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EXPERIENCES OF SOYBEAN-CENTERED
CROP ROTATION IN YU-SHU HSIEN

Chung-kuo Nung-pao
(Journal of Crops)
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Yu-shu Hsien is the main area of soybean production in Kirin province. The area planted in soybeans yearly is around 110,000 shang, and output is high, stable, and of good quality. According to output statistics, from 1949 to 1961 the mean yield of soybeans was 1,242 kilograms per hectare in Yu-shu Hsien; this unit yield exceeds the mean value for Kirin Province.

A wealth of experiences has been accumulated by the farmers of Yu-shu Hsien from long years of soybean cultivation. A soybean-centered crop rotation system has been created. In this article, the author analyzes the good points of the present system based on data from investigation of the crop rotation system in Yu-shu Hsien. Also analyzed are current problems and methods of solving them.

Several Patterns of Crop Rotation

A large ratio of soybeans (usually 35-37% of the total area planted in grain and beans) and the devoting to sorghum and millet 20% each of the total cultivated area have long been characteristic of crop cultivation in Yu-shu Hsien (Table 1).

A higher rate of the soybean crop is used commercially, and the crop is one of the main economic sources of the farmers. The sorghum crop is high-output grain crop locally, and is the staple food of the masses. In addition to a foodstuff, millet is used as the main animal fodder of the area. Generally speaking, this cultivation ratio has been comparatively stable in past decades. On the basis of the ratio, a

soybean-centered system of crop rotation has been formed through long years of production practice. Current topographical, pedological, and management conditions in Yu-shu Hsien will be described in the following.

Table 1. Average Cultivation Ratios of Various Crops in Yu-shu Hsien, 1949-1957

Crop	Soy-beans	Sorghum	Millet	Corn	Small miscellaneous grains	Wheat	Paddy rice	Other
% of total area planted in grains and beans	37.7	20.3	19.2	7.4	11.5	2.9	0.8	0.2

1. Crop Rotation in the Western Low-relief Plain

Soil in this area is fertile. There is a thick layer of black earth with high humus content and high water retention capacity. The soil is classified as leached chernozem. The topography is broad and flat with low undulating relief. The cultivated area in the western portion accounts for approximately 60% of the total cultivated area of Yu-shu Hsien.

According to the investigations of the Shuang-shan Production Team of the Hsing-fu Production Brigade, En-yu Commune, the total area cultivated by the Production Team is 121.82 hectares, including 109.41 hectares of flat mounds and 12.41 hectares of depressions and secondary depressions.

In 92.26% of the flat mound area the crop rotation pattern is soybeans -- sorghum -- soybeans -- millet, and in the remainder of the area, soybeans -- sorghum (or wheat) -- millet. The crop rotation pattern is soybeans -- sorghum (or corn mixed with soybeans) -- wheat -- darnels or sorghum -- darnels (or continuous cultivation of sorghum for three or four years with darnels planted later) in the depression area.

2. Southeast Hilly Area

The soil in this area is predominantly podzolic soil transformed from grass, with a thin layer of black earth and low fertility. Most of the cultivated land is uneven mounds with relatively steep slopes. In the upper portion of the cultivated land, soil erosion by water is comparatively serious. Soil quality and topography vary; the masses say that "there are three changes of soil quality in one step." The cultivated area comprises 28% of the total cultivated area of the hsien.

According to the investigations of the First Production Team of the Chung-ho Production Brigade, Hsiang-yang Commune, the crop rotation patterns are the following: infertile mounds, miscellaneous beans -- millet (20.8% of cultivated land); flat mounds of medium fertility, soybeans -- sorghum -- soybeans -- millet (51.8% of cultivated land), and soybeans -- sorghum -- millet (9.7% of cultivated land); depressions, soybeans -- sorghum (17.7% of cultivated land) and darnels -- darnels.

