

SOYBEAN CROPPING SYSTEMS IN SOUTH CHINA

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Abstract

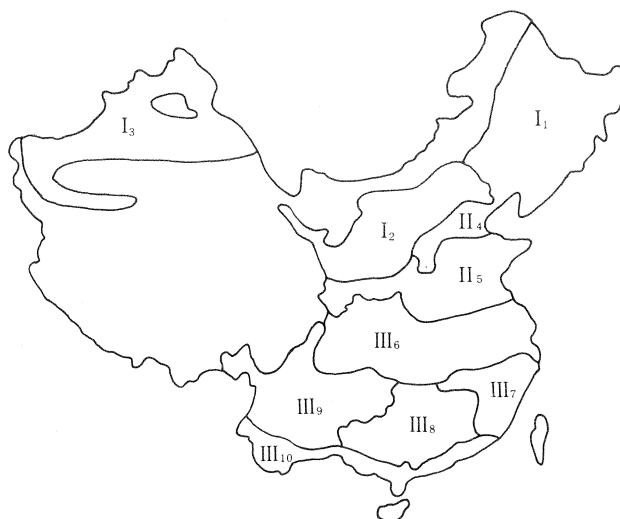
The regionalization, including three regions and ten sub-regions, with respect to cropping systems of soybeans is presented. The cropping systems and related soybean cultivars of the Chang-Jian Valley, Southeastern, Mid-southern, Southwestern, and Tropical sub-regions in the Southern Multiple Cropping, Multiple Planting Region are described. Among them, the Chang-Jian Valley Sub-region is the most important area for soybeans in the Southern Region. There is a potential to raise the soybean production in this region since it is possible to increase both the acreage and unit acreage yield. The approaches are discussed.

Regional distribution of soybeans in China

The cultivated soybean (*Glycine max* (L) Merrill) is believed to have originated in China (Probst and Judd, 1973), although there are conflicting views as to which part of China is the primitive center of origin for the cultivated soybean (Wang and Gai, 1981 ; Hymowitz, 1970). The long history of production and adaptation of soybeans resulted in the widespread distribution of soybeans in China, from Heilongjiang in the north to Hainan island in the south, from Taiwan in the east to Xinjiang and Xizang in the west, and from the plains to the plateaus below 2000 m in elevation. A variety of cropping systems and a large number of land cultivars fitted to the various environments have evolved throughout the years.

Wang (1943, 1958) divided the soybean area in China into five regions : (1) the Spring Planting Soybean Region, (2) the Summer Planting Soybean, Winter Fallow Region, (3) the Summer Planting Soybean Region, (4) the Fall Planting Soybean Region, and (5) the Double Soybean Region. During the past three decades, the position of the crop in China has changed greatly, with the acreage of rice increasing gradually and the soybean acreage decreasing correspondingly. There has been a tendency to increase the cropping index throughout the country, in order to increase the total output of food to meet the requirements of self-sufficiency for the growing population of the country. The intercropping of soybeans with other crops, mainly corn, was recommended in northern China, and the practice of double cropping and triple cropping with soybeans expanded northwards in central and southern China. To make full use of solar energy and the growing season, multiple cropping was adopted when the temperature in early spring was suitable for the spring planting of soybeans and the temperature in late fall or early winter allowed a normal ripening of the fall planting. Since the cropping system changed considerably and there were spring, summer, and fall plantings in southern China, Wang and Gai (1981) combined the latter three regions of Wang's regionalization into one. Therefore, they divided the soybean area into three regions : (1) Northern Spring Region, (2) Northern Summer Region, (3) Southern Region (Fehr and Gai, 1980). Lu *et al.* (1981) further divided the above three regions into ten sub-regions. Pu and Pan (1982) modified Lu's sub-region classification in changing both the boundaries and terminology. The three regions and ten sub-regions of Pu and Pan, in a modified and reduced form, are as follows (Fig. 1) :

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- I Northern Single Cropping, Spring Planting Region
 - I₁ Northeastern Sub-region
 - I₂ Northern Plateau Sub-region
 - I₃ Northwestern Sub-region
- II Northern Double Cropping, Summer Planting Region
 - II₄ Hai Valley Sub-region
 - II₅ Huang and Huai Valley Sub-region
- III Southern Multiple Cropping, Multiple Planting Region
 - III₆ Chang-Jiang Sub-region
 - III₇ Southeastern Sub-region
 - III₈ Mid-southern Sub-region
 - III₉ Southwestern Plateau Sub-region
 - III₁₀ Tropical Sub-region

Fig. 1 Regions of soybeans in China.

