

Chapter 1

The Sweetpotato Economy of China With New Estimates of Sweetpotato Utilization

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Abstract

Sweetpotato is the fourth major staple crop and the second largest feed grain in China. Sweetpotato was one of the first agricultural commodities liberalized in the early reform period in China, but inter-regional trade remains small. In many rural areas, it is planted primarily as a subsistence crop intended to address household demand for feed and other uses.

While production has remained fairly stable at 20-23 million tons/year since the 1970s, sweetpotato area has declined significantly. Yield growth of sweetpotato has generally been lower than cereals except in recent years. Further, utilization of sweetpotato as a food staple declined from about 50 percent of total production in the 1970s to less than 15 percent by the end of the 1990s. Feed and industrial use grew significantly over this period. By the late 1990s, feed use accounted for more than 40 percent and processing demand accounted for one-third of total sweetpotato production. Only about 15 percent of sweetpotato production was consumed directly as food. Although China is a net exporter of sweetpotato and the largest sweetpotato producer in the world, sweetpotato has never been an important commodity in international trade.

Introduction

China is by far the largest producer of sweetpotato in the world, accounting for 85 percent of global production (Table 1). In China, sweetpotato is the fourth major crop (after rice, wheat, and maize).⁴ Since 1970s, the area to sweetpotato in China has declined significantly from a peak of 11 million hectares. By 1998, production area was down to about 6 million hectares although total production remained relatively constant at 20-23 million tons/year throughout this period as yield increases offset area decline. Moreover, utilization of sweetpotato changed over the past two decades from being primarily a food crop to primarily a feed crop. Sweetpotato is now the second most

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⁴ In this paper we follow the Chinese classification system wherein sweetpotato is classified as a “grain” crop. Production and yield estimates reported in the paper are on a dry weight basis, i.e., fresh weight divided by 5. This also follows the Chinese statistical procedure to compare and aggregate root and tuber crop production with cereal grains. This adjustment factor is meant to account for the higher water content of roots and tubers, but probably results in under-reporting of sweetpotato production. For example, some new varieties currently widely grown in China have 25-30 percent dry matter, whereas even cereal grains can contain 10 percent moisture.

important feed grain in China after maize. Despite its importance to China's agricultural sector, sweetpotato has generally been a neglected crop by government policy. A clearer understanding of sweetpotato's role, potential and changing utilization patterns in China can contribute to the formulation of appropriate policies for the sector. This is especially important because of sweetpotato's role in meeting the rapidly growing feed demand for livestock and its contribution to farm income and employment, particular in poor, rural areas.

The objective of this chapter is to characterize the changing pattern of sweetpotato production and utilization in China. To accomplish this objective, provincial-level statistics on production, area and yield trends were collected and analyzed. To estimate utilization trends, knowledgeable individuals from key producing provinces were interviewed. These data were then combined to construct sweetpotato food balance sheets for each province and for the nation as a whole.

Discussions with plant breeders and researchers working on sweetpotato indicate a bright future for the crop. They claim that there is a high potential for substituting sweetpotato for maize as feed in swine production, especially among small-scale producers. Since livestock production, particularly swine production, has been mostly small scale at the farm household level, and sweetpotato is mainly produced and used on the farm instead of flowing into the market, feed use of sweetpotato may increase in the short- and medium-term (Gitomer 1996). Other uses of sweetpotato such as starch for both food processing and other industrial uses may also have large potential if better processing technology and more efficient markets are developed (Zhang 1999). However, others believe that the potential of sweetpotato as a substitute for feed maize is limited due to the increasing opportunity cost of labor, commercialization of livestock production, poor storability of sweetpotato in fresh form, low energy density on a fresh basis, and low protein content. These debates are becoming an important issue deserving close attention by researchers and agribusiness sectors.

Sweetpotato production

Sweetpotato in the overall economy

The growth of agricultural production in China since the 1950s has been one of the main accomplishments of the nation's development policies. Except during the famine years of the late 1950s and early 1960s, the country has enjoyed rates of production growth that have outpaced the rise in population (Table 2). Even in the 1970s prior to the reform period, agricultural gross domestic product in real terms and grain production grew at 2.7 percent 2.8 percent per annum, respectively (Table 2). Except for grain and oil crops, production in horticulture, livestock and fishery have been growing at accelerated rates since the reform started in 1979, with average annual growth rate of between 7 and 14 percent (Table 2). For grain production, after accelerating to 4.7 percent per year in the early reform period (1978-84) its growth slowed to about 1.8 percent during 1985-99, but even this rate is higher than the population growth rate.

Before the 1980s, sweetpotato had long been one of the most important food crops in China's agricultural economy. The crop's area reached an historical high of over 11 million hectares in 1970 and accounted for 9.4 percent of total grain area (Table 1). But its importance in grain production has since declined. By 1999, its share of the total area sown to grain was only 5.3 percent and its share of total grain production was just under 5 percent.

The reduced importance of sweetpotato in China's grain economy is due both to the reduction in area planted to sweetpotato and a relatively slow rate of yield improvement. In contrast to the acceleration of overall grain production growth in the early reform period (1978-84), sweetpotato production growth declined from 2.4 percent per year in the pre-reform period (1970-78) to 0.5 percent per year during 1978-84 (Table 3). In the early reform period, the area of sweetpotato fell by 3.3 percent per year, compared with a rate of decline of 1.1 percent for all grains (Table 3). Although annual growth rate of sweetpotato yield was raised from 1.3 percent in 1970-78 to 3.8 percent in 1978-84, this performance was considerably less than that achieved by the major grains, which averaged about 6 percent per year. Since the mid 1980s, total grain area has remained about constant although sweetpotato area has continued to decline. Sweetpotato yield growth continued to underperform compared with rice, wheat and maize up until the mid 1990s. Only in the recent few years has the performance of sweetpotato yield been better than cereal grains. Annual yield growth rate reached 2.2 percent in 1995-99, well offsetting the change in the crop area (-0.6 percent per year). This resulted in an annual increase in sweetpotato production of 1.6 percent in these years (Table 3).