3. Central River Terrace Area

This area, distributed along the banks of the Sungari River and its tributaries, has low, level topography and fertile alluvial black prairie soil. The water table is high, and floods easily occur in the rainy season. The cultivated area makes up about ten per cent of the total cultivated area of the hsien. Crop rotation patterns are soybeans -- sorghum -- millet (primary) or soybeans -- sorghum -- soybeans -- millet (secondary) on the plains, soybeans -- sorghum in secondary river terraces, soybeans -- sorghum -- corn or soybeans (or mixed with corn) -- wheat -- sorghum in slightly alkaline secondary terraces, and sorghum -- non-glutinous rice (or darnels) on river terraces.

As mentioned above, the present crop rotation pattern in Yu-shu Hsien is mainly soybeans -- sorghum -- soybeans -- millet on the flat mounds and plains, soybeans -- sorghum -- millet in scattered plantings covering a wide area, **soybeans** (or corn mixed with soybeans) -- sorghum distributed on river terraces, and miscellaneous beans -- millet distributed in mound areas. The main crop rotation pattern is soybeans -- sorghum -- soybeans -- millet.

Analysis of Present Crop Rotation Patterns

In general, the present soybean-centered crop rotation pattern in Yu-shu Hsien emphasizes miscellaneous grains with alternate cultivation of soybeans for short-term crop rotation. Practice has proven that this pattern is coincident with local natural conditions, production characteristics, and bumper harvest requirements. The five following points will be discussed.

1. In crop rotation, soybeans and sorghum are good crops to precede millet because they facilitate high stabilized output.

According to the investigations of earlier agriculturists, among the main crops which may be planted locally, soybeans may be planted after harvesting of millet and sorghum. The soybeans thus planted will grow vigorously with many branches and nodes, large leaves and stalks, developed root systems, and good bacterium radicala growth. As a result, growth in the first period is rapid, and there is considerable accumulation of dry matter. The numerous blossoms and legumes in the later period (Table 2) obviously provide for increase in unit yield of soybeans.

Table 2. Influence of Different Preceding Crops on Growth of Soybean Stalks (Yu-shu, 1960)

Preceding crop	seedling stage (investigated 12 June)			blossom stage (investigated 24 July)			vigorous blossom stage (investigated 12 August)	ripe stage (investigated 25 September)
	number of nodes	number of roots	number of root tubercles	stalk dry weight (grams)	leaf weight (grams)	leaf area (cm ²)	number of blossoms	number of legumes
millet	8.6	26.0	5.5	10.26	16.22	1335.4	64.7	41.0
sorghum	9.7	18.0	3.6	6.96	13.51	1197.5	61.9	33.2
corn	6.9	14.2	---	7.34	14.20	999.2	45.8	---
beets	---	---	2.5	3.66	4.13	355.9	43.8	25.0
soybeans	6.2	14.0	2.0	3.22	3.85	340.9	49.0	19.2

If the soybean output after corn harvest is taken as 100, it will be 127.9 after harvesting of millet, 114.8 after harvesting of sorghum, and 73.5 with repeated soybean cultivation (Table 3). Difference in soybean growth and output when the crop follows different preceding crops is to different nutritional conditions. As shown by the determination of the effective phosphorus content, the effective phosphorus content is 6.80 milligrams per 100 grams of soil after harvesting of millet, 7.3625 mg after harvesting of corn, and only 6.6256 mg after harvesting of soybeans. Soybeans are very sensitive to the content of effective phosphorus in the soil, especially during the seedling stage. Soybean root system and bacterium radiciala growth and the blossoming and legume-bearing rate are proportional to the content of effective phosphorus in the soil.

