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The Distribution of Soybean Production and Resources in China

Soybean, *Glycine max* Merrill, is one of the most ancient of cultivated crops, and in China has been grown for 4-5 thousand years. It belongs to the Fabaceae (sic)¹ family. Soybean is also called "Huangdou" and once was called "Dadou Jiao" in many ancient Chinese books. China not only has the longest history of cultivating soybean, but is its center of origin. Soybeans spread to other countries directly or indirectly from China. They were introduced into Korea 2500 years ago and from there to Japan 2000 years ago. They spread into East Asia in the 7th century AD directly from China and continued spreading into the Philippines, Indonesia, and Malaysia 300 years ago. In 1739, soybeans were introduced to France and spread throughout Europe later. In 1898, Russians brought soybean seeds from Northeast China and spread the crop in central and northern Russia. Soybeans were first grown in the United States before 1804 and had been widely planted until 1924. At the end of the 19th century, soybeans were brought into other countries of the Americas. In the 20th century, soybeans spread within Africa. Presently, soybeans are cultivated in more than 50 countries and regions; however, it is mainly produced in China, the United States, Brazil, and Argentina etc.

Soybean crops are widely distributed in China, extending from the eastern seashore to western Zinjiang province and from southern Hainan island to northern Heilongjiang province. They are planted everywhere except in some cold regions with extreme altitude above sea level. It is naturally limited to those areas whose average temperature is below 10°C, the cumulative temperature is below 1900°C., and the annual precipitation is below 250 mm without irrigation.

China has the greatest resources of soybean varieties in the world. They are normally grouped by the following characteristics:

- Plant type: bushy, clustering, fan-shaped, short-erect type;
- Pod characters: definite type, indefinite type, sub-definite type;
- Seed capsule color: yellow, green, black and brown;
- Seed shape: circular, oval, disc-shaped, long oval, and kidney-shaped;
- Sowing season: spring, summer, fall and winter;
- Uses: oil, human food, animal feed, and green manure.

The planting area of soybean in China has fluctuated greatly in the past 50 years. It reached 12,730,000 hectares with 10,050,000 tons in 1957, but dropped to 7,067,000 hectares with 7,450,000 tons yields. Recently [in 1977] resumption and development of soybean cultivation have been emphasized. Consequently, its planting area stays around 8,000,000 hectares and yields are kept above 13,000,000 tons. Soybean production is concentrated mostly in Song-Nen-Liao Plains and Sanjiang Plain in Northeast China,

¹ Translator footnote: should be "Leguminosae"

Huanghuai Plain around Huanghuai Watershed Area. Secondly, it is more or less concentrated in grown in Hai-river Plains, Jin-Shaan border and the middle section of Yellow River in Northern China and lower section of Yangzi River, Poyanghu Plain, Zhebei Plain, Hubeijianghan Plain, along the rivers of Sichuan Province, and Min-yue Plain in South China and western plains of Taiwan Province, etc.. As a whole, soybean is produced the most in Heilongjiang Province, Jilin Province, Liaoning Province, Hebei Province, Shandong Province, Henan Province, Jiangsu Province, and Anhui Province.

The production conditions of soybean in different areas of China also differ greatly. Thus, to understand the soybean growing regions in China is very important. Based on differences in the natural climate, cultivation systems, ecotypes, development history, distribution and boundaries, two levels of soybean regions are proposed: the first level is based on the maturity date of major crops, results in 5 main regions in China; the second level is based on diversities in natural conditions in each main region, leading to 7 sub-regions, which provide a general picture of soybean production all over the country.

A. *Northern spring soybean region*

This includes Heilongjiang Province, Jilin Province, Liaoning Province, Inner Mongolia, Ningxia, Xinjiang and North of Hebei Province, Shanxi Province, Shaanxi Province, Gansu Province etc. This region is divided into 3 sub-regions, among which the Northeast spring soybean sub-region is an important production base for domestic trade and export.

1) *Northeastern spring soybean sub-region (I_1)*

Included areas: Heilongjiang Province, Jilin Province, Liaoning Province, and the four eastern alliances of Inner Mongolia.