Cropping systems of soybeans in southern China

The acreage and production of soybeans in the Southern Region are indicated in Table 1. Both accounted for about 23% of the whole country. The average yield in 1977 was 1.12 ton/ha. Within this region, both acreage and production of soybeans in the Chang-Jiang Valley Sub-region were superior to the total of the other four sub-regions, and the average yield (1.34 ton/ha) was also higher than in the other sub-regions.

Obviously, from 1955 to 1977, the soybean acreage in the Southern Region was reduced by one-third, while the total production remained at the same level. There was some restoration of soybean acreage afterwards. However, the trend to expansion has not been limited to the Southern Region but has also involved other regions at various periods of the year so as to maximize the use of the growing season through the expansion of multiple cropping systems, especially through the expansion of the spring and fall plantings of soybeans. This is chiefly because, as mentioned above, soybeans had already spread all over the country.

The major cropping systems of soybeans in the sub-regions of the Southern Region are listed in Table 2, and the dates of developmental stages in Table 3.

Table 1 The acreage and production of soybeans in southern China^a

Sub-region	Year	Soybean acreage			Soybean production	
		(1,000 ha)	% CA ^b	% TCA ^c	(1,000 ton)	% TSP ^d
Chang-Jiang	1955	1,561.1	7.1	13.7	1,312.0	14.4
	1977	859.6	4.5	12.3	1,154.5	15.1
Southeastern	1955	241.9	7.1	2.1	150.0	1.6
	1977	142.7	4.6	2.1	163.5	2.1
Mid-southern	1955	386.0	6.3	3.4	140.5	1.6
	1977	241.3	4.1	3.4	167.5	2.2
Southwestern	1955	278.8	4.3	2.5	167.0	1.8
	1977	226.4	4.3	3.2	223.0	2.9
Tropical	1955	114.3	3.3	1.0	53.5	0.6
	1977	130.2	4.1	1.9	83.0	1.1
Total	1955	2,582.1	6.3	22.7	1,823.0	20.2
	1977	1,600.1	4.4	23.0	1,791.5	23.4

a. Abbreviated from Pu and Pan (1982).

b. Percentage of soybean acreage accounting for the cultivated acreage in the sub-region.

c. Percentage of soybean acreage accounting for the soybean acreage in the whole country.

d. Percentage of soybean production accounting for the soybean production in the whole country.

The Chang-Jiang Valley Sub-region, including parts of the province along the river, has three planting types of soybeans, i.e. summer, spring and fall, in the decreasing order of relative importance. Triple cropping applies to spring and fall soybeans and double cropping to the summer planting (Table 2). Formally, there were only the summer and spring plantings and the fall one was newly developed during the 1970s.

The summer soybean crop is usually cultivated in upland fields with or without corn intercropping. The spring one is usually planted while a winter crop, such as wheat or barley is still present. The fall one may follow either pattern, in paddy fields, or upland fields and may be planted with early corn.

The cultivars of Maturity Group 0 (such as Taixing-heidou) and Group II (such as Aijiao zao) are used for the spring planting with an average yield of 1.2-1.5 ton/ha. Group V (such as 1138-2, Houzima, and Suidaohuang) and Group VI (such as Nannong 493-1, 4-1, 19-15) are for both the summer and fall plantings, with an average yield of 1.8-2.0 ton/ha and 1.2-1.5 ton/ha, respectively.

The Southeastern Sub-region, including southern Zhejiang, northeastern Jiangxi, most part of Fujian and the whole Taiwan, has fall, spring and summer plantings in the decreasing order of relative importance, in contrast with the situation in the Chang-Jiang Valley Sub-region where the fall planting is the most important. Both spring and fall soybeans are usually found in paddy fields, and only a small acreage of summer soybean is in upland fields. The spring crop is usually planted while a winter crop is still present.

Cultivars of Group III (such as Shangyu-kanshanbai, Jinjiang-zhuzidou, and Jinxian-liuyueba) are used for the spring planting, with an average yield of 1.1-1.4 ton/ha, Group VIII (such as Shangrao-daqingzi, Lanxi-daqingdou, and Liancheng-baihuadou) and Group VII for fall and summer plantings, with an average yield of 1.1-1.4, and 1.6-1.8 ton/ha, respectively.