Table 3. Influence of Different Preceding Crops on Soybean Output (Kilograms per Hectare; Yu-shu, 1960)

Previous crop	investigated plot	area	output	output ratio (%)
millet	36	211.75	1,986.1	127.9
sorghum	36	202.03	1,782.0	114.8
corn	4	10.23	1,552.0	100.0
beets	6	18.20	1,457.5	93.9
soybeans	3	5.65	1,141.5	73.5

Crop rotation provides not only good preceding crops for soybeans but also good preceding crops for sorghum and millet. Planting crops after harvesting of soybeans tends usually to provide for an obvious output increase (Table 4). Since the climate is dry and windy in Yu-shu Hsien during the spring sowing season, the temperature increase is rapid. But since millet and sorghum seeds are small, shallow sowing is required. In order to have seedlings of more or less the same height, water supply should be adequate. The original plot does not need to be harrowed after harvesting of soybeans, and sorghum and millet can be sown in rows after ditches are dug. Thawed water can ascend through the soil capillaries. Since sowing is shallow and the increase of soil temperature rapid, the soil is hot and moist in the sowing bed and the seedlings will be strong and of uniform height. For planting of soybeans, old mound plots should usually be harrowed to make new mound plots with applications of basal fertilizer. After harvesting of soybeans, sorghum and millet can be planted without making new mound plots. Thus the new crops can sufficiently utilize the residual effect of the

basal fertilizer applied for the previous crop (soybeans). The effective fertility of soil planted in beans is generally high. According to the results of experiments conducted at the Kung-chu-ling Agricultural Experimental Farm during the Japanese occupation of Manchuria, the effective nitrogen content after harvesting of soybeans is 12.5 ppm, and is 10.6 ppm for grain after harvesting of millet. Thus output tends to increase when Gramineae crops are planted after harvesting of soybeans.

Table 4. Influence of Different Preceding Crops on Output of Sorghum and Millet (Kirin Institute of Agricultural Research)

cultivated crops output and ratio preceding crop	sorghum		millet	
	output (kg/ hectare)	ratio (%)	output (kg/ hectare)	ratio (%)
soybeans	2,503.0	100.0	1,981.9	137.5
sorghum	1,606.0	64.2	1,440.3	100.0
millet	1,669.7	66.7	1,013.7	70.4
beets	---	---	1,532.2	106.4

Will soybean output be reduced if this crop is cultivated repeatedly? According to investigations in Yu-shu Hsien, since the soil is fertile and the black earth layer thick, and since basal fertilizer is applied for soybean planting along with the making of new mound plots, the output of the second soybean crop does not differ greatly from that of the first (Table 5).

Table 5. Relationship between Crop Rotation Pattern and Soybean Output (Yu-shu, 1960)

crop rotation pattern	investigated plot	output (kg/hectare)	output ratio (%)
first crop	16	1,754.1	100
second crop	22	1,743.1	99.3

As mentioned above, the output of grain and soybeans has increased in Yu-shu Hsien where the cultivation pattern consists of soybean-centered crop rotation and two continuous plantings of soybeans when the crop rotation ratio of Leguminosae and Gramineae crops is 1:1.

2. The present pattern of crop rotation maintains and increases soil fertility.

The rational cultivation system should be a combination of simultaneous land utilization and maintenance of soil fertility. In Yu-shu Hsien, crop rotation of two continuous plantings of soybeans is carried out according to crop characteristics and cultivation and fertilization systems. The natural conditions make possible the increase of land fertility by simultaneous utilization of land and maintenance of soil fertility.