Planting area and yields: accounting for 25% of national soybean sowing area and 35% of national yields.

Major production area: Song-Nen Plains, Sanjiang Plains, and Liao River Plains.

Frost-free period: 100-170 days (from north to south).

Cumulative temperature of above 10°C: 1900-4000°C (from north to south).

Annual precipitation: 350-1200 mm (from west to east).

Sowing and harvest: sowing between late April and middle May; harvesting in the middle and late September.

Growth period: 105-155 days.

Pod characteristics: mainly indefinite and sub-definite pod formation type, definite type is grown in the southern and southeastern areas.

Varietal characteristics: mostly good quality, high oil content, yellow seed color, light and bright hilum color.

Main varieties planted: Suinong 14, Kennong 4, Kennong 7, Hefeng 35, Beifeng 12, Tongnong 11, Jilin 38, Liaodou 10, Tiefeng 27, and Dandou 8.

2) *Loess Plateau spring soybean producing sub-region (I_2)*

Included areas: Northern Hebei Province, Northern Shanxi Province, Northern Shangxi Province, Region #1 of Inner Mongolia Plateau, middle reaches of the Yellow River irrigation area and Ningxia area.

Planting area and yields: accounting for 4.1% of national soybean planting area.

Frost-free period: 180-220 days.

Cumulative temperature of above 10°C: 3000-4000°C.

Annual precipitation: 200-500 mm.

Sowing and harvest: sowing between late April and middle May; harvest in September.

Growth period: 105-145 days.

Pod characteristics: mainly indefinite pods.

Varietal characteristics: mostly black soybean is capable of withstanding drought and infertile soil.

3) *Northwestern spring soybean producing sub-region (I₃)*

Included areas: Xinjiang Province.

Planting area and yields: less than 400 thousand hectares.

Frost-free period: 110-200 days.

Sowing and harvest: sowing between April and May; harvest between August and September.

Growth period: 100-150 days.

Pod characteristics: both indefinite and definite pods.

Varietal characteristics: seed color includes yellow, black, and green soybeans, etc.

Major varieties: imported from Northeastern China with same altitude

B. *Huanghuai Watershed area, summer soybean region*

It also is a winter wheat production area in Northern China, divided into 2 sub-regions.

1) *Middle of Ji-Jin area, (Hebei-Shaanxi Provinces), spring & summer sub-region (II₄)*

Included areas: south to the Great Wall in Hebei province, North to Shijiazhuang and Tianjing, Middle and southeast of Shaanxi Province.

Planting area and yields: around 3 million hectares.

Frost-free period: 175-220 days.

Cumulative temperature of above 10°C: 3800-4300°C.

Annual precipitation: 400-800 mm.

Sowing and harvest: sowing in middle and late June, harvest in middle and late September.

Growth period: 90-150 days.

Pod characteristics: mainly indefinite and sub-definite type pods.

Varietal characteristics: mostly yellow, green, brown, and black seed color.

Main varieties planted: Tongzhou-black-soybean, Jindou #2, and Taiguzao, etc.

2) *Huanghuai Watershed area summer soybean sub-region (II₅)*

Included areas: south of Tianjing and Shijiazhuang, Shandong Province, greater part of Henan Province, north of Hongze Lake in Jiangsu Province, north of Huaihe River in Anhui Province, southwest of Shanxi Province, middle region of Shaanxi Province, and the Tianshui area in Gansu Province.

Planting area and yields: accounting for 30% of national soybean planting area and above 30% of national soybean yields.

Frost-free period: 180-220 days.

Cumulative temperature of above 10°C: 4000-4800°C.

Annual precipitation: 500-1000 mm.

Sowing and harvest: sowing in middle and late June; harvest between middle September and early October.

Growth period: 90-110 days.

Climate characteristics: cumulative temperature in growth period is 2400-2700°C, plenty of rainfall in growth period, thus suitable for the growth of soybean.

Pod characteristics: mainly definite pods.

Varietal characteristics: mostly yellow soybeans, some are green soybeans, and in infertile soils, there are brown and black soybeans, hilum is brown and black in color.

