan and Hebei which constitute the first record of cassava related activities in these provinces [5] Cassava

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[5]Liang Guangshang (ed) Mushu Zaipei yu Liyong author s preface and pp 4 9 and 10

Table 1 Area Sown with Cassava in China and Major Chinese Cassava-Growing Provinces 1943-1984

	China	Guangdong	Guangxi	Fujian	Taiwan	Yunnan	Guizhou	Hunan	Zhejiang Jiangxi
			(thousand hectares)						
1943		33 4							
1950			41 5						
1951			37 6						
1952			48 5		8 0				
1953			41 3		9 0				
1954			67 5		10 4				
1955			62 6		10 7				
1956			93 0		10 6				
1957			104 3		10 9				
1958			132 6		12 3				
1959			118 8		11 9				
1960			127 9		13 0	2 0			
1961	365 3		104 4	>6 7	17 2		0 6		
1962			(183 5/158 7)		18 2				
1963			153 4		20 2				
1964			154 3		19 8				
1965		<149*	158 5		20 5				(0 3)
1966			102 2		21 0				
1967			70 3		22 0				
1968			73 7		25 0				
1969			124 7		25 9				
1970		<201*	145 6		24 7				
1971			129 6		24 6				
1972		167 3	124 5		24 6				
1973			107 9		24 3				
1974			100 8		26 8				
1975		<223*	131 9		21 8				
1976			110 5		22 2				
1977			74 6		22 3				
1978	(470 530)	<236*	131 0		19 5				
1979			156 0		17 0				
1980			207 8		14 9				
1981	(350)	(200)	190 4		13 9				
1982		≤195	175 2		9 9				
1983		≤158	120 6		5 8				
1984		≤159	94 0		5 2				

Notes Empty data cells indicate that the statistical information is not available and do not denote zero values Parentheses enclose rough estimates for the indicated or nearby years The applicable years for parenthesized estimates were not stated in the source Other provinces where farmers grow cassava include Hubei and Sichuan but sown area is minor Taiwan Province is now normally not included in national aggregated statistics for the People s

Republic of China although separate data entries for Taiwan are not unusual among PRC statistical compendia Taiwan is probably included in the 1961 national figure however

* These figures probably overestimate officially recorded plantings by 20-40 thousand hectare
See Table 7

Sources

Guangxi

Guangxi Jingji Nianjian Bianjibu [Guangxi Economic Yearbook Editorial Department] (eds) Guangxi Jingji Nianjian 1985 [Guangxi Economic Yearbook 1985] (Nanning Guangxi Jingji Nianjian Bianjibu 1985) pp 531 and 593

The 1976 figure was confirmed in Guangxi Nongye Dili Bianxiezu [Guangxi Agricultural Geography Editorial Board] (eds) Guangxi Nongye Dili [Guangxi Agricultural Geography] (Nanning Kexue Chubanshe [Scientific Publishing House] 1980) p 76

The lower figure for 1962 is from Liang Guangshang (ed), Mushu Zaipei yu Liyong (Guangzhou Guangdong Keji Chubanshe 1981) p 9

Taiwan

Republic of China Executive Yuan Directorate-General of Budget Accounting and Statistics Statistical Yearbook of the Republic of China 1985 (Taipei Republic of China 1985) p 281

The 1952 54 figures were added from

Republic of China Directorate-General of Budget Accounting and Statistics Statistical Yearbook of the Republic of China 1982 (Taipei Republic of China 1982) p 115

China and other Provinces

The 1978 figure is from Zhongguo Kexueyuan Dili Yangjiusuo Jingji Dili Yanjiushi [Chinese Academy of Science Institute of Geography Economic Geography Research Laboratory] Zhongguo Nongye Dili Zonglun [A General Treatise on Chinese Agricultural Geography] (Beijing Kexue Chubanshe 1980) p 129

The 1981 figure is from James H Cock and Kazuo Kawano Cassava in China unpublished trip report

Table 2 Cassava Production Area and Yield in Guangxi Zhuang Autonomous Region 1950-1984

	Production		Area	Yield	
	(Grain Equivalent) Tons	(Fresh Root) Tons	(Hectares)	(Grain Equivalent) T/Ha	(Fresh Root) T/Ha
1950	30 045	150 225	41 507	0 724	3 619
1951	39 365	196 825	37 567	1 048	5 239
1952	41 870	209 350	48 493	0 863	4 317
1953	36 635	183 175	41 340	0 886	4 431
1954	42 535	212 675	67 453	0 631	3 153
1955	35 365	176 825	62 647	0 565	2 823
1956	58 280	291 400	93 013	0 627	3 133
1957	91 000	455 000	104 320	0 872	4 362
1958	165 205	826 025	132 567	1 246	6 231
1959	140 330	701 650	118 840	1 181	5 904
1960	88 045	440 225	127 913	0 688	3 442
1961	115 855	579 275	104 353	1 110	5 551
1962	189 260	946 300	183 547	1 031	5 156
1963	152 335	761 675	153 433	0 993	4 964
1964	160 225	801 125	154 307	1 038	5 192
1965	167 835	839 175	158 520	1 059	5 294
1966	84 435	422 175	102 220	0 826	4 130
1967	173 715	868 575	70 300	2 471	12 355
1968	162 120	810 600	73 667	2 201	11 004
1969	216 750	1 083 750	124 733	1 738	8 689
1970	235 990	1 179 950	145 600	1 621	8 104
1971	211 295	1 056 475	129 613	1 630	8 151
1972	262 270	1 311 350	124 480	2 107	10 535
1973	206 545	1 032 725	107 900	1 914	9 571
1974	170 765	853 825	100 847	1 693	8 467
1975	260 425	1 302 125	131 900	1 974	9 872
1976	187 065	935 325	110 473	1 693	8 467
1977	141 865	709 325	74 567	1 903	9 513
1978	258 295	1 291 475	131 020	1 971	9 857
1979	312 645	1 563 225	155 993	2 004	10 021
1980	481 215	2 406 075	207 760	2 316	11 581
1981	484 280	2 421 400	190 387	2 544	12 718
1982	468 255	2 341 275	175 173	2 673	13 365
1983	326 680	1 633 400	120 640	2 708	13 539
1984	241 180	1 205 900	94 001	2 566	12 829

Notes Cassava production and yield data are often quoted in Chinese statistical sources on a grain equivalent basis Since 1964 the conversion to grain equivalence for all root and tuber crops has meant dividing the fresh weight by five although this would undervalue cassava sweet potatoes and taro relative to most cereal crops in terms of calories per unit weight It is assumed that the production and yield data in the source for this table appeared in

International Center for Tropical Agricultural Research (CIAT) Cali Colombia June 1982 pp 1 2

The 1961 figure is from Liang Mushu Zaipei yu Liyong p 9 This source also stated that national cassava sown area remained around 5 million mu during the 1960s (300-367 000 hectares assuming 4 5-5 5 million mu) The figure for Hunan Zhejiang and Jiangxi combined was given as around 5 000 mu (333 ha) in each year of the 1960s

Guangdong — The overestimates for Guangdong for 1965 1970 1975 1978 1979 and 1982 84 are from Table 7 A 1981 overestimate of 201 thousand hectares was also calculated The 1979 and 1982-84 estimates are relatively close approximations The 1965 1970 1975 and 1978 figures probably overestimate by at least 20-40 thousand hectares See Table 7 The 1943 and 1972 figures are from Liang Mushu Zaipei yu Liyong p 9 and the 1981 estimate is from Cock and Kawano Cassava in Asia p 1

seems to enjoy some very minor farmer cultivation in Sichuan but probably not elsewhere within the experimental area In fact it is not yet clear from the estimates of national Guangdong and Guangxi cultivation assembled in Table 1 that cassava expansion efforts have resulted in significant increased plantings outside of those two provinces

In the absence of a reliable national cassava production series the best approximation would be to synthesize production series for Guangdong and Guangxi Fortunately complete 1950-84 series for Guangxi were published in 1985 (Table 2) These data though not necessarily without flaws provide the best understanding of year to year movements in cultivation and yields A glance at Table 2 will

grain equivalent form The original data have therefore been multiplied by five to calculate fresh root weight

Source Guangxi Jingji Nianjian Bianjibu (eds) Guangxi Jingji Nianjian 1985 (Nanning Guangxi Jingji Nianjian Bianjibu 1985) pp 531-532 and 593

confirm that the 35-year period encompasses considerable variation in both

During the 1950s some government initiated efforts were undertaken to expand cultivation of cassava which was viewed as a crop capable of providing considerable bulk and caloric content per unit area One cannot rule out the possibility however that a portion of the implied increase in cultivation reflected previously unregistered cassava areas eventually included in statistical coverage especially during the formation of agricultural producers cooperatives (1954 56) and the people s communes (1958) Elsewhere[6] it has been demonstrated that most of the implied growth in total root and tuber crop area since 1952 is likely to be real the actual figures remaining in all probability within about 5 percent (below) the official data

The considerable increase in cassava area in 1958 parallels an even larger reported increase for all root and tuber crops While 1958 was a year of extreme statistical distortion casting doubt on

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[6]Bruce Stone An Analysis of Chinese Data on Root and Tuber Crop Production The China Quarterly September 1984 pp 594 630

the magnitude of the increase the implied growth was no greater than that of 1956 much of which may have been real 1958 was also a year in which great efforts were made to increase foodcrop production by whatever means possible Root and tuber crops including cassava were correctly identified as the easiest means to effect a short term leap in bulk food production It is difficult however to accept the implied 1958 increase in average yield to ar unprecedented level especially in view of the (except for sweet and white potatoes more modest) expansion of area planted with other food crops and maintenance of yields in that year In sum while it appears that the total Guangxi foodcrop data (excluding cassava) have been adjusted in the 1985 Guangxi Economic Yearbook for the statistical distortion typical of 1958 published materials it is quite possible that those for cassava may not have been particularly in the yield category

The decline in 1959 area however followed by some recovery in 1960 are undoubtedly real although it is impossible to verify the exact figures Inflated reports of miraculous grain production success in 1958 led authorities to increase area sown with economic crops in 1959 at the expense of staples [7] When the truth became clear (1958 had been a good but not spectacular year) it was too