In the crop rotation pattern of two continuous plantings of soybeans, the cultivated area planted in soybeans amounts to 50% of the total cultivated area. Soybeans, in addition to increasing the nitrogen content of the soil, also activate phosphorus and potassium, not only maintaining but increasing the effective fertility of the soil. According to Huang Ho-hsin's (7806 0735 9515) data, the effective phosphorus and potassium contents may reach 90 kg and around 200 kg per hectare respectively after harvesting of soybeans. Since the quantity of displaced cations in the roots of Leguminosae is high, more potassium cations can take part in the root ion exchange. With the increase of the quantity of displaced cations, the energy to combine with calcium of the plants is also increased, as is the calcium adsorption of the roots. Thus the relatively insoluble phosphorus combines with calcium and is activated. The quantity of falling soybean leaves is high, so the organic content of the soil can be increased by 0.05% after the cultivation of one soybean crop. Since soybeans contain bacterium radiciala, the ionized nitrogen can be solidified. According to reports, nearly ten kilograms of nitrogen, an amount equivalent to 50 kg of ammonium sulfate or five tons of manure, can be solidified per mou. Most of the nitrogen content in soybeans -- two-thirds of the total nitrogen requirement -- is solidified by bacterium radiciala. The other one-third of the nitrogen required comes from the soil. According to analysis of the nitrogen content of soybean stalks and beans, the nitrogen content of the roots and leaves comprises about half the total quantity. Because of this, all the soybean roots and leaves are left in the fields. The quantity of soybeans sown in Yu-shu Hsien is five per cent of the harvested quantity. In other words, five per cent of the amount of nitrogen taken from the soil by the beans is returned. That the cultivation of soybeans can increase the nitrogen content of the soil is evident. In Yu-shu, an area with wide expanses of land, a small population and insufficient quantities of fertilizer, the supply level of nitrogen contained in the soil is an important condition for determination of output. Thus the biological solidification of nitrogen has an obvious function

in regard to increasing output.

In the pattern of crop rotation with two continuous plantings of soybeans, one application of manure in three years is changed to one application of manure every two years. Since only when new mound plots are made for planting of soybeans is there an opportunity to apply large quantities of basal fertilizer, only limited amounts of fertilizer can be applied when crops are planted without harrowing the original mound plot. The cultivation of soybeans with application of basal fertilizer can increase the biological solidification of nitrogen. Moreover, since soybeans draw little nitrogen from the soil, the applied fertilizer is actually used mostly to replace the soil nutrients consumed by Gramineae crops. According to investigations of fertilization level of the Hsing-lung-tien Production Brigade, Yu-shu-chen Commune (with good management), basal fertilizer was applied to 99% of the area planted in soybeans, to 62% of the area planted in sorghum, and to 73.7% of the area planted in millet. On the average, 20 tons of manure were applied as basal fertilizer; this converts into 40 kg of nitrogen if the nitrogen content of manure is assumed to be 0.2%. For the sowing of 80 kg of soybeans in two plots in crop rotation, the average quantity of refined manure applied per hectare is seven tons, equivalent to 28 kg of nitrogen assuming that the manure has a nitrogen content of 0.4%. The total amount for the two plots is 56 kg of nitrogen. However, at present, this quantity of fertilizer is applied to 65% of the cultivated area in cases where new mound plots are not made, so actually only 36 kg of nitrogen is applied. This is altogether 116 kg (80 kg of sown soybeans and 36 kg of nitrogen). According to papers, the nitrogen absorbed is 26 kg per 1,000 kg of sorghum seed and 47.5 kg for millet. According to the mean yield in Yu-shu Hsien from 1949 to 1962, the nitrogen absorbed was 44.2 kg for 1,707 kg of sorghum, and 58.4 kg for 1,231 kg of millet. The total quantity of nitrogen absorbed is 102.6 kg. Therefore, with cultivation of two consecutive soybean crops, more nitrogen enters the soil than is consumed.

In the three-crop rotation pattern (soybeans -- sorghum -- millet) with soybeans as the first crop cultivated and similar fertilizer applicational levels, 76 kg of nitrogen enter the soil but 102.6 kg of nitrogen are consumed, producing a nitrogen deficit. Equilibrium cannot be attained even with the increase of nitrogen content brought about by the cultivation of soybeans. Moreover, since the level of fertilizer application is not that high with low fertilizer quality, the nitrogen deficit is comparatively serious in this rotation pattern. This adequately explains the advantages of maintaining nitrogen equilibrium through two consecutive plantings of soybeans as opposed to three-crop rotation.