China's sweetpotato economy and its growth pattern have attracted very little attention from researchers. In the past, China tightly regulated its rice, wheat, and maize sectors, but let sweetpotato be largely unregulated since the beginning of the reform period (Zhang 1999). However, liberalization of sweetpotato production did not stimulate the sector's growth, neither in terms of area or yield. Rather, the principal effect of economic reforms appeared to be on how sweetpotato was utilized. Explanations for the performance and trends in sweetpotato production and utilization have to come from other forces of change in the economy and the sweetpotato sector itself. Some of these forces include changes in the structure of food demand and commodity utilization. Factors affecting technological progress in sweetpotato also play an important role.

Rising incomes, urbanization, market development, and other transitional forces push consumers to demand more rice and wheat and less coarse grains such as maize and sweetpotato (Huang and Bouis 1996 and 2000). These same forces lead consumers to demand more livestock, fish and horticultural products. The demand for animal and fish products in turn increases farm-level demand for animal feed. The rapid expansion of maize utilization reflects this trend. The growth of maize production has outpaced all other grains since the 1970s despite the substantial decline in demand for maize as food (Table 3).

Sweetpotato production did not seem to be much influenced by the opportunity of expanding and changing consumer demand. Sweetpotato area steadily declined during the entire reform period, and yield improvement was slow prior to the mid 1990s (Table

3). The absence of much yield growth during 1978-95 raises the question whether sufficient resources were devoted to research and extension for sweetpotato. Research-driven technological change has been the engine of China's agricultural economy in general and for cereal grains in particular (Huang and Rozelle 1998). Our interviews with the officials from the Ministry of Agriculture and the Ministry of Sciences and Technology find that sweetpotato has indeed been a relatively neglected crop by the research community. The impressive yield growth recorded for sweetpotato in the late 1990s may be explained by the rapid diffusion of some new production technologies, such as virus-free planting material, which boosted yield by about 20 percent in Shandong Province (Fuglie *et al.* 1999).

Regional distribution of sweetpotato production

Sweetpotato is widely grown in almost every province in China. After it was introduced to China in the 16th century, sweetpotato became one of the major staple food grains in many parts of the county. Farmers plant sweetpotato in every province, but cropping patterns, crop intensity, and importance of sweetpotato vary from region to region (JSAAS and SDAAS 1984).

Geographical distribution extends from Hainan Island (18° North latitude) to Heilongjiang province (45° North latitude), and covers altitudes from sea level to more than 2,000 meters (Lu *et al.* 1989). Based on the ecological conditions and planting seasons, sweetpotato production in China can be divided into five agro-climatic zones (JSAAS and SDAAS 1984): (I) Northern Spring Sweetpotato Region, (II) the Huang-Huai Basin Spring and Summer Sweetpotato Region, (III) the Yangzi River Basin Summer Sweetpotato Region, (IV) the Southern Summer and Fall Sweetpotato Region, and (V) the Southern Fall and Winter Sweetpotato Region (Map 1).

The Northern Spring Sweetpotato Region (Region I) is a humid or semi-humid monsoon temperate and cold temperate zone. In this region, sweetpotato is planted in both plain and hilly or mountainous areas. Because the temperature is low and the growing season is short in the regions, sweetpotato is a very minor crop.

The Huang-Huai Basin Spring and Summer Sweetpotato Region (Region II) has been showing the most significant decline in sweetpotato area and production since the mid 1980s. The region accounted for more than 20 percent of sweetpotato area and nearly 30 percent of production in the early 1980s, but both area and production shares declined significantly over time. By the later 1990s, the region's share in China's sweetpotato area and production fell to less than 15 percent and 20 percent, respectively. While all provinces in the region showed a decline in the crop area, most of reduction in sweetpotato area occurred in Shandong province, from about 1 million hectares in the early 1980s to less than 500,000 hectares in the late 1990 (Appendix Table 1). This decline in sweetpotato area occurred in an area where sweetpotato yield and recent yield growth have been relatively high for China. From an ecological point of view, the region located in Huang-Huai basin has favorable climatic conditions for sweetpotato production. It is a temperate semi-humid monsoon area with large differences between day and night temperatures, and often has dry sunny days with sunlight sufficient for high photosynthetic efficiency. Our field interviews with farmers and local agricultural

officials provided several hypotheses on the reasons underlying the decline in sweetpotato area. These included the changing patterns of sweetpotato utilization, decline in sweetpotato profitability compared with other crops, and a weakening of the linkage between sweetpotato and pig production.

The Yangzi River Basin Summer Sweetpotato Region (Region III) is the most important region for sweetpotato production in China, accounting for about 60 percent of national production. The region includes almost all the Yangzi River Basin such as Jiangsu, Anhui, and Henan provinces, south of the Huai River, the most southern part of Shaanxi province, most of the Guizhou province, the northern parts of Hunan, Jiangxi, and Yunnan provinces, and the entire Sichuan Basin. The climate in the region is characterized by the northern monsoon subtropical humid. Solar radiation and sunlight are the lowest among all the regions. The influence of the large number of rivers in the upper and middle reaches of the Yangzi River, high evaporation and heavy clouds and fog all tend to affect sweetpotato cultivation adversely. Sweetpotato is primarily planted in hilly areas on loess and red soils. The main production area is the Sichuan Basin. The growing season in this region is 140-170 days, beginning late April, May and June with harvesting in late October and November. Sweetpotato production in Region III has been rising.

The other two regions, the Southern Summer and Fall Sweetpotato Region (Region IV) and the Southern Fall and Winter Sweetpotato Region (Region V) are located in southern China. Together, these regions account for 15-20 percent of national sweetpotato area and a smaller share of production, as yields in these regions are generally lower than the national average.