Table 2 The major cropping systems of soybeans in southern China

Sub-region	Planting	RI ^a	Crops in a year	Notes
Chang-Jiang	Spring	2	Winter wheat (barley)-spring soybean-late rice	Relay cropping
	Summer	1	Winter wheat (rape seed)-summer soybean	Intercropping or not
	Fall	3	Winter crop-early rice or corn-fall soybean	Relay cropping (corn)
South-eastern	Spring	2	Winter crop-spring soybean-late rice	Relay cropping or not
	Summer	3	Winter crop-summer soybean	
	Fall	1	Winter crop-early rice-fall soybean	
Mid-southern	Spring	1	Winter crop-spring soybean-hybrid rice or sweet potato	Relay cropping or not, Intercropping with corn or not
	Summer	3	Winter crop-summer soybean	
	Fall	2	Winter crop-early rice-fall soybean	
South-eastern	Spring	1	Rape seed-spring soybean	Intercropping with corn
	Summer	2	Winter wheat-summer soybean	Intercropping with corn
Tropical	Spring	1	Winter crop or rice seedling bed-spring soybean late rice	
	Summer	3	Early rice-summer soybean-late rice or sweet potato	
	Fall	4	Winter crop-early rice or rice seedling bed-fall soybean	Intercropping with sweet potato or not
	Winter	2	Winter soybean-early rice or rice seedling bed-late rice	

a. RI-relative importance. "1", "2", "3", and "4" indicate the relative importance in the decreasing order.

Table 3 The dates of developmental stages of various planting types of soybeans in southern China

Sub-region	Planting type	Planting ^a	Flowering	Maturity
Chang-Jiang	Spring	3L-4E	5L-6M	7L-8M
	Summer	5L-6E	7L-8M	9L-10M
	Fall	7L-8E	8L-9E	10L-11E
Southeastern	Spring	3L-4E	5M-6E	7M-7L
	Summer	5L-6E	7L-8M	9L-10M
	Fall	7L-8E	8L-9M	11E-11M
Mid-southern	Spring	3M-4E	5M-5L	7E-7M
	Summer	5L-6E	7M-8E	10E-10M
	Fall	7M-8E	9E-9M	11E-11M
Southwestern	Spring	4E-4M	7E-7M	8M-9E
	Summer	5E-5M	7M-7L	8L-9L
Tropical	Spring	3E-3M	4M-4L	6E-6M
	Summer	5L-6E	7M-7L	8M-9E
	Fall	7M-8E	8L-9E	10M-10L
	Winter	12L-1E	2L-3E	4M-5E

a. The number indicates the month, and the letter the dates in which E represents the first ten days, M the second ones, and L the last ones in a month.

The Mid-southern Sub-region, including most part of Hunan, Guangdong, and Guangxi provinces, and the southwestern Jiangxi province, also has spring, fall, and summer types of soybeans with a different order of relative importance from the Southeastern Sub-region.

Both spring and fall soybeans are mainly found in paddy fields with or without relay cropping for the spring one. If the spring soybean is found in upland fields, intercropping with corn sometimes is practiced. The summer type is basically in upland fields, intercropped or not with sweet potato or corn.

Cultivars of Group III (such as Xiangdou No 3) and Group IV (such as Yishan-liuyuehuang) are used for the spring planting, with an average yield of 1.0-1.2 ton/ha. Group VIII (Qiudou No 1, Guangxi-dawudou, and Bayueqing) and VII (Ruijin-xiohuangdou) are used for the fall and summer plantings, with an average yield of 1.0-1.2, and 1.4-1.6 ton/ha, respectively.

The Southwestern Sub-region, including most parts of Guizhou and Yunnan provinces, and western Guangxi, Sichuan, and Hunan provinces, is mainly located on the plateau Yun-Gui with a relatively cool summer in contrast with the situation in the other sub-regions. Only spring planting and to a lesser extent summer planting can be found in this region. Since basically, the soybeans are cultivated in upland fields and intercropped with corn, the yield per unit acreage (0.75-1.00 ton/ha) is comparatively low.

The cultivars consist essentially of Group IV, such as Beishuedou, and Liuyuehuang.

The Tropical Sub-region, including the tropical part of Guangdong, Guangxi, and Yunnan, has spring, summer, fall, and winter plantings. The spring and winter plantings with an average yield of 1.0-1.2 ton/ha, have more potential than the summer and fall ones with a yield of 1.4-1.6 ton/ha, because farmers can make use of the fallow season, especially in winter.

Both paddy and upland fields are used for soybeans. In the case of upland fields, intercropping with sweet potato is practiced for the summer and fall plantings.

The cultivars used for the spring and winter plantings consist of Group III (such as Heibiqing), IV (such as Beihuadou), and V (such as Yangchun-qingdou). It is interesting to note that the same set of cultivars can be used for the summer and fall plantings. Some summer cultivars such as Suidaohuang (Group V), from the Chang-Jiang Valley, performed very well in the spring, summer, and fall plantings in this sub-region.