3. The present crop rotation pattern is advantageous to the elimination of weeds.

Yu-shu Hsien has wide expanses of land but a small population,

with an average of 1.83 hectares of cultivated land per laborer. Weed damage in the fields is serious, and 50% of the field work is usually spent on weeding. The adoption of two consecutive plantings of soybeans with alternate building of new mound plots can effectively control weed damage.

Investigations show that, regardless of whether new mound plots are built, the weed seeds are distributed regularly in the cultivation layer, 80% being found in the top 8-12 centimeters of the 20 cm-thick layer of topsoil, and only 1.6% being found at depths above 8 cm. When new mound plots are not built, the sowing depth usually does not exceed the depth at which weed seeds are most highly concentrated. Moreover, since 80-90% of the weed seeds are found between the roots, the seedling holes are more or less free of weed seeds, and the manual labor spent in weeding seed holes is greatly reduced. In this pattern of cultivation, one plowing is conducted before spading the soil, so large quantities of weeds can be eliminated. Building of new mound plots usually begins after the middle of April, the time at which most of the weed seeds and reproductive organs of perennial weeds in the topsoil begin to grow. Overturning during the building of new mound plots turns these weed seeds down into the deep layer, where they suffocate. This is both effective and saves labor. According to investigations in Yu-shu Hsien made during the soybean seedling stage, the number of weeds per square meter on new mound plots is 40% less than that on old mound plots; the number of weeds on new mound plots is still smaller than with level cultivation.

The growth of soybean branches and leaves is vigorous, so the plant leaves can cover the mound plot at an early time and thus restrain the growth of weeds. Observations indicate that weed growth is weak after soybean leaves have covered the plots because most weeds need light. There are very few weed seeds, or weeds may even die without bearing seeds. Even though there are a few weeds taller than the soybean stalks, the weeds can be eliminated before they blossom and bear seeds through major weeding operations.

4. The present crop rotation pattern provides for full utilization of human and animal power.

The short growing season in Yu-shu Hsien means that agricultural activities are concentrated. Since the hsien has broad expanses of farmland and only a small population, rational arrangement of labor required for sowing, spading, and plowing is of importance in regard to ensuring a bumper harvest. The sowing season in Yu-shu Hsien generally runs from "grain rains" [about 20 April to 4 May] to "grain in ear" [from 6-20 June], or approximately one and one-half months. From spading and plowing around the time of "grain in ear" to the time when crop leaves cover the mound plots near "small heat" [7-21 July] is also one and one-half months. Since this latter period is during the rainy season, field operations are impossible during about two weeks of this period due to inclement weather. It is necessary to make full utilization of time, both in

sowing and in field management. The soybean-centered pattern of crop rotation with two consecutive plantings of soybeans provides for rational utilization of manpower and animal power by arranging activities at different times.

In accordance with the biological characteristics of the rotated crops and local natural characteristics, sorghum and millet are usually planted without making new mound plots, while soybeans are planted in new mound plots. Since sorghum and millet seedlings grow first, spading and hoeing are conducted first. Soybean seedlings grow later, so spading and hoeing of these is done later. Since little shade is provided by sorghum or millet leaves, the mound plot is not covered by leaves until late, and weed growth is greater. The vigorous soybean growth during the first stage provides a great deal of shade and allows the mound plot to be covered early by leaves. The farmers customarily spade and hoe the old mounds once for sorghum and millet, once again for soybeans, once again for soybeans, and once again finally for sorghum and millet; in other words, spading and hoeing begin and end with old mound sorghum and millet. Thus can weed growth be controlled, the biological requirements of the crops met, and labor adjusted to the situation of more land and a limited population.