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[7] Li Choh-ming The Statistical System of Communist China (Berkeley University of California Press 1962) Kenneth R Walker Food Grain Procurement and Consumption in China (Cambridge Cambridge University Press 1984) Nicholas R Lardy Agriculture in China s Modern Economic Development Cambridge Cambridge University Press 1983

late to correct spring planting Some compensation would have been made with 1959 fall planted cassava however and in 1960 in view of poor harvests for all foodcrops the previous year The yield decline in 1960 is consistent with widespread natural disasters throughout China estimated to be the worst in the twentieth century These were somewhat less severe in Guangxi than in some other provinces but yields of other Guangxi food crops reportedly de line by a weighted average of 9 percent during 1960 and 1961 [8] Spring planted cassava in particular is subject to insect damage during the seedling period and in the fall typhoon damage

The low area figure for 1961 is consistent with both poor statistical coverage during the period and significant rural dislocation associated with the 1960-61 famine throughout China which may have partially extended into Guangxi The large increase in cassava area in 1962 followed by subsidence during the following few years is also explainable in terms of reaction to the 1960-61 famine

Geographic coverage may not have been consistent throughout the series Qinzhou Special District was transferred from Guangxi to Guangdong in 1955 then back to Guangxi in 1965 Qinzhou includes the entire current Guangxi coast and extends north from the current provincial border to the Yu River then angles southwest towards the

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[8]Guangxi Jingji Nianjian Bianjibu [Guangxi Economic Yearbook Editorial Board] Guangxi Jingji Nianjian, 1985 [Guangxi Economic Yearbook 1985] (Nanning Guangxi Jingji Nianjian Bianjibu 1985) p 530

border with Vietnam In 1976 area sown with foodgrains in Qinzhou covered 461 333 hectares Area planted with root and tuber crops in the western district of Guangdong circa 1957 (including Qinzhou Special District and Zhanjiang Prefecture) consisted of 28 3 percent of total area sown with foodcrops (excluding soybeans) a little less than 5 percent of which was planted with cassava and mao potatoes [9] These reports suggest that something on the order of 6 thousand hectares of cassava were transferred from Guangxi to Guangdong in 1955 then (potentially more extensive cassava area) back to Guangxi in 1965 This could explain the counter trend movements of cassava area in the Guangxi series for 1955 and 1965

Data oscillations during the succeeding decade (1966-77) are less understandable as a function of nationwide economic developments and may be peculiar to cassava or to Guangxi Hypotheses for explaining these oscillations include the lagged effect of earlier shocks echoed via the rotation system (see below) and periodic reclamation initiatives In Guangxi cassava is often grown during the early years of a reclamation project in order to earn some economic return before reclamation is complete When the quality of farmland construction and field preparation permits cassava is often phased out to make way for more highly valued crops

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[9]Bruce Stone An Analysis of Chinese Data on Root and Tuber Crop Production pp 612-615

The low planted area figures for 1967 and 1968 and particularly the high average yield estimates for those years are especially anomalous Although fertilizer use accelerated during the 1960s widespread application to cassava as early as 1967-68 is very unlikely One is consequently motivated to hypothesize about a statistical quirk e g independent production and area estimates with the latter underestimated due to statistical confusion typical of the early years of the Cultural Revolution period (1966-77)

Even excluding 1967 and 1968 the data indicate a marked increase in yields from an average of 4 5 tons per hectare (1950 66) to 9 0 tons per hectare (1969 77) or 10 3 tons per hectare (1969 84) Some of this increase per unit productivity is explainable in terms of initiation of fertilizer application and cultivation of cassava on state farms with plentiful access to fertilizers But state farms in Guangxi occupied only 20 thousand hectares (1982) and large portions of this total were devoted to cultivation of grain crops and sugar cane [10] It seems unlikely therefore that increased fertilizer use alone can fully explain this yield increase

In the absence of definitive information what could explain a sudden doubling of average yields in the mid-1960s? One hypothesis would emphasize technical change Much of the important selection and breeding work was undertaken in the late 1950s and early 1960s

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[10]Zhongguo Guojia Tongjiju Zhongguo Tongji Nianjian 1983 pp

The South China Tropical Crops Research Academy bred or selected many of the well-known varieties under current production representing significant improvement in aggregate speed and quantity of root production during the 1959-62 period The South China Agricultural Science Academy in Guangzhou bred or selected for multiplication and dissemination several other higher yielding varieties during the 1957-62 period [11] Particular attention paid to cassava during this period may also have produced important results in improving field cultivation techniques

Another hypothesis would suggest that cassava cultivation on somewhat better land was initiated during this period The Cultural Revolution decade (1966-77) was marked by a policy of local self sufficiency in grain production and escalation of quota deliveries In some cases quotas were specified in terms of particular crops needed by the state In other cases quotas were specified only in terms of weight of staples leaving the choice of crops to each collectivity of farmers Although farmers received compensation for quota deliveries prices were notoriously low involving an implicit tax Land taxes amounting to roughly 5 13 percent of output during this period depending on location were also payable in kind Taxes and quotas were therefore obligations to be discharged with commodities achieving the highest bulk yield per unit area Although fresh weight of root and tuber crops was divided by 4 for these

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[11] Liang Guangshang (ed) Mushu Zaipei yu Liyong pp 77 78

accounting purposes through 1963 and by 5 thereafter cassava may have been cultivated and even fertilized by a wider variety of localities in South China with the express purpose of expeditiously discharging these obligations [12]

The determinants of variation during the final period (1978-84) are somewhat easier to identify with confidence The steady growth in yields is almost certainly related to an increase in manufactured fertilizer nutrient application Although average application levels for cassava are not known with precision nutrient application within China as a whole tripled between 1976 and 1984 and doubled between 1978 and 1984 culminating with an average rate of 120 6 kg /ha of sown area Efficiency of utilization also increased during the period Although the average level in Guangxi was somewhat lower it grew even more rapidly than the national average between 1976 and 1982 (to 110 2 Kg /ha) then stagnated in 1983 (112 4 Kg /ha) and 1984 (109 7 Kg /ha) paralleling yield progress in Guangxi [13]

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[12]For further discussion of these issues see Bruce Stone China s 1985 Foodgrain Production Target Issues and Prospects in Anthony M Tang and Bruce Stone Food Production in the People s Republic of China IFPRI Research Report no 15 (Washington D C International Food Policy Research Institute 1980) pp 147-149

[13]Bruce Stone Chinese Fertilizer Application in the 1980s and 1990s Issues of Growth Balance Allocation Efficiency and Response in US Congress Joint Economic Committee (eds) China s Economy Looks to the Year 2000 vol 1 The Four Modernizations (Washington D C U S Government Printing Office 1986 pp 453 496 and State Statistical Bureau PRC Statistical Yearbook of China 1985 (Hongkong and Beijing Economic Information and Agency and China Statistical Information and Consultancy Service 1985) p 283

Application of manufactured fertilizers to cassava is likely to be much below the average level for all crops in Guangxi except on state farms but scattered survey reports [14] confirm that on farmers fields near cassava research institutions in South China yields which are comparable to the recent Guangxi provincial averages are only obtainable with fertilizer application or under good soil and climatic conditions atypical of most Chinese cassava growing areas One of the survey respondents however also indicated that the cassava research in China had made significant progress in developing improved varieties and low-cost cultural practices a decade earlier Yet the predominant varieties planted in the 1980s were among those selected (or bred) during the late 1950s and early 1960s (see below)

The rise and fall in cassava area during the 1978 84 period is attributable to a number of factors the most powerful of which has been the rise and fall of opportunities for export to the European Community With EC pressure on Thailand (the dominant and low cost supplier) to reduce exports during the late 1970s Chinese exports responded to the opportunity with rapid growth in 1979 1980 and 1981

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[14] Delphi Survey for the Assessment of Potential Yields of Cassava circulated to cassava breeding institutions in China and elsewhere by J S Sarma International Food Policy Research Institute 1986 The respondent who mentioned varietal and cultural improvement a decade ago was Liu Yingjing of the South China Institute of Botany in Guangzhou

(Table 3) before similar pressure eventually forced a deceleration beginning in 1982 (with 1981 fall sown cassava) [15]

Other circumstances contributing to this responsiveness involve changes in rural institutions since 1978 79 farmers have been allowed more control over cropping and management decisions but are also afforded less market security from the government as a guaranteed buyer At the same time very poor locations typical of many Chinese cassava growing areas have been released from tax and quota obligations while the government in response to substantial success in accelerating national foodcrop production growth began emphasizing higher quality in farm procurement items compared with the considerable previous period emphasis on cheaper bulkier products such as most root and tuber crops and the lowest quality grades of cereal crops These considerations coupled with the overall liberalization of economic activities in rural areas explains the fall in cassava area to a 1984 level below that typical of the pre-1978 period The decline in sown area cuts across most grain crops throughout China but is particularly noteworthy in proportional terms in the case of crops typically grown in poorer farmlands and characterized by low prices and weak markets such as sorghum white potatoes bean crops and no doubt cassava (Table 4) In Guangdong and Guangxi although unsuitable for such a warm moist climate

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[15]Bruce Stone An Analysis of Chinese Data on Root and Tuber Crop Production pp 623-625 Bruce Stone An Examination of Economic Data on Cassava Production Utilization and Trade in China pp 16 22

Table 3 PRC Cassava Exports 1963 1984

	Dried Cassava			Cassava Tapioca	Cassava Starch	TotalCassav Exports in Fresh Root Equivalents
	To European Community Only (metric tons)	Share of EC net Cassava Imports (percent)	Total Exports (metric tons)	(metric tons)	(metric tons)	(metric tor
1963	20 977					
1964	33 393					
1965	72 676					
1966	57 077					
1967	53 173					
1968	28 015					
1969	1 324					
1970	4 984					
1971	14 859					
1972	16 070					
1973	8 083					
1974	4 111	0 2[-]	4 000		11 429	
1975	4 211	0 2	4 000		11 429	
1976	7 253	0 2[+]	7 000	6 500	2 000	60 657
1977	999	0 0[+]	1 000	2 000		11 948
1978	1 327	0 0[-]	1 000	1 000		7 403
1979	51 449	1 0[-+]	51 000	5 800	2 060	183 522
1980	335 989	6 9[+]	336 000	20 500	2 500	1 067 070
1981	606 589	9 1[-]	607 000	10 000	1 500	1 788 073
1982	440 181	5 4[+]	445 000	14 000	1 500	1 343 397
1983	15 222	0 4	460 000			1 314 285
1984	143 000	2 7			1 314 285	