In fact, a certain amount of the soybeans produced has not been included in the statistics of total soybean acreage and production, especially in the Chang-Jiang Valley, Southeastern, and Mid-southern Sub-regions. They are planted on ridges along paddy fields, with one planting (spring) or two plantings (spring and fall). The soybeans harvested are essentially for farmers' self-consumption.

Approaches to increase soybean production in southern China

During the recent years, the soybean acreage in southern China has somewhat recovered for the following reasons : (1) requirement of protein for the people, (2) soil improvement through nitrogen-fixation by *Rhizobium* and rotation between paddy crops and upland crops, (3) effective utilization of solar energy and land by soybeans, a short-season crop on fallow land, and (4) effective utilization of land through intercropping and relay cropping.

There is a potential to raise the soybean production in southern China since it is possible to increase both the acreage and unit acreage yield.

Some of the acreage for rice double cropping, for the cropping system winter crop-early rice-late rice, can be diverted into the cropping system winter crop-spring soybean-late rice to obtain a good harvest of late rice and an adequate income along with a reduction in cost and labor. Some of the acreage mentioned above can also be diverted into the cropping system winter crop-early rice-fall soybean with the same advantage. This is especially true in the Chang-Jiang Valley Sub-region, as well as Southeastern, and Mid-southern Sub-regions. In these areas, rice is cultivated on the hills and slopes where irrigation systems have not been established very well yet. Summer type of

soybean is suited to such kind of land. In the latter two sub-regions, the red-soil problem (aluminum toxicity and very low fertility) must be taken into account. Soybean cultivation would be more suitable than the cultivation of rice or other crops for the improvement of the soil and increase of income.

Some amount of corn acreage (monocropping) in the Southwestern Sub-region can be converted into intercropping with soybeans. Also some acreage of winter fallow land can be used for winter soybean in the Tropical Sub-region.

There is no official estimate on how much land could be planted to soybeans in southern China since soybeans are not a major crop, especially in the latter four sub-regions. However, scientists believe that there should be and will be some increase of soybean acreage for all-round and long-term increase of total food production.

The increase of unit acreage yield is especially promising. The yield of soybeans in the Southern Region was relatively low due to the following reasons : (1) Soybeans were usually cultivated on very poor land and management was less satisfactory than for rice. (2) There was less emphasis on soybean cultivation than on corn cultivation due to the intercropping system. (3) The land cultivars were still broadly used because cultivar improvement lagged behind the requirements, especially in the latter four sub-regions. Accordingly, there is a potential to raise the unit acreage yield of soybeans.

Among the five sub-regions, the Chang-Jiang Valley Sub-region is more important than the others for the increase of soybean production. Multiple cropping systems have received much attention (Lin and Gai, 1978). There are several breeding programs in Nanjing and Wuhan to meet the requirements for various planting types of soybeans. The fall planting has been developed and expanded recently. It is more difficult to cultivate soybeans in this area compared with the other sub-regions because of the limitation of the growing season and high temperature at planting time. The most important aspect is to select the preceding crop not too late, then to plant soybeans as early as possible after the harvesting, as well as to obtain good stands with a planting density of 450-600 thousand seedlings per hectare by preparing a fine soil and using irrigation. Fertilizer application including nitrogen, phosphorus and potassium is also essential for increasing yield. However, the weed problem for the fall soybean is not as serious as for other planting types.

In the other sub-regions, the natural environment such as temperature, solar energy and, therefore, the growing season are better than in the Chang-Jiang Valley, except for the soil conditions. The prospect for the increase of soybean yield can be also be considered since several programs on cultivar development and cultivation techniques have been established in each provincial institution.

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Discussion

Navarro, R.S. (The Philippines) : In the rice-soybean cropping pattern, do you prepare land for soybeans ?

Answer : It depends on the type of crop. For the spring type, there is no land preparation and soybeans are planted immediately before wheat is harvested while rice is still present. For the summer type, the fields are plowed or no tillage is performed after harvesting of wheat. In the fall cropping there is no land preparation and soybeans are planted approximately 5 days before corn harvesting. In the case of stubble planting, soybean is planted beside rice.

Yap, T.C. (Malaysia) : You have mentioned that you had more than 200 varieties of soybean in China. Could you indicate how a variety is released for commercial production in China ? Are there regional trials ?

Answer : There is a system of regional testing before releasing a variety. Sometimes several regions are involved. There is a soybean cultivar board composed of several experts in each soybean-producing province to decide whether a cultivar can be released. If a new cultivar is expected to be used in several provinces, the breeder can apply for the release to the national soybean cultivar board after the cultivar has been evaluated in an interprovincial regional test. The provincial regional tests are carried out for two or more years at a certain number of locations.