Region IV includes a long and narrow strip just north of the tropic of Cancer in the south and central parts of the semitropical humid monsoon climate region. This includes the southern parts of Fujian, Jiangxi, and Hunan, the northern parts of Guangdong and Guangxi, central Yunnan and a small part of southern Guizhou. Summer sweetpotato is sown in May and harvested between August and October. An autumn crop of sweetpotato is planted between early July and early August, and harvested between late November and early December. Sweetpotato in this region is mainly distributed in hilly areas on red, yellow and crimson soils.

Region V includes the south of Guangdong, Guangxi, Hainan, Yunnan, Taiwan, and the South China Sea islands. It belongs to humid tropical monsoon climate area with a hot season of 8-10 months long and the lowest day and night temperature differential in China. Although sweetpotato can be grown year-round, farmers plant it mostly in the autumn and winter months. Fall sweetpotato in the lowlands is planted from mid-July to mid-August, whereas upland areas are planted from early July to early August. Both are harvested from early November to late December with a growing period of 120-150 days. Most winter sweetpotato is planted in November and harvested in April or May of the following year, with a growing period of 170-200 days.

Table 4 presents sweetpotato production by province. While sweetpotato production is widely distributed all over China's 30 provinces, the top 10 provinces accounted for 82 percent of total area sown in the country, and 87 percent of national

production in 1997-1999. Indeed, most of the production is concentrated in the 5 provinces of Sichuan, Shandong, Henan, Guangdong (including Hainan island) and Anhui. These five provinces accounted for 62 percent and 67 percent of sweetpotato area and production, respectively, in 1997-99. Sichuan alone accounts for more than 20 percent of China's sweetpotato production. Apparently, the economic reforms introduced in the late 1970s did not affect the geographic distribution of sweetpotato substantially.

The share of production of the top five and top ten provinces declined between 1984-86 and 1997-99 (Table 4). Within the top five sweetpotato-producing provinces, the most significant changes took place in Sichuan and Shandong. Both area and production increased in Sichuan, while both fell in Shandong. Sichuan overtook Shandong as the largest sweetpotato producer in the 1990s. This further points out the importance of sweetpotato utilization and demand forces in shaping the crop's production pattern.

Sweetpotato utilization in China

Previous estimates of sweetpotato utilization

Lack of available information on utilization of sweetpotato has been one of the most serious difficulties in understanding the sweetpotato economy of China. While several studies have attempted to estimate sweetpotato demand by various users, these studies are based either on small samples in specific locations or a particular point in time. Not surprisingly, inconsistencies emerge when one attempts to put these estimates together. Projections based on alternative assumptions of sweetpotato utilization could lead to a wide range of perceptions on the future of sweetpotato in China with implications for policies affecting crop production, processing and investment.

Table 5 summarizes our review of some previous studies on sweetpotato utilization in China. While most of these studies show that direct food consumption of sweetpotato has declined over time, the magnitude of the estimates vary widely. For example, one estimate claims the share of sweetpotato used for direct food consumption declined from 50 percent in the 1950s to 12 percent by the 1980s, while other studies estimated that direct food consumption still accounted for as much as 34 percent of sweetpotato utilization (Gitomer 1996) or even 77 percent in the 1980s (FAO). Significantly different estimates are also found for utilization of sweetpotato for feed, industry, and food processing. Estimates of the proportion of feed utilization for the 1990s ranged from 34 percent to 85 percent, and processing demand ranged from less than 15 percent to 40 percent.

Despite these discrepancies, the literature does provide some consensus on structural changes in sweetpotato utilization over time. Sweetpotato was an important food crop in China in 1950s-1960s. However, with the rapid economic development and rising farmers' incomes since the beginning of the reform period in 1978, sweetpotato, often considered as an inferior good, has been gradually moving from being a staple food to feed and other uses. Rice and wheat are being substituted for coarse grain (including sweetpotato) in food consumption as incomes rise (Huang and Bouis 1996). However,

demand for sweetpotato in food processing expanded as rural markets developed and food consumption diversified (Zhang 1999). Further, there are apparently large differences in utilization patterns among regions. This suggests that estimates of utilization trends based on a small case study may not be appropriate for analysis of regional or national trends.

New estimates for sweetpotato utilization in China

To develop a consistent and plausible set of estimates for sweetpotato utilization in China, a nationwide survey of agricultural leaders and administrators from Agricultural Bureaus (in charge of sweetpotato production) and Grain Bureaus (in charge of grain marketing) in each province was conducted. Knowledgeable officials in each province were asked to make their best estimates of sweetpotato utilization in their province over time. After receiving the survey forms from all provinces, a consulting meeting of experts on sweetpotato production and marketing was held in Beijing to evaluate and revise the estimates. Table 6 summarizes the results from two leading sweetpotato production provinces, Sichuan and Shandong from the 1950s to the 1990s. Table 7 presents yearly estimates of sweetpotato utilization for all China from 1980 to 1997.

The estimates from this survey confirm large differences in sweetpotato utilization across regions and over time. For example, in the 1950s the proportion of sweetpotato used as feed was small and similar in Sichuan (14 percent) and Shandong (20 percent). Over time, feed use of sweetpotato grew substantially in both provinces, but much more rapidly in Sichuan. By the 1990s feed utilization reached 60 percent in Sichuan but only reached 30 percent in Shandong. On the other hand, food use stood at about 10 percent in both provinces. An important difference was the emergence of a large, sweetpotato-based food processing industry in Shandong in the 1980s and 1990s. By the 1990s, nearly half of sweetpotato production in Shandong was used to manufacture starch for food processing industries. Food processing demand also grew in Sichuan over this period, but not as rapidly as in Shandong.