Notes and Sources

European Community data for dried cassava imports from China and other countries are compiled from EUROSTAT and NIMEXE Analytic Tables for Foreign Trade (which are in close agreement) Total dried cassava cassava tapioca and cassava starch export data are from Food and Agriculture Organization of the United Nations Supply Utilization Accounts Tape 1984 Rome 1985 The fresh root equivalents of all cassava exports aggregated together appear in FAO Standardized Commodity Balance Tape 1984 Rome 1985 The 1983 and 1984 data must be regarded as open to some question and may be revised in future compendia

Table 4 Area Sown with Major Cereals Bean Crops Roots and Tubers in China 1976 85

	Rice	Wheat	Corn	Soybeans	Millet	Sorghum	Sweet and White Potatoes	Only Sweet Potatoes	Only White Potatoes	Other Cereals & Bean Crops	Total Foodgrains
	(thousand hectares)										
1976	36 217	28 417	19 228	6 691	4 501	4 329	10 366			10 994	120 743
1977	35 526	28 065	19 658	6 845	4 477	3 759	11 229			10 841	120 400
1978	34 421	29 183	19 961	7 144	4 271	3 456	11 796	6 800	5 000	10 355	120 587
1979	33 873	29 357	20 133	7 247	4 173	3 173	10 952			10 355	119 263
1980	33 879	29 228	20 353	7 227	3 872	2 693	10 153			9 829	117 234
1981	33 295	28 307	19 425	8 023	3 888	2 610	9 621			9 789	114 958
1982	33 071	27 955	18 543	8 419	4 039	2 783	9 370	6 916	2 454	9 283	113 463
1983	33 137	29 050	18 824	8 414	4 087	2 707	9 402	6 840	2 562	8 426	114 047
1984	33 179	29 577	18 537	7 286	3 797	2 384	8 988	6 426	2 562	9 136	112 884
1985	32 070	29 218	17 694	7 718			8 571				108 845

Sources Most data were converted from Chinese unit figures or were calculated from data appearing in State Statistical Bureau (SSB) PRC Statistical Yearbook of China 1985 (Hong Kong and Beijing Economic Information and Agency and China Statistical Information and Consultancy Service Centre (CSICSC) 1985) p 253 1985 data were added from SSB PRC China A Statistical Survey in 1986 (Beijing CSICSC 1986) p 37 1982 84 figures for sweet potatoes and for white potatoes are from He Kang et al Zhongguo Nongye Nianjian Bianji Weiyuanhui [Chinese Agricultural Yearbook Editorial Committee] (ed) Zhongguo Nongye Nianjian 1983 [Agricultural Yearbook of China 1983] (Beijing Nongye Chubanshe [Agricultural Publishing House] 1984) p 40 He Kang et al Zhongguo Nongye Nianjian 1984 (Beijing Nongye Chubanshe 1985) p 88 He Kang et al Zhongguo Nongye Nianjian 1985 (Beijing Nongye Chubanshe 1986) pp 147 148 The estimates for sweet and white potatoes in 1978 are from Bruce Stone An Analysis of Chinese Data on Root and Tuber Crop Production The China Quarterly September 1984 p 628

wheat had been cultivated for import substitution purposes With relaxation of this uneconomic emphasis on wheat sown area declined in the two provinces Less drastically area sown with several other food crops such as paddy sweet potatoes sorghum and millet also fell in favor of economic crops especially sugarcane (Tables 5 and 6)

After 1979 is it possible to confirm that the trends indicated for Guangxi are representative nationally? Even without national data the addition of series for Guangdong would provide a reasonable proxy Unfortunately cassava series for Guangdong are unavailable but a very rough approximation may be discerned from Table 5 The left hand column is comprised of figures quoted for Guangdong specifically The center column is derived from data appearing in the 1984 and 1985 Guangdong Statistical Yearbooks These data are not estimates of cassava area per se but are formed by deducting data for sugar cane peanuts sesame jute kenaf and tobacco from figures for total area planted with economic crops The estimates in parentheses to the right more closely approximate cassava plantings inasmuch as area sown with all oil crops all fibers and medicinal herbs have also been deducted from the economic crop area along with sugarcane and tobacco on the basis of recent Agricultural Yearbook of China volumes to arrive at the residuals During the recent decade at least cassava has been classified as an economic crop in production statistics rather than as a foodcrop and the calculated residual should be predominantly

T bl 5 S d P t f F Ed l E C Oth Ed bl F C op f G g Z g t 1979 198

	S A						P d t					
	1979	1980	1 81	19	1963	1964	1979	198	1981	19 2	19 3	1984
			th d						th d		ton	
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t	10 7	41 6	2	1 0	17 80	14 8	9	2	20	23	15	1
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C	4)	45 87	43 00	41 67	38 80	40 13	65	65	65	70	6	70
S	130 07	139 27	1 0 07	1 60	138 7	1.5 60	100	115	120	145	110	120
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g C	181 60	17 8	20 80	273 47	28	316 13	B218 20	9226 0	13698 0	172 8 80	12500 00	17692 00
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comprised of but should overestimate area planted with cassava The estimate in the right hand column is derived by deducting published Chinese estimates for area sown with cassava in Guangxi (1961) Taiwan (1961) Fujian (1961) Yunnan (1960) Guizhou (1961) and Hunan Zhejiang and Jiangxi (circa 1960s) from a published 1961 national figure The calculated figure substantially exceeds the residual based overestimates of cassava area in Guangdong for surrounding years in a period when cassava area in other Chinese provinces was undoubtedly small These data are evidently in conflict

An examination of 1950s Chinese material provides an impression that 1950s cassava area in Guangdong was greater than that implied by the residual-based overestimates in the center column of Table 7 Guangxi cassava area in 1957 for example was around one-quarter of all Guangxi farmland planted with root and tuber crops If the same proportion were relevant for Guangdong 1957 cassava area would total more than 300 thousand hectares But whereas 36 21 percent of Guangxi root and tuber crop production consisted of crops other than sweet potatoes this figure was only 13 percent for Guangdong and included cassava taro white potatoes and mao potatoes primarily the first two categories [16] Still 1957 Guangdong cassava area could easily have been in the range of 100 200 thousand hectares

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[16]See data and Chinese sources cited in Bruce Stone An Analysis of Chinese Data on Root and Tuber Crop Production pp 609 616

Table 7 Estimates of Area Sown with Cassava in Guangdong Province 1943 1984

	Guangdong Cassava area estimates in Chinese sources	Residual based estimates of other economic crops in Guangdong		National estimate minus Guangxi Yunnan Fujian Taiwan Guizhou Hunan, Zhejiang & Jiangxi
		(thousand hectares)		
1943	33 4			
1952		25		
1957		57		
1961				240
1962		25		
1965		149		
1970		201		
1972	167 3			
1975		223		
1978		236		
1979			(215)	
1980		237		
1981	200		(201)	
1982		243	(195)	
1983		188	(158)	
1984		206	(159)	

Sources Data appearing in the left- and right-hand columns are based on Table 1 except that the Taiwan Province figure deducted along with those from other provinces from the national estimate for 1961 (10 000 ha) was taken from the same source as the national figure Liang Guangshang (ed) Mushu Zaipei yu Liyong p 9 Data appearing in the center column are based on data from Guangdongsheng Tongjiju [Guangdong Province Statistical Bureau] (ed) Guangdongsheng Tongji Nianjian 1984 [Guangdong Province Statistical Yearbook 1984] (Xianggang Xianggang Jingji Daobao Shechuban [Hong Kong Economic Reporter Publishing House] 1984) pp 113-114 and Guangdongsheng Tongjiju Guangdongsheng Tongji Nianjian 1985 [Guangdong Province Statistical Yearbook 1985] (Xianggang Xianggang Jingji Daobao Shechuban 1985) pp 107-108 Sown area data for sugarcane peanuts sesame jute kenaf and tobacco were deducted from total area sown with economic crops Data for rapeseed and other oilcrops other fibers and medicinal herbs have also been deducted from the figures appearing in parentheses on the basis of Zhongguo Nongyebu [Chinese Ministry of Agriculture] Zhongguo Nongye Nianjian 1980 1982 1983 1984 and 1985 (Beijing Nongye Chubanshe [Agricultural Publishing House] 1981 1983 1984 1985 and 1986)

During the 1950s cassava was treated explicitly as shulei [including both tuber crops and tuberous roots] which in turn were classified as liangshi [staple food crops] occasionally as part of miscellaneous grains By the mid-1970s however it is clear that cassava was excluded from shulei and liangshi statistics and incorporated as a sub category or as a residual within jingji zuowu [economic crops] The transition date has not been clearly determined although 1964 and 1976 have been suggested as candidates [17] In view of the trends exhibited for Guangxi in Table 2 and the foregoing discussion attempting to resolve the conflict implied in Table 7 it seems likely that the 1950s economic crop statistics appearing in the Guangdong Province Statistical Yearbooks though recently published are unlikely to have been adjusted for inclusion of cassava hence the center column cannot be used as a proxy for cassava area for the 1950s nor probably for 1962 From 1965 onward however these residuals may well provide the best indication of trends in (though not exact estimates of) Guangdong cassava area since cassava is likely to dominate the category It should be noted however in view of economic liberalization since 1979 that the divergence of this residual series and actual cassava area is likely to have increased especially since the decline in export opportunities in the early 1980s

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[17] op cit pp 600 604

Unfortunately despite the availability of an official cassava series for Guangxi and a rough approximation of trends for Guangdong it is still not possible to be definitive about national trends for China It is clear that cassava was planted on less than 100 thousand hectares in the mid-1940s rising quickly to perhaps around 250 thousand hectares by 1957 and 355 thousand hectares (excluding Taiwan) by 1961 during the famine Total plantings on the Chinese mainland probably subsided to roughly 300 thousand hectares by 1965 and were certainly not much lower in 1972 when plantings in Guangdong and Guangxi alone totalled 292 thousand Official area sown with cassava in the two southern provinces seems to have risen to 370 thousand hectares in 1979 perhaps peaking in 1980 at 410-420 thousand hectares subsiding to 390 tha and 370 tha in 1981 and 1982 and plummeting to 275 tha and 250 tha in 1983 and 1984