Soybean cultivation usually requires about one-third less labor than sorghum or millet cultivation. The labor distribution in the growing stage is different for the three crops. More labor is required in sowing soybeans, almost double that required for sowing sorghum and millet. Part of the labor saved during the sowing of sorghum and millet can be used for soybean sowing preparations. During the busy stages of spading, hoeing, and field management, the amount of labor expended on soybeans is considerably lower than that spent on sorghum and millet, usually only about one-half -- although one-fourth of the field-management labor for sorghum and millet is spent in thinning seedlings. In Yu-shu Hsien, sorghum and millet seedlings are usually thinned after spading and hoeing once, the time of thinning coinciding precisely with the first spading and hoeing of soybeans. Thus labor can be used economically and labor productivity increased.

5. The present crop rotation pattern provides for sufficient utilization of soil and climatic conditions suited to soybean growth.

Soybeans are a crop which does best in warm temperatures where there is an abundance of water. Such natural conditions as fertile soil with high water retention capacity, sufficient sunlight, summer temperatures between 20 and 24°C, and adequate rainfall during the blossoming stage are advantageous to soybean growth and enhancement of crop quality.

Most of the cultivated land in Yu-shu Hsien is level and fertile neutral soil with a thick layer of black earth having both high humus content and water retention capacity. The water table is shallow, ideal for soybean cultivation.

During the first stage of soybean growth, the climatic temperature and rainfall are low, which promotes the growth of the seedling root systems. The period of vigorous soybean growth from July to August is the time when rainfall and sunlight are abundant and temperatures range from 21-23°C. These conditions are suited to the biological requirements of soybean blossoming and setting. Analysis from 1931 to 1960 in Yu-shu Hsien (a range of 30 years) of the relationship between climatic factors and agricultural harvests shows that in five of eleven bumper harvest years soybean harvests were a fraction smaller than the harvests of other crops, but also that in three of six years of poor harvests the soybean harvests were above average. This indicates that soybean output in Yu-shu Hsien is comparatively stable, and it is because of this stability that the hsien has become a major soybean-producing area. In addition to economic factors, natural conditions also play a decisive role.

Table 6. Types and Characteristics of Soils in Which Most Soybean Crops Are Cultivated

soil name		quality	humus	black earth layer (cm)	pH value	% of total cultivated area
colloquial name	embryological name					
black earth (P)	leached black earth	loam and argillaceous soil	3,247	above 60	6.5	17.95
black earth (H)	predominantly medium podzolic soil transformed from grass	argillaceous loam	3,123	around 50	7.0	7.02
black yellow earth (P)	leached black earth	argillaceous loam	2,906	30-50	6.5	24.37
black yellow earth (H)	predominantly weak podzolic soil transformed from grass	argillaceous loam	2,237	above 30	6.5	3.36
secondary yellow earth (P)	leached black earth	argillaceous loam	1,992	20-30	6.0	8.56

Note: (P) = plain area; (H) = hilly area; content of humus is within a depth of 25 cm.

Table 7. Comparison of Thirty-year Climatic Factor Means and Climatic Factor Means for Eleven Bumper Harvest Years

time record climatic factors	April	May	June	July	August	September	remarks
temperature (°C) (*)	5.8	14.0	19.9	22.9	21.3	15.0	* 30-year mean
temperature (°C) (**)	6.4	14.7	20.7	23.4	21.6	14.9	** mean value of 11 bumper harvest years
rainfall (mm)*	24.7	58.3	109.0	167.2	119.9	54.6	
rainfall (mm)**	24.2	55.0	85.0	156.9	120.9	57.1	
sunlight (hours)*	243.6	251.8	254.3	241.2	262.5	235.6	
sunlight (hours)**	239.8	257.1	270.1	256.7	252.5	239.2	

Table 7 shows that the 30-year climatic factor means in Yu-shu Hsien are close to the climatic factor means for the eleven bumper harvest years. Although the 30-year mean temperature was lower, rainfall was slightly higher. The mound plot method of cultivation generally adopted in local cultivation of soybeans provides for increase of soil temperature and discharge of excessive water to create environmental conditions suited to soybean growth.