The field interviews in Sichuan and Shandong reveal that the less dramatic shift of sweetpotato to feed in Shandong is associated not only with rapid development of the local food processing industry but also with the availability of alternative animal feeds such as maize. Shandong, one of most developed agricultural food processing provinces in China, has taken advantage of its proximity to urban and export markets to process sweetpotato for various food and industrial products such as noodles, starch and alcohol. In Sichuan, on the other hand, growth in maize production has not kept up with the rapid growth in livestock production. Sichuan is not only the largest sweetpotato production province but is also largest and one of the fastest-growing livestock producing provinces. While the maize deficit in Sichuan has been partially filled by shipments of maize from northern China (especially Jilin and Liaoning provinces), high transport costs and lack of capital to purchase feed by small farmers in Sichuan provide greater incentive for farmers to use home-grown sweetpotato as feed.

At the national level, the estimates show that feed and processing demands have dominated sweetpotato utilization since the mid 1980s (Table 7). Feed use exceeded food

use by 1985 and processing demand surpassed food use by 1988. By 1997, the proportion of sweetpotato used for feed had reached 41 percent and processing use was 33 percent. It is interesting to note that although both feed and processing utilization rose significantly in the past two decades, the growth in processing use has been larger than the growth in feed use (a result consistent with a study in Sichuan by Zhang 1999).

Sweetpotato food balance sheet for China

From household income and expenditure surveys conducted by the State Statistical Bureau and interviews and surveys done for this study, direct food consumption of sweetpotato by rural and urban consumers was estimated. These, together with sweetpotato utilization information presented in Table 7 and production and trade data from government publications (SSB), a sweetpotato supply and utilization food balance sheet was created for China from 1980 to 1997 (Table 8). Year-end stocks were estimated as the residual of the production, trade and consumption balance.

Total utilization of sweetpotato remained at 20-24 million metric tons (mmt) per year during the entire period between 1980 and 1997. This demand was met entirely through domestic production. Although China is a net exporter of sweetpotato, it has never been an important commodity in China's trade. Sweetpotato in many rural areas is intended to address household food and feed needs and to earn cash income through processing into starch and food products, not primarily for direct marketing. Among various uses, direct food consumption declined from 8.5 mmt in 1980 to less than 3 mmt in 1997, while feed demand increased from 7.3 mmt to 8.4 mmt, and industry use (processing) increased from 3.5 mmt to 6.8 mmt over this period (Table 8). The small quantity of exports reported refers only to trade in fresh sweetpotato. There was also a small but growing export of sweetpotato processed products such as starch and starch-based noodles, but the overall quantities of these exports are not known.

The decline in sweetpotato consumption as direct food resulted from two major factors. One is income growth, which is negatively correlated with per capita sweetpotato consumption, and the second is rural to urban migration. Urban residents consume only about one-third the amount of sweetpotato consumed by rural villagers. In China, the proportion of urban population increased from less than 20 percent in 1980 to 30 percent in 1997. It is expected that growing urbanization will continue to be a major factor lowering per capita sweetpotato food consumption in the future.

Conclusions and implications

The role of sweetpotato in China's agricultural economy has undergone a fundamental change over the past decades. Overall sweetpotato production has remained relatively stable at 20-23 million tons per year while area planted to sweetpotato declined from 11 million hectares to 6 million hectares between the 1950s and the 1990s. Sweetpotato's share of total grain production in China fell by nearly half from 9.8 percent to just under 5 percent. Further, rising incomes and urbanization of China's population has reduced demand for coarse grains, including sweetpotato, as food. Instead,

sweetpotato has become an important feed and industrial crop. It remains the second most important feed grain in China (after maize) and has become an important source of starch and raw material for food processing industries. Patterns of sweetpotato utilization vary considerable among regions of China, with relatively greater use by food industries in the more developed coastal provinces and greater use as animal feed in interior provinces.

The increase in demand for feed grain and raw materials for food product industries is expected to continue to rise rapidly in the coming decades. This rapidly rising demand has sparked considerable concern in China, whether China can meet this demand domestically or instead rely increasingly on grain imports. Trends in China's sweetpotato economy show that this crop can and is playing an important role in helping China meet the new demands of its population. However, sweetpotato has been neglected by policy, and investment in crop improvement has been low. One indicator of this is that the rate of growth in sweetpotato yield has generally been below that for cereal grains. Interviews with scientists and some recent examples of the impact of new sweetpotato production technology show that there is good potential for improving the productivity of sweetpotato crop production with appropriate investments in research and extension.

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Table 1. Sweetpotato production in China, 1961-1997

Year	Sweetpotato production		Total grain production ^a		Sweetpotato as % of total grain production		China as % of world sweetpotato production	
	Area (000 ha)	Production (000 t)	Area (000 ha)	Production (000 t)	Area (%)	Production (%)	Area (%)	Production (%)
1961-65	9,865	16,796	121,107	171,910	8.15	9.77	78	78
1969-71	11,262	20,026	119,239	233,683	9.44	8.57	92	70
1982	6,908	2,920	113,396	353,425	6.09	6.20	87	75
1990	6,256	20,771	113,466	451,841	5.51	4.60	53	79
1995	6,085	23,485	110,061	466,617	5.53	5.03	68	86
1999	5,963	20,474	113,161	508,387	5.25	4.96	65	74

^a Grain includes rice (measured in paddy form), wheat, maize, soybean, sweetpotato, potato, sorghum, barley and millet. Sweetpotato and potato production are included on a dry weight basis. Dry weight is computed by dividing fresh weight by 5.

Sources: MOA, Agricultural Yearbook of China, various issues; MOA, Statistics for China Rural Economy, 1949-86. Sweetpotato production and area in 1961-65 and 1969-71 are from FAO Production Yearbook, various issues.