But whether cassava area rose appreciably outside of these two southern provinces since the early 1960s is not clear The (undated) total of 350 thousand hectares given to the CIAT delegation by Chinese cassava breeders in spring 1982 would imply that it has not while the (undated) Institute of Geography estimate (around 500 thousand hectares) published in 1980 suggests either considerable expansion into other provinces or more aggressive estimates of non-field cultivation Barring the unlikely event of relatively even distribution among other mentioned provinces officially recorded plantings of 120 190 thousand hectares outside of Guangdong and Guangxi implied by the Institute figure and the provincial estimates

would surely have been mentioned by the breeders or in cassava-related publications while the 350 thousand hectare figure though purportedly including an estimate for cassava on private plots does not even appear to cover probable plantings in the two southern provinces

Part of the problem is that cassava area is undoubtedly more difficult to estimate than that of most field crops since considerable proportions are grown on private plots on narrow strips adjacent to roads and fields on hilly and incompletely cleared land not yet or normally considered farmlands and on tiny corners not even counted among private plot statistics There is even some illegal cultivation under trees on state rubber plantations for example [18] The Institute of Geography figure probably incorporates a more aggressive estimate based on some survey evidence of these kinds of plantings which in large part elude official statistical coverage

All that can be claimed with near certainty is that national cassava planting reached another major peak in the late 1970s or early 1980s and then declined rapidly with the subsidence of opportunities for international trade increasing liberalization of rural economic activities and a probable cut back in the government s role in cassava marketing

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[18] op cit p 621

National production trends are even less discernible The only available figure for recent production is 3 million tons provided to the CIAT delegation in spring 1982 [19] although like the 350 thousand hectare figure provided at the same time it may well be an underestimate The best indication of national yield trends is undoubtedly the Guangxi series in Table 2 with some reservations about a few of the years such as 1967 and 1968 The national average implied by the figures given to the CIAT delegation is 8 6 tons per hectare suggesting that average yields in Guangdong and elsewhere are lower than in Guangxi But this comparison too cannot be taken too literally since the four to five tons per hectare 1981 Guangdong average suggested by such an exercise implies too great a divergence between Guangxi and Guangdong particularly in view of greater general availability of fertilizer in the latter province

Within these two southern provinces some of the principal cassava growing areas can be identified The first record of Chinese cassava cultivation was in 1820 in Gaozhou County part of Zhanjiang Prefecture in southwestern Guangdong [20] Gaozhou is not a coastal county and earlier cultivation is entirely possible In the 1950s there is continued record of cassava in Zhanjiang Prefecture where uplands constituted 27 5 percent of cultivated land a greater

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[19]James H Cock and Kazuo Kawano Cassava in China unpublished trip report International Center for Tropical Agriculture Palmira Colombia June 1982 p 1

[20]Liang Guangshang (ed) Mushu Za pei yu Liyong p 4

proportion than in other Guangdong Prefectures Suixi County and the Zhanjiang city suburbs (where uplands comprised 12 percent) in the center of the prefecture and Xuwen County on the southern tip of the Leizhou Peninsula are mentioned in 1950s literature on cassava but the crop may have been grown more generally throughout the grain deficient Leizhou Peninsula and in the uplands adjacent to the Jianjiang Plain where miscellaneous grains (80 9 percent of which were root or tuber crops) comprised 44 percent of staple foodcrop production in 1955 Throughout the Zhanjiang Prefecture and enclosed municipal areas root and tuber crops (valued at one-fourth fresh weight) constituted only 28 percent of staple crop production which occupied 95 percent of sown area Sweet potatoes were the principal root crop however with cassava and mao potatoes comprising a little less than 5 percent of root and tuber crop production [21]

But cassava cultivation clearly was not limited to southwestern Guangdong in the 1950s There is also record in the Economic Geography of South China (1959) of cassava and taro being grown in the mountainous uplands surrounding the Sui and Xi River Valleys in West Central Guangdong notably Huaiji Guangning Sihui Gaoyao and Deqing Counties all in Zhaoqing Prefecture Cassava was not specifically mentioned in the discussion of Hainan Island but has

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[21]Sun Jingzhi (ed) Huanan Dichu Jingji Dili [Economic Geography of South China] (Beijing Kexue Chubanshe [Scientific Publishing House] 1959) Translated in Joint Publications Research Service August 24 1969 no 14954 pp 137-138 and 178 179 When these statistics were gathered the region included the Qinzhou Special District encompassing known cassava growing areas such as Hepu County and the Beihai suburbs

been grown there at least since 1912 when a well-known Malaysian variety was introduced into Dan Xian rubber plantations According to 1951 statistics roots and tubers accounted for 38 5 percent of grain consumption in plains areas of the Island and 69 8 percent in hilly districts paddy rice providing most of the remainder in both cases [22]

In Guangxi cassava was generally distributed in the Xunjiang and Liujiang Valleys (east central Guangxi) characterized by relatively barren drought prone land Yet yields of 7 5 15 0 tons per hectare were cited It was used as food feed and to produce starch for cotton yarn in the city of Wuzhou in east central Guangxi on the Guangdong border where Guangxi s first starch factory was opened in 1952 Cassava was also widely planted in southeastern Guangxi and along the southern coast especially Hepu County and the suburbs of Beihai on the southeast coast But although Beihai and Wuzhou remained major centers by the mid-to-late 1950s cassava starch factories and consequently expanded cassava cultivation had spread widely in the Autonomous Region including Ningming in the southwest Bama Yaozu Autonomous County toward the northwest and Wuming in the center of the Region [23] In Yunnan cassava cultivation in 1960 was recorded in Hekou Yaozu Autonomous County in the south

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[22] op cit pp 137 138 and p 201 See details of varietal transfer below

[23] op cit pp 258 and 333-334 Guangxi Jingji Nianjian Bianjibu Guangxi Jingji Nianj an 1985 p 192

along the Vietnamese border in Dehong Daizu Jingpozu Autonomous Prefecture in the west along the Burmese border and elsewhere [24]

By 1972 Zhaoqing Prefecture had taken over as the principal cassava growing region of Guangdong accounting for 57 thousand hectares or 33 9 percent of the provincial figure for that year Zhanjiang Prefecture was next with 33 thousand hectares or 19 5 percent The remaining 77+ thousand hectares were distributed throughout Guangdong including Hainan Island and Shaoquan Meixian Shantou Foshan and Huiyang Prefectures Some of these secondary regions increased cassava plantings rapidly in the late 1970s Cassava area in Meixian Prefecture for example in the northeast corner of the province grew from 10 800 hectares in 1977 to 40 000 hectares in 1978 [25]

In spring of 1982 a delegation of cassava breeders from the International Center for Tropical Agriculture (CIAT) visited a number of cassava growing areas in Guangdong including Baisha County and Haikou Municipality on Hainan Island three state farms in Zhanjiang Prefecture and Dongguan County (Huiyang Prefecture) on the Pearl River Delta Some impression of area trends on the Delta can be obtained from statistics for Dongguan Cassava plantings declined from 8 600 ha (1957) to 4 600 ha (1977) with much of the decline occurring in the 1970s Cassava area then fell even more rapidly to

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[24] Liang Guangshang (ed) Mushu Zaipei yu Liyong p 9

[25] Ibid

3 157 4 ha in 1978 then 3 100 ha (1981) and 2 816 8 (1982) But on the other side of the Delta in Taishan (Foshan Prefecture) cassava was not grown on a large scale until recently And Fucheng Commune (within Dongguan County) cassava area fell from 500 to 367 hectares between 1980 and 1981 but recovered to 434 ha in 1982 [26]

Yields observed by the CIAT delegation were generally in the 6 to 8 ton/ha range but 20-25 tons/ha was claimed for some state farms and experiment stations [27] Average yields for Dongguan County on the Delta were 11 73 tons/ha in 1978 and 15 76 tons in 1982 Fucheng Commune within Dongguan County claimed around 15 tons/ha in 1980 14 43 tons/ha in 1981 and 17 75 tons/ha in 1982 [28] In Guangdong generally with 1200-1800 mm of annual rainfall yields on farmer s fields with poor soils have been estimated by one Chinese breeder to fall typically between 5 to 7 tons per hectare and between 10 to 13 tons under good climatic conditions and soil conditions Throughout Southern China (800-2000 mm/yr annual rainfall) yields are estimated by another breeder to be 5 to 9 tons per hectare on poor soils and 15 30 tons/ha (avg 20 tons/ha) under good conditions Without fertilizer or irrigation however poor soil yields were reported to be 3 to 6 tons/ha (average 4 tons) and for good soils

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[26]Cock and Kawano Cassava in Asia op cit The 1957 1977 and 1981 figures for Dongguan County are from p 13 The 1978 and 1982 data the Fucheng Commune data and the impressions for the 1970s and for Taishan are from Prof Graham Johnson Dept of Anthropology and Sociology University of British Columbia correspondence Sept 19 1983

[27]Cock and Kawano Cassava in China p 1

[28]Graham Johnson op cit

with good weather 12 to 18 tons/ha In Zhaoqing and Shaoguan Prefectures (1450-1700 mm/yr avg rainfall) farmers yields without fertilizer and irrigation were reported by an agronomist specializing in cassava to average 6 4 tons/ha under poor conditions and 11 2 tons/ha under good conditions With fertilizer but without irrigation these averages rose to 11 69 tons/ha and 19 7 tons/ha with ranges of around 4 tons/ha Average yields on research stations run 2 to 10 tons per hectare higher than those quoted above for farmers fields [29]

These data in sum would seem to suggest that most cassava in Guangdong is grown on poor land especially uplands and until recently rarely received much fertilizer Total cassava area has fallen during the past decade or so on better lands such as those typical of the Pearl River Delta (with scattered temporary exceptions due to the short lived EC export opportunities) leading to some decline in the average quality of farmland growing cassava This decline has been more than counterbalanced by the increase in fertilizer application to cassava in recent years such that average yields (though not necessarily total production) have increased sharply The higher cassava yields on state farms and for private and cooperative farming in the Pearl River Delta locations like

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[29]Delphi survey responses sent to J S Sarma (IFPRI) for Shaoquan and Zhaoqing Prefectures by Huang Xi of the Institute of Drought Grain Crops Guangdong Province Academy of Agricultural Sciences Guanzhou June 28 1986 for Guangdong by Liu Yingjing of the South China Institute of Botany Chinese Academy of Sciences Guangznou June 30 1986 and for South China Academy of Tropical Crops Research Dan Xian Hainan Island June 20 1986