Main varieties planted: Yudou #2, Ludou #2, Ludou #4, Zhongdou #19, Yudou #8, Kefeng #6, Jidou #4, Zhonghuang #6, Fudou #5, Xudou #8, Wailu, and Daqingdou, etc.

C. *Yangzi River Watershed area spring-&-summer soybean region*

Including summer soybean in provinces along Yangzi River, south edge of Huanghuai Watershed area, and Southwest Yun-gui Plateau. It is divided into 2 sub-regions.

1) *Yangzi River Watershed area spring and summer soybean sub-region (III₆)*

Included areas: along Yangzi River area in Jiangsu and Anhui Provinces, Hubei Province, South of Shaangxi and Henan province, North of Zhejiang, Jiangsu, and Hunan Provinces, Sichuan Basin, and Eastern hilly area of Sichuan Province.

Planting area and yields: accounting for 12% of national soybean planting area and 15% of national soybean yields.

Frost-free period: 210-310 days.

Cumulative temperature of above 10°C: 4,500-5,500°C.

Annual precipitation: 1,000-1,500 mm.

Sowing and harvest:

Summer soybean: sowing between late May and early June, harvest between late September and early October.

Spring soybean: sowing in early April, harvest in middle and late July.

Growth period: (summer) 120-150 days, (spring) 95-110 days.

Pod characteristics: mainly definite pods, some indefinite type pods.

Varietal characteristics: mostly medium and small sized seeds.

Main varieties planted: Zhongdou #19, Nannong #493-1, Sudou #1, Yudou #18, Chuandou #2, and Zhechun #3, etc.

2) *Yun-gui Plateau, spring & summer soybean sub-region (III₇)*

Included areas: Most parts in Yunnan and Guizhou Provinces, western Hunan and Guangxi Provinces, and southwestern Sichuan Province.

Planting area and yields: accounting for 3% of the national soybean planting area.

Frost-free period: 275-350 days.

Annual precipitation: 750-1500 mm.

Sowing and harvest:

Summer soybean: sowing in early May, harvest between middle August and early September.

Spring soybean: sowing in early and middle April, harvest between late August and early September.

Growth period: 100-150 days.

Pod characteristics: mainly definite pods.

Varietal characteristics: mostly yellow, brown, gray, and green seed color.

Main varieties planted: yellow-coat soybean, green-coat-yellow-soybean, Yulinzao-yellow-soybean, Zaochadou, Dabaidou, and Maoerhui.

D. Southeastern China spring, summer, & fall soybean region

Included areas: Southern Zhejiang Province and Fujian Province; many areas in Jiangxi Province, Taiwan Province, Hunan Province, Guangdong Province, and Guangxi Province.

Planting area and yields: accounting for 15-16% of national soybean planting area and 4-5% of national soybean yields.

Frost-free period: 270-320 days.

Cumulative temperature of above 10°C: 5,500-7,500°C.

Annual precipitation: 1,000-2,000 mm.

Sowing and harvest:

Fall: sowing between late July and early August, harvest in middle November.

Summer: sowing between late May and early June, harvest between late September and middle October.

Spring: sowing in early April, harvest in early and middle July.

Pod characteristics: mainly definite type.

Varietal characteristics: mostly yellow seed coat for spring soybean, and black and green seed coat for fall soybean.

Main varieties planted:

Summer: Ruijing-small-yellow-soybean, Wuming-black-soybean, and Guangxi-large-green-soybean, etc.

Spring: Jingjiangzhudou, Youwudou, Jinzhuhuang, Zaochadou, and Guangxiliangshuidou, etc.

Fall: the same as spring.

E. Four-season soybean in Southern China region

Included areas: Southern edges of Guangdong, Guangxi, and Yunnan Province, Southern tip of Fujian Province.

Planting area and yields: accounting for less than 2% of the national soybean planting area.

Frost-free period: almost no frost.

Cumulative temperature of above 10°C: 7,500-9,000°C.

Annual precipitation: 1,500-2,000 mm.

Sowing and harvest:

Winter: sowing between late December and early January the following year, harvest in late April.

Fall: sowing in early July, harvest in late September.

Summer: sowing between late May and early June, harvest in middle and late August.