Table 2. Annual growth rates (%) of China's agricultural economy, 1970-99

	Pre-reform	Reform period		
	1970-78	1979-84	1985-95	1996-99
Gross domestic product (GDP)	4.9	8.5	9.7	8.0
Agriculture GDP	2.7	7.1	4.0	3.6
Grain production	2.8	4.7	1.7	1.9
Oil crops	2.1	14.9	4.4	3.4
Fruits	6.6	7.2	12.7	9.4
Red meats	4.4	9.1	8.8	9.2
Pork	4.2	9.2	7.9	9.0
Fishery	5.0	7.9	13.7	10.4
Population	1.80	1.40	1.37	0.97
Per capita GDP	3.1	7.1	8.3	7.0

Note: Figure for GDP in 1970-78 is the growth rate of national income in real terms. Growth rates are computed using regression method. Growth rates of individual and groups of commodities are based on production data; sectoral growth rates refer to value added in real terms. Growth rate of sweetpotato production in 1970-78 includes both sweetpotato and potato.

Source: SSB, Statistical Yearbook of China, various issues; MOA, Agricultural Yearbook of China, various issues.

Table 3. Growth rates of grain production, sown area and yields in China, 1970-1999

Commodity	Pre-reform	Reform period		
	1970-78	1978-84	1984-95	1995-1999
Grain Production	2.8	4.7	1.7	1.9
Sown area	0.0	-1.1	-0.1	0.7
Yield	2.8	5.8	1.8	1.2
Rice				
Production	2.5	4.5	0.6	1.6
Sown area	0.7	-0.6	-0.6	0.3
Yield	1.8	5.1	1.2	1.3
Wheat				
Production	7.0	8.3	1.9	2.1
Sown area	1.7	0.0	0.1	0.1
Yield	5.2	8.3	1.8	2.1
Maize				
Production	7.4	3.7	4.7	3.2
Sown area	3.1	-1.6	1.7	2.9
Yield	4.2	5.4	2.9	0.3
Sweetpotato				
Production	2.4	0.5	0.4	1.6
Sown area	1.1	-3.3	-0.3	-0.6
Yield	1.3	3.8	0.7	2.2
Cash crop sown area	2.4	5.1	2.1	3.5

Note: Growth rates are computed using regression method.
Sources: SSB.

Table 4. Sweetpotato production in top ten producing provinces in China.

Province	Sown area (000 ha)	Yield (ton/ha)	Production (000 tons)	Per capita production (kg/person)	Share in national total	
					Area (%)	Production (%)
Annual average for 1984-86						
National total	6232	3.40	21172	25.0	100	100
Shandong	856	5.42	4634	68.6	14	22
Sichuan	1221	3.19	3891	43.6	20	18
Anhui	654	3.74	2447	54.5	10	12
Henan	799	2.69	2153	31.3	13	10
Guangdong	580	2.41	1401	27.0	9	7
Jiangsu	284	4.76	1354	26.1	5	6
Hebei	359	3.26	1170	24.4	6	6
Hunan	267	2.97	794	16.2	4	4
Fujian	218	3.52	767	33.2	3	4
Zhejiang	119	5.36	639	18.7	2	3
Top 5	4110	3.56	14525	45.1	66	69
Top 10	5358	3.59	19249	36.4	86	92
Annual average for 1997-99						
National total	5946	4.11	24414	26.6	100	100
Sichuan	1463	3.48	5098	54.3	25	21
Shandong	451	6.90	3113	44.3	8	13
Henan	609	4.46	2716	36.2	10	11
Guangdong	589	4.29	2525	42.4	10	10
Anhui	477	4.50	2150	42.9	8	9
Fujian	289	4.79	1384	51.9	5	6
Hunan	302	3.76	1136	21.3	5	5
Jiangsu	163	6.15	1002	19.1	3	4
Hebei	249	3.91	972	18.3	4	4
Hubei	212	4.20	889	22.3	4	4
Top 5	3589	4.35	15602	44.7	61	64
Top 10	4804	4.37	20985	36.5	82	87

Note: Sweetpotato production is reported on a dry weight basis. Dry weight is computed by dividing fresh weight by 5. Guangdong includes Hainan and Sichuan includes Chongqing.

Table 5. Review of sweetpotato utilization estimates for China.

	1950s ¹	1950s ²	1960s ³	1970s	1980s ¹	1980s ⁴
Direct food	50%	60%	>50%	N.A.	12%	77%
Feed	30%	N.A.	N.A.	N.A.	30%	15%
Seed	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Processing /Industry	10%	N.A.	N.A.	N.A.	45%	3%
Waste	N.A.	N.A.	N.A.	N.A.	N.A.	5%
	1980s ⁶	1980s ⁷	1990s ³	1990s ⁵	1990s ⁸	1990s ⁹
Direct food	15%	39%	<15%	14%	10	4~18%
Feed	30%	34%	N.A.	34%	70	71~85%
Seed	N.A.	2%	N.A.	N.A.	N.A.	6~9%
Processing /Industry	44% ⁶	20%	N.A.	40%	<15%	0%
Waste	N.A.	5%	N.A.	N.A.	N.A.	2~7%

Sources:

¹: Unpublished material by Qiu, Lin, Ping and Dai, Juangsu Academy of Agricultural Sciences; and Hu Jian Xun and Liu Xiao Ping, Anhui Academy of Agricultural Sciences, 1995.

²: Lu *et al*, 1989.

³: Li Weige, 1992; Wang, Song and Zhang, 1995.

⁴: The FAO balance sheet for 1984.

⁵: Adapted from Tang *et al*, 1990. National data is the percentage breakdown, which refers to Shandong, Sichuan, Anhui, Henan, Jiangsu, Hebei, and Hunan only, based on provincial percentages weighted by production.

⁶: Wiersema, Heslen and Song, 1989. Of the 44% of production utilized for processing, 14% is devoted to food products and 30% to industrial products including starch, alcohol and others.

⁷: Adapted from Gitomer C. S. 1996. National data is the percentage breakdown, which refers to Shandong, Jiangsu, Sichuan, Guangdong and Guangxi provinces only, based on provincial percentages weighted by production.

⁸: Data for Sichuan only from Sichuan government office.

⁹: Authors' field survey, 1998. Data only refers to Sichuan, Chongqing and Shandong in livestock production areas rather than sweetpotato processing areas.