Dongguan County are partially explainable in terms of greater access to (and more attractive relative prices for) manufactured fertilizers as well as to often better soil and higher standards of agronomy But an additional important factor relates to varietal adoption An especially small portion of cassava grown on state farms and on the Delta is likely to be utilized for direct human consumption so there is little reason for managers and farmers to cultivate the lower yielding sweeter varieties characterized by low cyanide and higher protein content as well as greater overall palatibility (see below) The argument is at least partially relevant for Zhaoqing and Shaoguan Prefectures which are becoming one of Guangdong s major regions for processing industries utilizing cassava and for similar reasons east central and southern Guangxi historically among the principal cassava-growing areas within the Autonomous Region

Cassava production systems

Cassava in China is grown both extensively and in small plots and scattered plantings Extensive cultivation is most notable on but by no means confined to state farms and is principally associated with starch production the domestic animal feed market and exports Outside the state farm sector with the formal dissolution of the communes in favor of the household production responsibility system it is safe to assume that extensive cultivation has declined somewhat since the early 1980s However

Graham Johnson has pointed out [30] that rural reforms have in some instances strengthened rather than weakened cooperation in South China so it cannot be assumed that extensive cultivation in the old cooperative sector has disappeared

Since the formation of agricultural producers cooperatives (1954 56) and the people s communes (1958) collective lands constituting the vast majority of Chinese farmlands have been cultivated communally However the 54 thousand communes have normally not been the principal cultivation unit More often smaller units the 719 thousand brigades or most commonly the 5 6 million production teams have cultivated as cooperative groups A production team normally consisted of around thirty farm families (an average of 139 people) that pooled usually contiguous land and shared cultivation responsibilities [31] The principal farm unit varied geographically in size but by the late 1970s averaged around 8 6 hectares in Guangdong and 8 9 hectares in Guangxi and certainly less in the very densely populated Pearl River Delta of Guangdong [32]

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[30]Graham E Johnson The Production Responsibility System in Chinese Agriculture Some Examples from Guangdong Pacific Affairs vol 55 no 3 (Fall) 1982 pp 430 449

[31]Zhongguo Guojia Tongjiju [State Statistical Bureau of China] Zhongguo Tongji Nianjian 1983 [Statistical Yearbook of China 1983] (Beijing Tongji Chubanshe [Statistical Publishing House] 1983) p 147

[32]Ibid p 148 Dili Yanjiusuo Zhongguo Nongye Dili Zonglun pp 77 79

Since the early 1980s however cultivation of collective lands is no longer a communal responsibility but has been delegated to several specialized households Normally it is the particularly skilled farmer who is entrusted with responsibility for farming collective lands But in relatively advanced communes or in suburban areas non agricultural activities with higher income earning potential attract the most able workers

Aside from collective lands individual farm families maintain private plots of normally 0 03 0 05 hectares which are used primarily for family production of food items especially vegetables and livestock products (and consequently fodder for the latter) Although no estimates are available for cassava cultivation on such lands the importance of cassava as a swine feed the considerable importance of swine in the livestock economy of South China and the dominance of family-owned and managed swine within the swine husbandry sector suggest that private plot cultivation of cassava in South China is not trivial

In addition to formally established private plots assigned to each family there appears to be cultivation of cassava on an even more fragmentary basis on narrow strips adjacent to roads and fields on steep hillsides and other areas not formally counted among cultivated lands and illegally in economic forests reclamation areas and other lands managed by the state The latter may be distinguished however from planned cultivation on such lands by the State Farm and Reclamation Bureau While land is being cleared and

reclaimed cassava is often grown as an intermediate crop for a few years until it is discontinued when field transformation progress allows cultivation of the principal crop [33]

Finally cassava is planted as a field crop on state farms There its cultivation is especially extensive and is characterized by high standards of agronomy and abundant application of modern inputs particularly fertilizers Visitors interested in cassava are often brought to state farms to view extensive cultivation and high yields but state farm plantings remain a small proportion of total cassava area Cultivated area on state farms in Guangdong varied between only 60 and 64 thousand hectares from 1981 to 1984 and remained at 20 thousand hectares in Guangxi In 1984 state farm sown area in Guangdong was only 86 900 hectares or less than 1 8 percent of the provincial total of which 72 200 hectares were planted with cereals beans sweet and white potatoes oilcrops and sugarcane leaving a residual of 14 700 hectares which could have been planted with cassava vegetables green manure other fodder crops or other southern industrial crops such as sisal hemp In Guangxi state farm sown area was only 17 400 hectares or less than 0 5 percent of the regional total of which the residual category including cassava

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[33]Bruce Stone An Analysis of Chinese Data on Root and Tuber Crop Production The China Quarterly September 1984 p 621 Liang Guangshang (ed) Mushu Zaipei yu Liyong p 36 Bruce Stone An Examination of Economic Data on Chinese Cassava Production Utilization and Trade

comprises but 3 300 hectares [34] Thus private and collective plantings dominate cassava area in China

Available international data on cassava utilization in China is unreliable but it is clear that animal (especially swine but also cattle fish and silkworm) feed is associated with each of the cassava production systems Exports and starch production as well as less traditional industrial and processing uses are associated with collective production and the state farms while direct human consumption is associated with private production and the collective sector in poorer areas Machine cultivation is associated with a portion of the extensive plantings between 100 m and 300 m above sea level Between 300 m and 1 000 m cassava is grown in rotation with dryland crops as far as 30°N Most cassava in China is unirrigated but the climate provides adequate moisture in most years and locations This is especially true in the south where fall-planted cassava is common [35]

Cassava is cultivated year round in South China with the principal plantings concentrated in spring and fall The planting material may be either freshly cut stakes or stored material Storage is practiced by cutting long stakes which may either be left in the sun in bundles or placed under trees Cuttings are fairly

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[34]China Agricultural Yearbook Editorial Board China Agricultural Yearbook 1985 (Beijing Agricultural Publishing House 1986) pp 114 and 185-186

[35]Liang Guangshang (ed) Mushu zaipei yu liyong p 36

short (10 15 cm) with minimal selection Planting is fairly deep (up to 10 cm and horizontal) Germination varies considerably by location but is frequently very poor and strands are not uniform Land preparation is generally acceptable and is done manually by draft animal or tractor-drawn implements [36]

Spring cassava (e g in the Guangzhou area) is typically planted between January and March and harvested in the fall after at least 8 months especially from October although for fodder purposes cuttings may be taken continuously over an extended period of time The spring and summer seasons considerably aid leaf and stem growth of spring-planted cassava and fall arrives optimally for starch formation Yields of spring planted cassava tend to be large but are less reliable since typhoons in fall occasionally cause damage Furthermore low temperatures in spring extend the budding and sprouting period and thus the risk of insect damage But spring planted cassava fits well into South Chinese intercropping and rotation systems facilitating the achievement of as many as three crops per year including one of cassava [37]

Fall- and winter planted cassava is common in the most tropical areas with harvests starting the following fall The peak period for both planting and harvesting is September to November Fall-planted

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[36]Cock and Kawano Cassava in China p 7

[37]The discussion of spring and fall planted cassava is primarily from material appearing in Liang Guangshang (ed) Mushu Zaipei yu Liyong pp 10 1 and 33 34

cassava is practicable from around Gaozhou County (21°56 N Zhanjiang Prefecture Guangdong Province) south where temperatures average about 22 7°C annually and the lowest average January temperatures exceed 15°C These areas also enjoy 1304-1718 mm of rainfall per year and 1941-2455 hours of sunlight higher than more northerly regions especially during the winter thereby providing more hospitable conditions for fall planting Of course fall-planted and spring-planted cassava are not mutually exclusive Qijing Brigade for example in Dianbai County (within the coastal zone lying along the South China Sea well to the south of Gaozhou) planted 25 thousand hectares of cassava in 1972 approximately one-third fall-planted two-thirds spring planted

A principal advantage of fall-planted cassava is the potential for avoiding typhoon damage This is particularly important on the Leizhou Peninsula and Hainan Island Insect damage to the sprouts is also lower since cricket populations decline rapidly in fall and the sprouting period is collapsed with sprouts and roots beginning within a week after planting Fall planted cassava can be more conveniently linked with sericulture since leaves are provided more opportunely without influencing root yield With the longer season cassava planted in fall facilitates fuller utilization of production capacity in local starch factories and is convenient for on-farm livestock development The principal drawbacks are the slower winter growth and the inconvenience of the longer season for rotation and multiple cropping Thus even in the far south if the cropping intensity is high cassava is apt to be planted in spring With

virtually all cassava north of 22°N and an important portion of the remainder planted in spring the majority of cassava in China is likely to be spring planted

The Chinese are well aware of the necessity of rotation and intercropping for continued cassava cultivation They estimate that yields decline by 20 30 percent in a second consecutive year of cassava cultivation and by 30 40 percent for three consecutive years [38] The CIAT delegation noted however that cassava is grown as a monocrop in some areas [39] South Chinese rotation systems are complex and varied those including cassava are no exception Figure A presents notable 2-year through 6-year rotation systems for cassava and other dryland food crops In newly reclaimed areas cassava is often grown for one or two years among jade cassia (Chinese cinnamon) mountain apricot bamboo tong oil tea oil rubber trees or in other economic forests Chinese literature points out the importance of rotation of cassava with green manure crops in economic forests to avoid erosion

Cassava is normally the principal crop in a small number of exceedingly poor localities and a very few state farms As Table 5 and 6 indicate the most important crop in South China is unquestionably paddy rice comprising 63 percent of sown area in Guangdong in 1984 and 59 percent in Guangxi Paddy fields occupy 63

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[38] Liang Guangshang (ed) Mushu Zaipei yu Liyong p 40

[39] Cock and Kawano Ca sava in China p 8

Figure A Cassava Rotation Systems in China

2 year systems

cassava - upland rice sweet potatoes
cassava - peanuts sweet potatoes
spring peanuts fall-planted cassava - fall harvested cassava
spring soybeans

3-year systems

cassava - sugar cane sugar cane
cassava peanuts wheat - upland rice sweet potatoes

4-year systems

cassava mung beans sweet potatoes sugar cane - sugar cane

5-year systems

peanuts wheat upland rice sugar cane - sugar cane-
sugar cane

6-year system

cassava sugar cane sugar cane - soybeans sweet potatoes
upland rice radishes - peanuts sweet potatoes