Although the climatic conditions of the surrounding hsien (such as Chiu-t'ai, Te-hui, Nung-an, and Shu-lan) are similar to those in Yu-shu, topographical and soil conditions are not as good, and as a result, the cultivation ratio is low. Some of the other areas such as Nung-an and the western portion of Te-hui have low, flat land, shallow water table, and alkaline soil, or, in the case of Chiu-t'ai, Shu-lan, and the eastern portion of Te-hui, mountainous or semi-mountainous terrain with complex topography and infertile soil. But even in Yu-shu Hsien the soybean distribution is uneven. The ratio of soybean cultivation is 42-45% at Hsin-chuang Commune in the plains area, but only 25-30% at Ch'eng-fa Commune on the river terraces in the center of the hsien.

The adoption of two consecutive plantings of soybeans in crop rotation can raise the cultivation ratio of soybeans to the highest limit

and thus make full use of the excellent local natural conditions in addition to vigorously supporting the economic construction of the State.

Farmers in Yu-shu Hsien have discovered the four following advantages of planting soybeans twice in a row in crop rotation: (1) a good preceding crop such as soybeans can raise the yields of sorghum and millet, and soybeans also benefit when planted in fields where sorghum and millet were previously grown; (2) the soybean plant has bacterium radiciala, and one application of basal fertilizer made every other year when new mound plots are built fertilizes the land; (3) soybean leaves can provide a great deal of shade, and the leaves cover the mound plots earlier; in addition, the building of new mound plots every other year keeps the ground relatively free from weeds; and (4) when the area is planted in 50% soybeans on the one hand and 50% sorghum and millet on the other, farming activities can be arranged so as to fully utilize labor.

As mentioned previously, the soybean-centered crop rotation system in Yu-shu Hsien with two consecutive plantings of soybeans is advantageous to the maintenance of soil fertility and high, stable yields, to the rational arrangement of man and animal power, and to the fulfilling of State production plans.

Problems to Be Noted in Crop Rotation With Two Consecutive Plantings of Soybeans

1. How Soybean Planting Ratio May be Rationally Arranged

The excellent natural conditions of Yu-shu Hsien and the farmer's abundance of experiences regarding soybean cultivation satisfy the prerequisites for large-scale cultivation of soybeans. One point worthy of note is that the area planted in soybeans has remained consistently stable at 35-37%, according to agricultural production statistics for the years 1935-1957. Since 1959, however, the area planted in soybeans has been increased to 115,000 shang, or 40% of the total area planted in grain and beans. The farmers complained of the difficulties involved in changing crops, so repeated cultivation prevails. An investigation of this problem was organized by the Yu-shu Hsien Party Committee, and according to the results of investigation of nine communes such as Hsieh-chia, Hei-lin-tzu, Yu-chia, and Ta-ling, approximately 7-8% of the total area devoted to soybeans was planted repeatedly in this crop. The investigation also showed that there were 90,000 hectares of infertile loess, easily flooded terraces and paddy fields unsuited to soybean cultivation. Around 220,000 hectares of cultivated land were suited to the crop, however. When the area planted in soybeans reaches 115,000 hectares, it will exceed 50% of the amount of cultivated land suited to soybean planting. The maximum ratio of soybean cultivation is 50% in the present crop rotation pattern, and thus repeated cultivation of soybeans exists.

With repeated planting of soybeans, shortcomings such as undesirable root system growth, short stalks, and obvious decrease in number of root tubercles (see Tables 2, 3, 7) begin to appear in the seedling stage.