Table 6. Sweetpotato utilization in Sichuan and Shandong provinces (%)

	1950s	1960s	1970s	1980s	1990s
Sichuan					
Direct food	65	60	50	20	11
Feed	14	19	29	60	60
Seed	6	6	6	5	5
Processing	3	4	5	10	19
Waste	12	11	10	5	5
Shandong					
Direct food	50	45	40	20	10
Feed	20	25	30	30	30
Seed	5	5	5	4	4
Processing	15	15	15	38	48
Waste	10	10	10	8	8

Note: Sichuan includes Chongqing.

Sources: Figures are provided by Sichuan and Shandong Academies of Agricultural Sciences.

Table 7. Changing utilization pattern (%) of sweetpotato in China, 1980-1997

	1980	1981	1982	1983	1984	1985	1986	1987	1988
Food	36	36	35	34	32	30	27	25	23
Feed	31	30	31	31	31	32	34	35	36
Seed	6	6	6	6	6	6	5	5	5
Processing	15	16	17	18	20	22	24	25	26
Waste	12	12	11	11	11	10	10	10	10
	1989	1990	1991	1992	1993	1994	1995	1996	1997
Food	21	19	18	17	16	15	14	14	14
Feed	37	38	39	39	39	40	40	40	41
Seed	5	5	5	5	5	5	5	5	5
Processing	27	28	29	30	31	32	33	33	33
Waste	10	10	9	9	9	8	8	8	7

Sources: Based on authors' surveys.

Table 8. Sweetpotato supply, utilization food balance sheet in China, 1980-97

	Units	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Area harvested	1000 ha	7914	7274	6908	6840	6427	6094	6175	6277	6307	6274	6256	6199	6062	6133	6062	6085	6062	5963
Yield	t/ha	2.992	2.957	3.173	3.537	3.547	3.394	3.244	3.646	3.315	3.337	3.32	3.369	3.493	3.685	3.545	3.86	4.085	3.434
Production	1000 t	23675	21505	21920	24190	22795	20686	20033	22886	20904	20936	20771	20886	21175	22603	21491	23485	24761	20474
Ending stock	1000 t	4735	4729	4722	4715	4708	4696	4686	4674	4659	4643	4627	4612	4596	4579	4551	4549	4549	4548
Net import	1000 t	-100	-100	-110	-121	-114	-207	-200	-229	-314	-314	-312	-313	-318	-339	-555	-41	-4	-10
Import	1000 t	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Export	1000 t	100	100	110	121	114	207	200	229	314	314	312	313	318	339	555	41	4	10
Consumption	1000 t	23581	21411	21817	24076	22688	20491	19843	22668	20606	20638	20475	20589	20873	22281	20964	23446	24757	20465
Food use	1000 t	8487	7706	7634	8183	7258	6144	5355	5664	4736	4331	3887	3703	3546	3562	3140	3282	3466	2865
Urban	1000 t	636	593	610	641	492	497	425	423	365	358	345	349	362	376	375	442	413	397
Rural	1000 t	7851	7112	7024	7543	6766	5646	4930	5241	4370	3973	3543	3355	3184	3187	2765	2840	3053	2468
Feed use	1000 t	7308	6422	6761	7461	7031	6553	6743	7930	7412	7630	7774	8023	8134	8683	8374	9378	9903	8390
Seed use	1000 t	1421	1290	1315	1451	1368	1241	1002	1144	1045	1047	1039	1044	1059	1130	1075	1174	1238	1024
Industry use	1000 t	3536	3425	3708	4332	4536	4505	4760	5664	5353	5568	5729	5966	6257	6902	6700	7737	8170	6753
Waste	1000 t	2829	2569	2399	2648	2495	2048	1983	2266	2059	2062	2046	1852	1877	2004	1675	1876	1981	1432
Per cap food	kg/cap	8.65	7.75	7.59	8.06	7.08	5.88	5.02	5.23	4.30	3.87	3.42	3.22	3.04	3.02	2.63	2.72	2.85	2.33
Urban	kg/cap	3.38	3.01	2.91	2.89	2.10	2.02	1.65	1.57	1.30	1.23	1.15	1.15	1.15	1.14	1.11	1.27	1.16	1.09
Rural	kg/cap	9.90	8.93	8.82	9.50	8.55	7.07	6.09	6.44	5.33	4.8	4.24	3.96	3.74	3.75	3.24	3.31	3.54	2.85
Population	Million	981.2	993.9	1005.9	1015.9	1025.6	1044.5	1066.8	1084.0	1101.6	1118.7	1135.2	1150.8	1165.0	1178.4	1191.8	1204.9	1217.6	1230.1
Urban	Million	188.2	197.4	209.6	222.0	234.3	245.7	257.3	270.2	281.7	291.0	298.7	303.7	314.6	328.7	338.3	347.4	355.6	364.7
Rural	Million	793.1	796.5	796.3	794.0	791.3	798.8	809.5	813.8	820.0	827.6	836.5	847.1	850.4	849.8	853.5	857.5	861.9	865.4

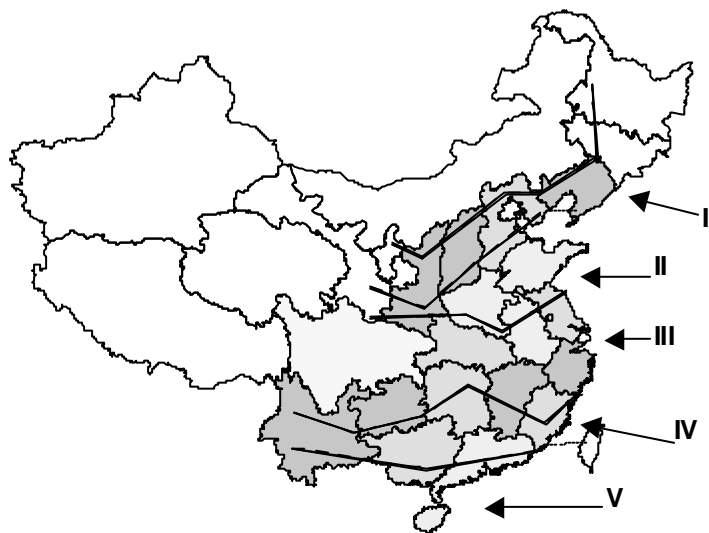
Note: Sweetpotato is reported on a dry weight basis. Dry weight is computed by dividing fresh weight by 5.