Notes and Sources

Liang Guangshang (ed) Mushu Zaipei yu Liyong p 40 In Cock and Kawano Cassava in Asia p 8 the authors noted that cassava was often grown with legume crops predominantly peanuts

percent of cultivated land in Guangxi and are similarly dominant in Guangdong Sweet potatoes are second in order of planted area in Guangdong and combined with white potatoes totalled 10 percent of sown area Peanuts (6 percent) and sugar cane (5 percent) rank third and fourth probably followed by cassava at around 3 percent Soybeans maize bast fibers and tobacco are also grown and until its de-emphasis in recent years wheat area exceeded cassava plantings In Guangxi maize is second at 11 percent of sown area followed by soybeans and sweet potatoes (5 percent each) sugar cane and peanuts (3 5 percent each) and green manure crops as a group (2 5 percent) Cassava at 2 1 percent is slightly below vegetables and melons as a group When cassava area peaked in 1980 its share was 4 3 percent ranking fifth behind rice maize soybeans and sweet potatoes and higher than all economic crops [40]

Yields

Most available information on cassava yields was provided in the section on production trends and distribution In that section it was suggested that the considerable increase in average yields during the latter 1960s (Table 2) was due to varietal improvement and to some extent improvement in cultural practices while yield growth since the late 1970s has been principally the result of increased fertilizer application to cassava complemented by some improvement in varieties and cultivation techniques Mean cassava yields throughout China (8 6 tons/ha in 1980) approximate the average for

[40]Table 5 and 6 China Agricultural Yearbook 1985 pp 114-126 and Dili Yanjiusuo Zhongguo Nongye Dili Zonglun pp 77 79

the rest of the world but are somewhat higher than mean yields in the remainder of Asia Mean yields in Guangxi (13 1 tons/ha 1981-84 average) however are somewhat higher than the international average and the highest yields from field cultivation in China (average 20-25 tons/ha with a maximum of 30 tons/ha or more) are comparable to the very highest yields in the world [41] But Chinese cassava is also grown on poor soils with no fertilizer or irrigation where average yields have been characterized in the 3 to 8 ton range The average figures cited above suggest that those poor conditions are more typical of Chinese cassava cultivation than the state farm or Pearl River Delta private and cooperative farming experience However survey results suggest that even on poor soils without irrigation fertilizer application can increase yields on both research stations and operating farms by an average of at least 6 tons per hectare

Yield differences among farms are due not only to differences in soil fertility climatic conditions adopted varieties and applied fertilizers but to substantial differences in management as well Farmers in some areas use unselected planting materials giving very poor stands and low yields On private plots management varies more than on collective lands within a single vicinity but the level of agronomy is often fairly high [42]

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[41] Ibid p 1 and 8 Delphi Survey responses and correspondence from James H Cock June 24 1983 Table 2

[42] Cock and Kawano Cassava in China correspondence from James Cock June 24 1983

Among the responses of three Chinese cassava breeders surveyed low yield potential of existing varieties and unavailability of fertilizers were both listed by each respondent as important constraints on farmers yields But the survey results also suggest that output marketing problems storage and processing difficulties and general lack of production incentives may restrict application of labor and fertilizers to cassava in some areas [43] Although there is considerable variation in the quality of cultivated varieties China has several popular varieties such as South China 205 providing reasonably high and stable yields It is the provisional conclusion of one international breeder that like Thailand in the recent past and Malaysia currently rigidly selected CIAT clones could outyield the best Chinese cultivars only slightly This contrasts with Indonesia and the Philippines where the best local varieties are more easily dominated [44]

Poor fertilizer response and inadequate extension were listed as a secondary constraint on yields as was inadequate moisture in some areas The 1982 CIAT delegation noted that fertilizer applications were not generally linked to soil analyses or recommendations made on the basis of experimental results Each of the surveyed breeders appeared to agree that pests and diseases were relatively unimportant

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[43]Delphi Survey results

[44]Kazuo Kawano Trip Report to China (18-24 January 1986) unpublished trip report provided in correspondence from Kawano April 14 1986

in limiting cassava yields The 1982 CIAT delegation also found that although pests and diseases were not chemically controlled they appeared to be of very low incidence and harvest losses from such sources were concluded to be minimal The most commonly observed disease was Cercospora leaf spots and during the dry months Tetranychus mites are reported to be a problem [45]

Costs of production and labor utilization

The 1982 CIAT delegation was told that labor use varied from 100 man days per hectare with mechanical land preparation to 270 days without machines and total production costs were estimated at $550 US per hectare 170 days may be somewhat excessive for manual land preparation but although the total of 270 days per hectare is higher than in some Asian countries it is not unprecedented The total cost figures are likely to have come directly from the production accounts of one or more Guangdong state farms where workers are paid set wages or from a small sub-group of more prosperous cassava growing collectives which happened to have kept good records and where yields are high Most of the implied cost per man-day of around $2 US would be labor A project prospectus for an agricultural credit application to the World Bank involving cassava cultivation implied a return to labor of $1 25 US per day Much of the labor involved

[45]Cock and Kawano Cassava in China p 7

especially where cassava is fertilized is for hand weeding since herbicides are not used [46]

Much of the non-labor costs on state farms would consist of fertilizer application The highest per hectare application rates encountered by the CIAT delegation in 1982 were 20 tons of organic manures 375 kilograms of superphosphate (45 68 kg of P_2O_5) and 150 kilograms of muriate of potash (37 5 kg of K_2O) [47] Such rates are likely to have existed only on state farms with plentiful access to fertilizers and/or few alternative uses Implied per hectare retail value of this level of manufactured fertilizer use alone would have totalled $ US [48] On collective lands with plentiful access to fertilizers use of manufactured products is less lavish but organic manure use with associated high labor requirements is very substantial In Fucheng Commune of Dongguan County on the Pearl River Delta average yields of 21-22 5 tons per hectare on 400 hectares of cassava were achieved with 225 kilograms of ammonium sulfate per hectare But in addition three organic manure applications were undertaken involving total per hectare use of 3 tons of swine and cattle manure 3 4 5 tons of human night soil and 15 tons of green manure (primarily legumes) mixed with 22 5 tons of soil On the Huashan State Farm in Lingshan County Guangxi per

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[46] Ibid pp 7-8 correspondence from John Lynam CIAT Cassava Program December 22 1983 Stone An Examination of Economic Data on Chinese Cassava Production Utilization and Trade pp 6-9

[47] Cock and Kawano Cassava in China p 7

[48]

hectare applications of 255 kilograms of ammonium sulphate and 15 tons of organic manure yielding 19 62 tons per hectare were estimated to provide 141 kilograms of *nitrogen* 79 kilograms of phosphoric acid and 180 kilograms of nitrogen [49]

One of the 1986 Chinese survey respondents provided a combined per hectare estimate of farmer fertilizer use on poor soil cassava lands in Guangdong of 150 kilograms associated with average yields of only 5 tons per hectare while another respondent based on Hainan Island (Guangdong) implied that no manufactured fertilizers were used on cassava by farmers regardless of soil conditions [50]

It is very unlikely that much fertilizer has been applied to cassava on distant collectives and private plots This is due to low farmgate cassava prices a weak cassava market in many areas (see below) and to the higher prices and difficult access associated with fertilizer purchase unless such purchase is linked to sales to government procurement organizations of farm goods in particular state demand Private plot production of cassava employing household labor and without manufactured fertilizer use could be conducted for purposes of home consumption and hog feed at very low implied return to labor However with the low yields associated with most production such returns could be well under $1 US per day and may have been sustainable only as a function of Chinese labor market

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[49] Liang Guangshang (ed) Mushu Zaipei yu Liyong p 86

[50] Delphi Survey responses

restrictions With increasing liberalization of economic activities in the 1980s labor opportunity costs have risen substantially in suburban and wealthier rural farm areas As export opportunities have declined these healthy economic movements have undoubtedly worked against cassava cultivation in such areas Opportunity costs would be less affected in poorer and more distant farm areas but the state s declining marketing role is less apt to be vigorously replaced by private market development in such areas

Technology development

Publication of Liang Tingdong s Zhong Mufanshu Fa [Cassava Planting Methods] in 1900 was a benchmark in the initiation of a formal process of cassava technology improvement in China which could span time and space As indicated in the first section cassava spread to Fujian and Taiwan in the 1920s roughly 100 years after its first known cultivation in neighboring Guangdong Introduction in Hunan and Jiangxi in the early 1940s may have been the first example of deliberate trans-provincial dissemination by Chinese scientific institutions

The Peoples Republic agricultural science establishment gave attention to cassava as a bulky relatively drought resistant crop which could be grown on poor soils and still provide growth in available calories per unit of farmland with some advantages in yield stability Alternatively it could also furnish raw materials for industry This orientation toward bulky cheaper food items and indu trial crops was well within a tradition established early in the

history of most socialist governments and still continues to distinguish the pattern of food production and availability although to a decreasing extent over time in the Soviet Union Eastern European countries and North Korea as well as in China Vietnam and other socialist nations more suited to cassava production [51]

Although dissemination of cassava was emphasized throughout the 1950s broadening cultivation in the two southern provinces and initiating it in Zhejiang and Jiangxi cassava research began to show results in the late 1950s Between 1957 and 1962 the Agricultural Science Department s Grain Crops Laboratory of the South China Academy of Agricultural Science in Guangzhou (23°8 N) selected 10 varieties from a pool of 30 for dissemination at least six of which have been extensively cultivated including Zajiao [Hybrid] no 4 and Yinni Xiye [Indonesian thin leaf] exhibiting 11 percent and 23 percent yield improvements over widely planted Hongweizhong [Red Tail Variety] and Mianbao Mushu [Bread Cassava] Zajiao no 1 and Nanwan Mushu [South Bay Cassava] yielding 70 86 percent of Hongweizhong but exhibiting other desirable characteristics such as superior edibility higher starch rates and/or yield stability Although breeding objectives for cassava have broadened considerably since the 1950s higher root yields and improved edibility remain as central

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[51]Shigeru Ishikawa China s Food and Agriculture A Turning Point Food Policy 2 (May 1977) p 93 Bruce Stone China s 1985 Foodgrain Production Target Issues and Prospects in Anthony M Tang and Bruce Stone Food Production in the Peoples Republic of China Research Report no 15 (Washington D C International Food Policy Research Institute 1980) pp 92 96