Spring: sowing in late February, harvest in early and middle June.

Pod characteristics: mainly definite type.

Varietal characteristics: mostly yellow and black seed coats.

Main varieties planted: Huangmaodou, Jiyouhuangdou, Huayaodou, Liuyuehuang, and Wudou.

Geographic factors play important roles in the distribution of soybean. Geographic factors lead to great differences in ecotypes of soybean.

A. Geographic distribution and kernel size of ecotypes

1) Northeastern area:

In the eastern plains area, 100 kernel weight is around 18-22 g; while in the western dry and alkali area, 100 kernel weight is about 13-16 g. If western area gets enough irrigation or it is along the river banks having plenty of water, large seed varieties can also be planted.

2) Huangtu Loess high plains (Northern Shanxi & Shaanxi Provinces)

This area is dry and unfertile, only suitable for planting small seeded soybean. 100 kernel weight is around 6-12 g.

3) Huang-huai plains area

This is an important summer soybean production area. The area is suitable for small and medium-sized varieties. 100 kernel weight is around 10-15 g.

4) Yangzi River Watershed area

Seed size varies widely. Generally, 100 seed weight of summer soybean is mostly 12-17 g. According to statistical analysis, varieties in Huinan area, Jiangsu Province, 12% are above 24 g for 100 seed weight; 28% are between 18 g and 24 g; 47% are 12-18 g; 3% are 6-12 g.

5) North of Japan and North of Korea

Because of good planting conditions and the demand for traditional food, the 100 seed weight of this area is generally around 22-35g. Some varieties can reach 42 g.

6) Southeast Asia area

Small-seed varieties, especially those small black soybeans which are more adapted to warm climate conditions, where rainfall is abundant, having short day length. 100 kernel weight is around 8-14 g.

7) Brazil

The major soybean production area is located between southern latitudes of 20-30 degrees, which is a subtropical zone. Most soybean harvests occur once a year, sowing around November and December. It is mostly hot and rainy during the growing period. 100 seed weight is mostly around 8-14 g.

8) United States

The climatic conditions and soil fertility are very suitable for the growth of soybean. Mostly sown in spring and harvested in fall. Harvested once a year. Most soybeans are used to extract oil. Since smaller-sized soybeans suffer less losses during mechanical harvesting processes, the objectives for soybean breeding in the United States are: anti-lodging, anti-pod-cracking, high yields, strong disease resistance, low rate in mechanical damage, and good chemical quality. Thus, most soybean 100 seed weights are around 12-18g.

B. Geographic distribution based on seed coat and hilum color

Generally, when growth conditions worsen, soybean size reduces and color darkens. In the northeastern soybean production region in China, high quality soybeans are required, and seed coats should be shiny and golden with lighter hilum color. In the west of Northeastern China and Shan-jin area, because of bad growing conditions, most

soybean are black or brown and of small size. In the watershed area of Yangzi River, soybeans are utilized as vegetables, so seed coats are mostly green.

C. Eco-geographic distribution based on oil and protein content

In general, with increase of latitude, the oil content of soybean also increases while protein content decreases.

According to analysis, northeastern spring soybean oil has content > southern summer soybean oil content > fall soybean oil content.

- Northeastern soybean region: 19-22% oil content, protein content is 37%-41%
- Huang-huai Plains soybean production region: 17-18% oil content, 40-42% protein content
- Yangzi River Watershed soybean production region: 16-17% oil content, 44-45% protein content

Some local areas within these three regions could show variations from the above.

D. Eco-geography based on fatty acids

Low temperature during seed formation period forms the formation of linolenic acid and linoleic acid, while reducing the formation of oleic. High temperatures have the opposite effect. Thus, with 1 degree of latitude in China, the Iodine number also increases by about 1.7. In an area having the same latitude, the situation will differ with different varieties.

With the shift in demand for production and consumption of soybeans, good quality varieties are being developed. Good quality includes visual and chemical properties. Good chemical properties refer to lipid content and protein content in the soybean. This leads to specific varieties: high lipid content (>23%) varieties and varieties with high protein content (>45%). Similarly, because of the demand for special uses, special varieties are bred, for example, varieties having different seed colors.