Source: From CAPSiM database and authors' estimates.

Appendix Table 1. Sweetpotato sown area (1000 hectares) by province, 1982-1999

Province	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Beijing	6	6	7	10	8	7	7	7	7	7	7	7	6	6	5	5	5	5
Tianjin	9	8	10	8	7	6	5	5	5	5	4	4	4	3	3	3	3	2
Hebei	336	348	357	369	352	346	346	334	322	312	298	320	287	266	265	256	244	246
Shanxi	37	39	45	46	45	48	49	48	49	46	48	53	53	52	55	49	52	55
Inner Mongolia	0.3	0.2	0.4	0.1	0.6	0.5	1.1	0.7	0.4	0.4	0.8	1.1	6.5	5	5.2	9.5	3	5
Liaoning	30	37	48	47	42	39	44	43	42	41	45	47	41	44	43	43	42	48
Jilin	4	4	7	6	4	5	5	5	6	5	5	7	6	7	6	6	6	6
Heilong	0	0	0	0	0	0	0	0	0	0	0	0	2.2	6.7	4.7	1.4	3	4
Shanghai	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.3	0.1	0.9
Jiangsu	326	316	295	282	275	266	251	248	222	215	193	164	180	167	181	170	163	157
Zhejiang	136	131	125	117	115	118	113	119	121	120	113	140	100	112	114	114	118	123
Anhui	683	746	690	613	658	669	703	644	643	593	570	512	526	523	501	462	476	494
Fujian	238	231	221	216	217	224	225	233	244	256	259	322	274	281	288	290	289	289
Jiangxi	109	104	105	106	105	107	113	120	128	140	142	107	151	144	159	167	161	157
Shandong	1081	1007	927	821	818	817	771	766	743	692	670	659	569	549	522	481	456	416
Henan	1081	970	851	763	783	767	805	759	746	708	725	531	649	699	660	623	591	612
Hubei	195	199	191	185	186	187	195	201	197	208	196	324	198	197	212	195	215	225
Hunan	297	288	271	266	265	272	277	285	297	313	306	328	303	301	303	302	302	303
Guangdong	615	610	592	569	579	584	574	582	589	587	558	623	639	622	617	610	606	552
Guangxi	230	216	211	216	237	258	250	252	248	262	253	271	308	313	323	331	346	344
Sichuan	1390	1305	1226	1207	1230	1287	1276	1316	1340	1357	1342	1376	1416	1415	1416	1466	1459	1464
Guizhou	92	95	97	97	110	113	117	130	126	137	125	150	159	177	183	191	211	217
Yunnan	56	78	55	42	41	57	75	80	84	85	87	87	80	79	84	90	90	105
Tibet	0	0	0.1	0	2	0	0	0	0	0	0	0	1.7	0	0	0	0	0
Shaanxi	98	102	102	106	98	102	100	100	97	96	103	102	104	108	109	96	99	109
Gansu	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Qinghai	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0
Ningxia	42	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0.1	1	0	0
Xinjiang	0	0	0	0	0	0	0	0	0	0	0	0	0.1	9.2	0	0	0	0
National total	6908	6840	6427	6094	6175	6278	6307	6274	6256	6199	6062	6133	6062	6085	6062	5963	5939	5937

Note: Sum of data from all provinces may not exactly equal national total figure due to rounding errors. Source: Agricultural Yearbook of China, various issues.



Panel A: Annual average in 1984-86

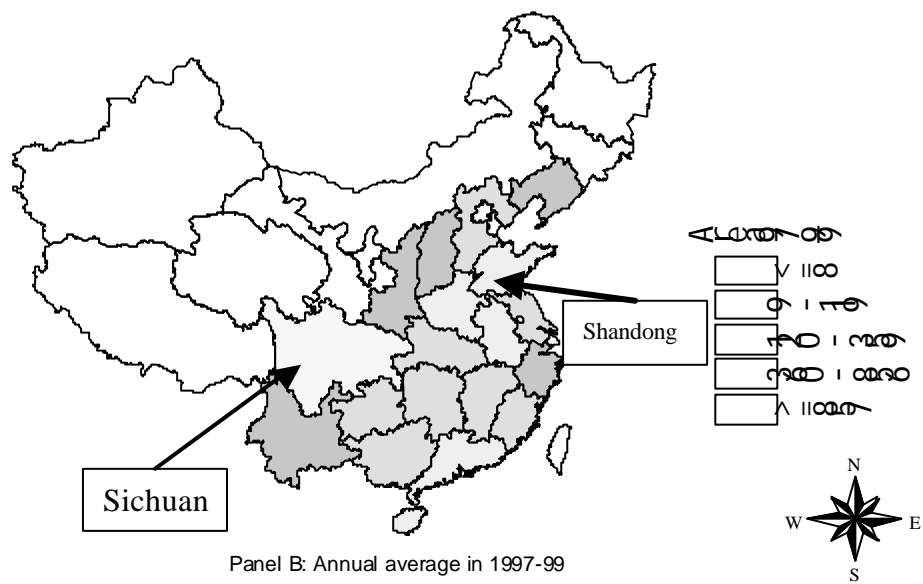
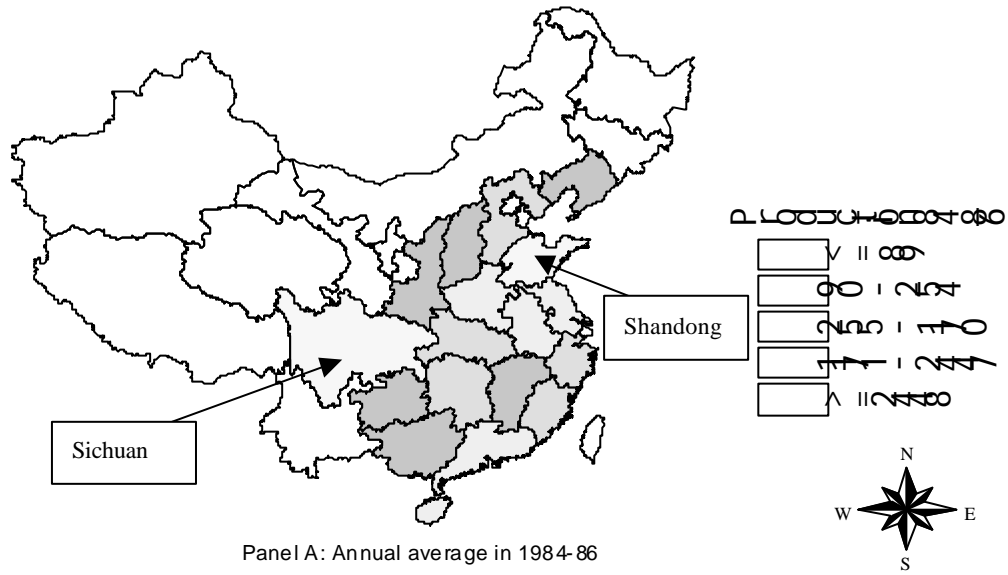