Table 9 Cassava Root Nutritional Content
(percent)

Variety	Water Content	Starch Rate	Soluble Sugar	Protein	Fat	Fiber
Mianbao Mushu 101 [Bread Cassava 101]	64 0	29 2	1 29	0 61	0 20	0 74
Naomi Mushu 102 [Glutinous Rice Cassava 102]	63 0	29 0	2 15	0 81	0 20	0 80
Malaihuang 103 [Malay Yellow 103]	63 2	31 3	1 46	1 09	0 15	0 72
Wenchang Hongxin 104 [Wenchang Red Heart 104]	62 4	30 5	1 26	1 55	0 21	0 84
Maoming Baixin 105 [Luxuriant & famous White Heart 105]	60 6	32 6	1 54	1 04	0 13	0 68
Hainan Hongxin 211 [Hainan(Island) Red Heart 211]	67 0	26 8	1 85	0 50	0 21	0 71
Huguang Qingjing 210 [Huguang Green Stem]	57 6	36 8	1 23	1 40	1 14	0 63
Hongweizhong 201 [Red tail variety 201]	71 0	23 7	2 22	0 59	0 32	0 68
Yinni Xiye 202 [Indonesian Thin Leaf 202]	65 4	27 7	2 03	0 73	0 13	0 76
Yinni Daye 203 [Indonesian Big Leaf 203]	66 0	28 2	1 69	0 92	0 14	0 61
Nanyang Qingpi 204 [South seas Green skin 204]	66 0	28 8	2 87	0 60	0 17	0 72
Nanwan Mushu 205 [South Bay Cassava 205]	66 0	28 1	1 85	1 13	0 17	0 64
Huanan 206 [South China 206]	59 0	35 6	1 93	0 99	0 16	0 71
Huanan 207 [South China 207]	64 8	29 6	1 00	0 88	0 12	0 74
Zijingzhong 208 [Purple stem variety 208]	70 1	21 5	3 43	0 47	0 19	0 90
Fanyu Zijing 209 [Fanyu (County)Purple Stem 209]	61 8	23 0	2 02	0 86	0 15	0 88
Average of all varieties	64 2	28 8	1 86	0 89	0 17	0 74

Sources Liang Guangshang (ed), Mushu Zaipei yu Liyong [Cassava Cultivation and Use] Guangzhou Guangdong Kezhi Chubanshe [Guangdong Scientific and Technical Publishing House] 1981) p 108

foci of the Chinese breeding program [52]

South China 201 is also known as Hongweizhong or Dongguan Hongwei [Dongguan Red Tail] A high yielding cultivar with high cyanide content it is the most popular variety for flour production Cultivated on plains hilly tracts and mountainous uplands this variety covers 70-80 percent of cassava area in many Guangdong and Guangxi Prefectures It is also experimentally cultivated in the Yangzi Valley

South China 202 or Yinni Xiye was introduced from Indonesia in 1956 by the South China Agricultural Science Department in Guangzhou It typically outyields Hongwei by a small margin but has the highest cyanide content of popular varieties and is thus also used in processing industries primarily for flour and starch production Plantings are concentrated on the Aoxi State Farms There has also been successful experimental cultivation in Nanjing

South China 205 or Nanwanmushu was the shortest of the sixteen leading cultivars tested and is famous for withstanding the August 17 typhoon in 1963 It combines yield stability with high potential

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[52]Liang Guangshang (ed) Mushu Zaipei yu Liyong pp 10 and 77 Much of the succeeding discussion on varieties and institutions is based on pp 77 80 and Table 9 with a few additions from Cock and Kawaro Cassava in Asia

and is good for flour and especially starch production where it significantly outperforms other popular varieties As Table 9 indicates Huguang Qingjing [Huguang Green Stem] or South China 210 and South China 206 have by far the highest starch rates per unit weight but Nanwanmushu s respectable rate coupled with higher yield potential make it a clear leader in starch per unit of harvested area Following Nanwanmushu South China 206 207 and Jinni Xiye feature the highest starch content per unit area South China 205 is an internationally recognized cultivar with similar characteristics to those of the Vassourinha variety of Brazil and the Philippines The greatest area of Nanwanmushu concentration is Zhongshan Dongguan and other counties in the Pearl River Delta but it is planted widely throughout Guangdong

South China 101 or Mianbao Mushu is also known as Malaihong [Malay Red] since it was introduced onto rubber plantations in Dan Xian from Malaysia in 1912 The variety combines yield stability with low cyanide content and reasonably high yield potential and is recognized as China s best tasting cultivar Plantings are concentrated on Hainan Island especially in Dan Xian Wenchang and Baoting Counties but bread cassava is also grown in most areas of Guangdong and has been experimentally cultivated in Hebei Province farther north than any other variety (39°20 N) Its characteristics are relatively similar to those of Aipin Valencia of Southeast Asia

South China 104 or Wenchang Hongxin [Wenchang Red Heart] is the highest yielding variety among the better tasting (sweeter) cult vars It has the highest protein content of the 16 leading

varieties also features low cyanide concentrations reportedly outyields Mianbao Mushu by 22 percent but is not typically preferred to the latter for direct consumption South China 104 is planted predominantly in Wenchang and Qiongshan Counties on Hainan Island with little cultivation elsewhere

Among other palatable varieties Maoming Baixin [Maoming White Heart] or South China 105 from Maoming Municipal Area near Guangdong s Leizhou Peninsula and Nuomi Mushu [polished glutinous rice cassava] or South China 102 are worthy of mention Both outyield Mianbao Mushu by 10 11 percent with substantially greater superiority in more northern areas Both are sweet and low in cyanide content with South China 102 lowest of the sixteen prominent varieties A variety known as 6068 is also famous for its excellent eating qualities and is planted on around 10 000 hectares despite its modest yields

In sum the South China Tropical Crops Research Academy concentrated not only on selection and dissemination of cultivars featuring higher and more stable root yields and improved edibility but has focused breeding attention in combining those characteristics and initiated research on starch content By focusing on faster as opposed to strictly higher root yields the Academy also brough to cassava breeding in this early period the beginnings of a quintessentially Chinese orientation breeding to fit rotational patterns and multiple cropping sequences

With the catastrophic famines of 1960-61 centered in North China and the Yangzi Valley efforts to spread cassava cultivation northward intensified considerably The focal institution in this effort was the Zhejiang Province Sub-tropical Crops Institute in Pingyang (27°38 N) Between 1962 and 1964 the institute introduced 31 varieties from Guangdong Guangxi and Fujian including Hongwei Nanwanmushu Inni Daye Shibeiqingjing [stone tablet green stem] and Zajiao nos 1-6 But as Table 10 indicates there has been experimental cultivation much further north although the South China Tropical Crops Research Academy has indicated that good growth and yields are consistently obtained only up to around 26°N which cuts across southern Hunan Guizhou Jiangxi and Fujian

Aside from the above-mentioned institutions some cassava related research is reportedly conducted in each of the provinces within which cassava has been introduced In South China other relevant institutions are the Guangxi Province Asian Tropical Crops Research Institute in Nanning the South China Crop Research Institute and the South China Institute of Botany within the Chinese Academy of Sciences the Institute of Drought Resistant Grains and the Upland Grains Department in the Guangdong Agricultural Science Academy and the South China Agricultural College all in Guangzhou However cassava research is not reputed to be a significant current focus of any of the Guangzhou institutions

Cassava research and development in China is increasingly shifting its focus from the original narrowly defined goals of

Table 10 Results of Cassava s North Migration Cultivation Experiments

Experimenting Unit	Location (N latitude)	Variety	Planting Date	Harvest Date	Total Growing Days	Fresh Root Yield (tons/ha)
Northwest Agricultural Science Academy	29°30	A B	Apr 25	Nov 25	216	33 0
Hubei Dashahu Farm	30°	A B D	Apr 21	Nov 22	216	18 75 30 0
Anhui Province Crops Institute	31°53	B	Apr 12	Nov 3	206	20 325
Nanjing Botanical Institute	32 04	A B C	Apr 15	Nov 5	205	23 25 24 4
China Root and Tuber Institute	33°58	A B	May 6	Oct 24	172	37 5 45 0
Shaanxi Province Grains Crops Inst	34°21	A B	May 7	Oct 23	170	5 775-17 7
Shandong Province Crops Institute	36°41	A	Apr 15	Oct 24	193	22 5
Luda (Dalian) no 1 Farm	38°54	A B	May 6	Oct 23	171	12 75 19 5
Hebei Province Forestry Science Institute	38 20	A B	Apr 21	Oct 24	187	37 5 45 0

Notes A= Naomimushu [Glutinous Rice Cassava]
B= Mianbaomushu [Bread Cassava]
C= Inni Xiye [Indonesian Thin Leaf]
D= Malaihuang [Malay Yellow]

Sources Liang Guangshang (ed) Mushu Zaipei yu Liyong [Cassava Cultivation and Use] Guangzhou Guangdong Kezhi Chubanshe [Guangdong Scientific and Technical Publishing House] 1981) p 26

improving yield and edibility The main improvement efforts still include edibility but also emphasize cultivation techniques especially cassava s relation to other crops in various systems and the combined development of cassava and non-crop rural activities Breeding objectives also include early planting early ripening and rapid maturity goals as well as disease resistance high yields and high starch and protein content [53]

Research and development goals related to cultivation techniques feature improvement in rotation synergies seasonal cultivation intercropping and achievement of two or even three ripenings per year Bean crop and cassava rotations and intercropping are of particular interest as techniques for developing soil strength The 1982 CIAT delegation observed that cassava was often intercropped with grain legumes in more intensively cultivated areas and estimated that yields of both crops were probably reduced by only 15-30 percent resulting in relatively efficient land use with good soil conservation properties [54]

Since 1979 non crop agriculture has been emphasized in China partially correcting for the substantial pre 1979 stress on food crops especially staples Consequently a recent goal for cassava development has been to integrate cassava with forestry animal husbandry sericulture aquaculture and rural sidelines for

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[53]Liang Guangshang (ed) Mushu Zaipei yu Liyong p 10

[54]Ibid correspondence from James H Cock Cassava Program Director CIAT June 24 1983

cooperative production Investigation of additional and even novel industrial uses is also of increasing interest

Survey respondents among Chinese cassava breeders and agronomists [55] appeared optimistic about the potential for growth in farmers yields during the next 4 and 14 years Respondents were instructed to base their assessments on existing varieties and those currently under development but their estimates differed considerably They were also optimistic about the prospects for increasing that potential via a doubling of research expenditures related to cassava with the most conservative assessments provided by the representative of the institution where most research on cassava is conducted In his view farmers yields on poor soils could increase from currently 3 6 tons per hectare to 4-8 tons by 1990 and 5-9 tons by 2000 or 5-10 tons and 6-12 tons respectively with a doubling of research expenditures With good soil and climatic conditions farmers yields could increase from currently 15-30 tons/hectare with fertilizer to 18-35 tons by 1990 and 20-40 tons by 2000 or 25 35 tons and 35-45 tons with a doubling of research resources

It is clear that yields can improve especially in Guangdong via greater access to manufactured fertilizers analysis and extension related to its optimal use and to proper selection of planting materials Fertilizer pricing distribution and analytic systems are undergoing considerable structural change in China

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[55] Delphi Survey responses

Proper resolution of remaining and newly emerging difficulties will be instrumental in achieving yield progress through growth in fertilizer use [56]

It also appears that there may be some limited potential exploitable with further international exchange of genetic materials [57] State farms are technological leaders in cassava cultivation though not for most staple crops and careful selection of planting materials and quest for improved cultivars are evident on state farms Yield progress on several state farms in recent years has allowed continued profitability of cassava cultivation despite declining prices This means that new improved varieties can move rapidly into full scale production in China What may be called for are institutional links which can bring state farm developments into the private and collective economy more expeditiously A new variety must undergo regional testing for three years The results are presented to the provincial seed commission which may then recommend the variety to seed production companies for multiplication

Work on intercropping and rotational systems is something Chinese researchers do particularly well and is likely to lead to some further improvements Some of these may not immediately

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[56]For details see Bruce Stone Chinese Fertilizer Application in the 1980s and 1990s Issues of Growth Balance Allocation Efficiency and Response in U S Congress Joint Economic Committee (eds) China s Economy Looks Toward the Year 2000, vol 1 The Four Modernizations (Washington D C U S Government Printing Office 1986) pp 453 496

[57]Cock and Kawano Cassava in China Kawano Trip Report to China (18 26 January 1986)

increase cassava yields per se but may improve the attractiveness of planting cassava and thus arrest its decline in area What is singularly missing for cassava as well as for many other crops is socio economic research in cassava areas particularly poorer ones Lack of agro-economic data and analysis for assessing constraints limiting farmers yields is recognized by the South China Tropical Crops Academy [58]

Finally with the reduction in export opportunities and the curtailed government role in marketing development of demand and market institutions are of particular importance for continued expansion of cassava production and use These issues will be undertaken in the following sections

MARKETS AND DEMAND

A synthesis of production and utilization

As indicated above production statistics for cassava in China are highly fragmentary except for Guangxi Zhuang Autonomous Region for which data are complete though even for Guangxi questions of reliability and comparability remain Utilization data however are almost wholly unavailable with the exception of the international trade data compiled from European Community Analytic Tables for Foreign Trade appearing in Table 3 Government procurement data for cassava assuredly exist but have not been made available in Chinese

[58]Delphi Survey response from Tan Xuecheng breeder

statistical compendia on marketing and trade Production data from cassava flour and starch factories as well as from other industrial processors are certainly generated but are not of sufficient importance to appear among national statistical series in the relatively detailed Guangdong Province Statistical Yearbooks and the Guangxi Economic Yearbook 1985 although the latter contains a single column of discussion of the starch market in which cassava is mentioned As a regionally concentrated crop cassava has not turned up among published results from national farm surveys Even Liang Guangshang s cassava-specific publication Mushu Zaipei yu Liyong [Cassava Cultivation and Use] provides not a single statistic on aggregate utilization

In the past it has been clear that FAO estimates of cassava use were all based on constant percentages of estimated production [59] For example the FAO Supply Utilization Accounts Tape 1981 evidently incorporated the following percentages feed use (25 percent) waste (5 percent) food use (67 percent) processing (3 percent) use for tapioca (70 percent of processing) starch use (30 percent of processing) [60] Since the production series was mechanically generated from virtually no statistical base the utilization series were inevitably unreliable even if the percentage shares were roughly correct Conversely regardless of the accuracy of the production estimates the utilization shares have assuredly not been

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[59]Bruce Stone An Examination of Economic Data on Chinese Cassava Production Utilization and Trade pp 13-22

[60]Food and Agriculture Organization of the United Nations Supply Utilization Accounts Tape 1981 Rome 1982

constant over time with feed and processing use increasing in importance at the expense of direct human consumption Moreover shares for feed and processing would exceed the shares implied by the 1981 Utilization Tapes even for the 1960s [61]

As an examination of Tables 11 and 12 will reveal FAO utilization series for China are now generated in a more complicated fashion but historical production area and yield figures are identical to those appearing on the older tapes Aside from the international trade series which relates well to and is probably based on the EC Analytic Tables for Foreign Trade FAO series are still generated from an extremely weak statistical basis which probably consists of no more than the partner country trade data and the single production figure circa 1980 provided to the 1982 CIAT delegation

In these recent FAO series such as Supply Utilization Accounts Tape 1984 released at the end of 1985 unprocessed feed is set at 10 percent throughout the 1961 83 period and waste is dropped from 5 percent on previous tapes to 3 percent for the entire period Direct food consumption estimates have become trended values declining from 72 0 percent of production in 1962 to 67 0 percent in 1979 (Table 12) Processed uses have become monotically non-decreasing trended values beginning somewhat arbitrarily at 15 0 percent in 1962 and rising to 20 0 percent in 1979 of which dried cassava (chips and

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[61]Stone An Examination of Economic Data on Chinese Cassava This paper was provided to both CIAT and the FAO Statistical Division s Basic Data Unit in 1983 and provided part of the basis for subsequent adjustments

Table 11 FAO Estimates of Chinese Cassava Production Area and Yield 1961-1984

	Harvested Area		Production		Yield	
	1982 Tape	1984 Tape	1982 Tape	1984 Tape	1982 Tape	1984 Tape
	(1000 hectares)		(1000 metric tons)		(tons per hectare)	
1961		80		940		11 750
1962		85		1000		11 765
1963		85		950		11 176
1964		90		1000		11 111
1965		90		1100		12 222
1966	95	95	1100	1100	11 579	11 579
1967	100	100	1200	1200	12 000	12 000
1968	120	120	1400	1400	11 667	11 667
1969	130	130	1500	1500	11 538	11 538
1970	140	140	1600	1600	11 429	11 429
1971	150	150	1800	1800	12 000	12 000
1972	160	160	1900	1900	11 875	11 875
1973	170	170	2000	2000	11 765	11 765
1974	170	170	2000	2000	11 765	11 765
1975	180	180	2100	2100	11 667	11 667
1976	180	180	2200	2200	12 222	12 222
1977	190	190	2200	2200	11 579	11 579
1978	200	200	2300	2300	11 500	11 500
1979	200	200	2500	2500	12 500	12 500
1980	226	226	3000	3300	13 274	14 602
1981	236	230	3120	3500	13 232	15 217
1982		235		3600		15 319
1983		240		3800		15 833
1984						

Source FAO Supply Utilization Accounts Tape 1981 Rome 1982 FAO Supply Utilization Accounts Tape 1984 Rome 1985

Table 12 FAO Estimates of Chinese Cassava Production and Use 1961-1983

	Production	of which Feed	Waste	Food	Processed	of which input to Chips & Pellets	Tapioca	Starch
					(1000 tons)			
1961	940	94	28	668	140	90	20	30
1962	1000	100	30	720	150	100	20	30
1963	950	95	28	666	160	110	20	30
1964	1000	100	30	699	171	120	21	30
1965	1100	110	33	756	201	150	21	30
1966	1100	110	33	740	217	160	22	35
1967	1200	120	36	807	237	180	22	35
1968	1400	140	42	959	259	200	24	35
1969	1500	150	45	1014	291	230	26	35
1970	1600	160	48	1099	293	230	28	35
1971	1800	180	54	1246	320	250	30	40
1972	1900	190	57	1330	323	250	33	40
1973	2000	200	60	1384	356	280	36	40
1974	2000	200	60	1380	360	280	40	40
1975	2100	210	63	1467	360	280	40	40
1976	2200	220	66	1519	395	300	50	45
1977	2200	220	66	1519	395	300	50	45
1978	2300	230	69	1606	395	300	50	45
1979	2500	250	75	1675	500	400	55	45
1980	3300	330	99	1466	1405	1300	60	45
1981	3500	350	105	1545	1500	2000	65	45
1982	3600	360	108	1512	1620	1500	75	45
1983	3800	380	114	1606	1700	1700	78	45

Notes and Sources FAO Supply Utilization Accounts Tape 1984 Rome 1985 To reach quantities of processed products extraction rates of 35 percent for chips and pellets (dried cassava) 22 percent for tapioca and 18 percent for starch are applied in FAO data

pellets for feed either for domestic use or export) starts at 2/3 of the processed amount in 1962 and rises to 80 0 percent in 1979 Cassava input to starch production begins at 20 0 percent of the processed amount in 1962 and declinesto 9 0 percent in 1979 The absolute quantities in FAO data form a step function remaining constant for five-year periods then increasing by 5 thousand tons in a single year then remaining constant again for five years Cassava input to tapioca production comprises the remainder with absolute quantities rising in similar monotically non-decreasing fashion but with shares declining slightly to 11 percent by 1979

FAO data appear in other formats but the statistical base or lack thereof remains the same For example the Standardized Commodity Balances Tape 1984 (Rome 1985) includes series for availability (production minus exports) food (direct food consumption plus cassava input to tapioca processing) and other uses (waste plus cassava input to starch processing) Because of the massive increase in exports in 1979-81 the post 1979 FAO series exhibit some peculiarities Dried cassava input on the Supply Utilization Tape increases from 20 0 percent to 42 6 percent of production from 1979 to 1980 (Table 12) for example and the program synthesizing these series generated large negative numbers for other uses in 1980 and 1984 on the Standardized Commodity Balance Tape

Nevertheless these series represent some improvement in credibility over the 1981 82 tapes The waste percentage has been lowered (to what is probably the minimum parametric value used by FAO) The estimated production shares of processed cassava have been