Figure 1. Annual sweetpotato area ('000 ha) by province in China in 1984-86 and 1997-99



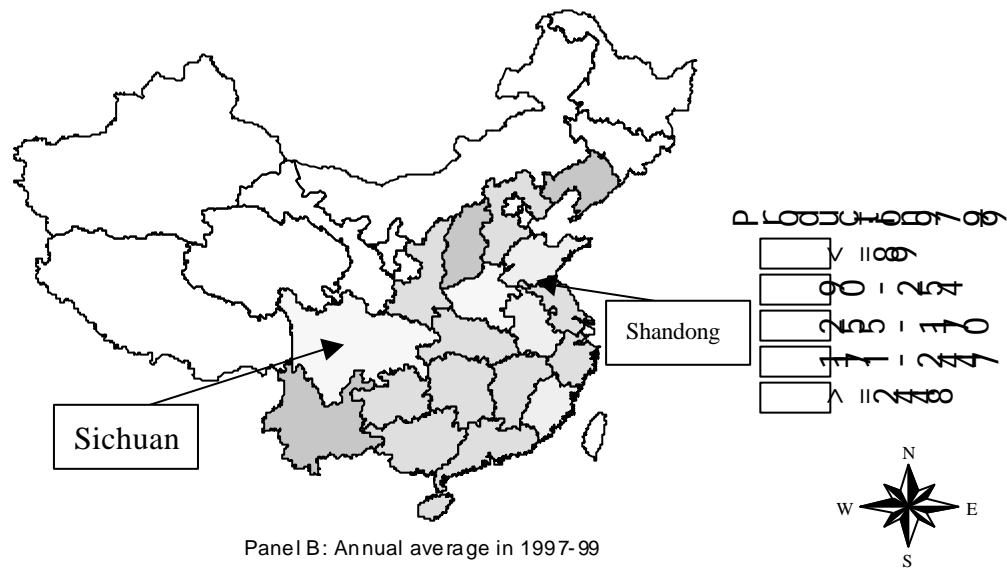
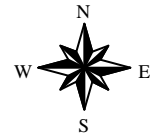
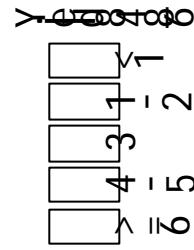


Figure 2. Annual sweetpotato production ('000 ton) by province in China in 1986-86 and 1997-99



Panel A: Annual average in 1984-86



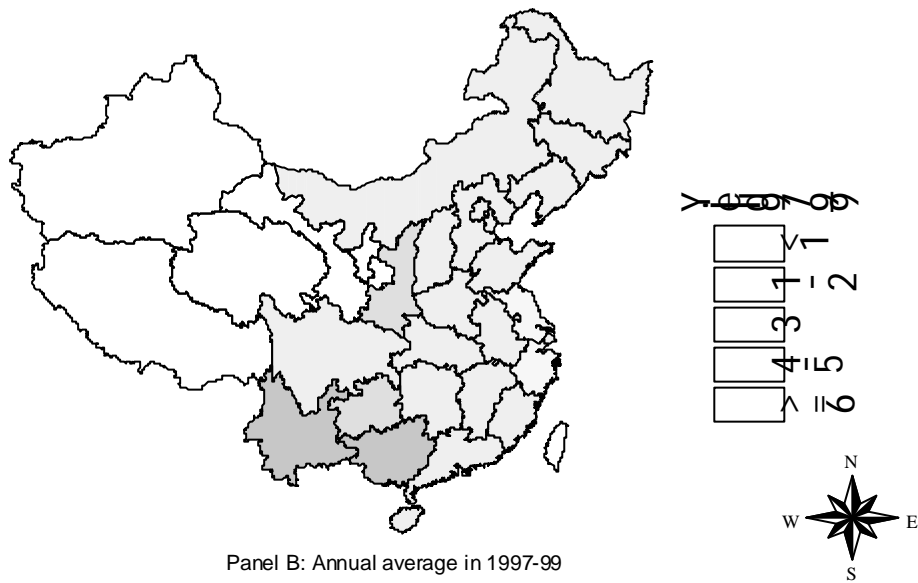


Figure 3. Annual sweetpotato yield (tons/ha) by province in China in 1984-86 and 1997-99