Table 8. Repeated Cultivation of Soybeans and Growth of Young Seedlings (Yu-shu)

cultivation pattern	stalk height (cm)	number of compound leaves	leaf area (cm ²)
change of cultivation	6.4	3.0	4.9 x 3.8
repeated cultivation	5.7	2.2	3.8 x 2.9

Table 9. Relationship Between Crop Preceding Soybeans and Soybean Disease and Insect Damage (Huai-te)

date of investigation name of disease or insect	26 June		19 July	
	larvae (maggots) of <u>Mimela lucidula</u> Hope		standing blight	
damage rate	number of stalks investigated	damage rate (%)	infection rate (%)	severe rate (%)
preceding crop				
millet	1,012	2.9	50.0	20.0
sorghum	1,227	5.7	30.0	10.0
soybeans	1,274	40.6	95.0	63.0
beets	-	-	40.0	18.0

The output of soybeans is thus appreciably decreased by repeated cultivation, as shown in Table 10. In addition, insect damage to the beans is more severe, the percentage of damaged beans is increased, and soybean quality is thus reduced. According to 1960 statistics for Yu-shu Hsien, the percentage of soybeans eaten by insects was 4.7% when the crop was preceded by millet, 2.7% when preceded by sorghum, and 14.7% with repeated cultivation of soybeans.

As proved by practice, the repeated cultivation of soybeans leads to lowered output and quality. In the present pattern of crop rotation in Yu-shu Hsien, the maximum area devoted to soybeans is 50%, or not more than 110,000 hectares. In the past, 35-36% of the total area

planted in grain and beans was planted in soybeans. This more suitable percentage eliminates the repeated cultivation of soybeans and facilitates the retention of soil fertility and the maintenance of stable and high outputs.

Table 10. Influence of Repeated Cultivation on Soybean Output (Yu-shu)

cultivation pattern	1954		1960	
	output (kg)	output rate (%)	output (kg)	output rate (%)
normal	1,986	100.0	1,754.2	100.0
repeated	950	47.8	1,141.5	65.1

2. How Unit Yield of Soybeans May be Increased

The unit yield of soybeans is still low in Yu-shu Hsien, generally slightly less than the mean yield of grain and beans. In 1962, the area planted in soybeans in Yu-shu Hsien was considerably reduced (by nearly 20,000 shang); this was the year in which the least area was planted in soybeans [during recent years]. Almost all of the 20,000 shang formerly planted in soybeans was devoted to sorghum. This destroyed the equilibrium between areas planted in soft crops such as soybeans and wheat and hard crops such as sorghum and millet. Soft and hard crops are customarily planted alternately; for example, a year in which more grain crops and less soybeans were grown would be followed by a year in which soybean cultivation would be increased and grain crops decreased. Destruction of the equilibrium also leads to instability in yearly crop ratio relationships. Otherwise the soft crop cultivation pattern of soybeans -- sorghum -- soybeans -- millet should have been changed to soybeans -- sorghum -- millet, with the appearance of repeated cultivation of sorghum, because the area planted in sorghum appreciably exceeded that devoted to millet, which is planted after harvesting of hard crops. This would have reduced the output (see Table 4). On the other hand, changing manure application and harrowing from once every two years to once every three years results in soil blocking and lowered fertility, conditions inadventagous to consistent increase of output.

According to investigations of soybean production in Yu-shu Hsien, there are many instances where more than one metric ton of soybeans was produced per hectare at various production brigades. The soybean production potential is thus considerable. The most positive method of increasing the total output of grain and beans is to raise the unit yield of soybeans by adopting practical cultivation measures. In this way, it will be possible to achieve the purpose of the current consistent production increase. Effective measures are briefly described in the following.

a. Improving sowing quality and ensuring complete and strong seedlings. According to field investigations, the percentage of soybean seedling attrition is 10-30%, causing uneven distribution of stalks. If the method of sowing can be improved, seedling beds checked, and poor seedlings replaced, output can be increased by 10-30%.

b. Timely spading and hoeing and proper application of supplementary fertilizer can promote vigorous soybean growth. Weeds can be effectively controlled through timely spading and hoeing. Loosened, warm, and moist topsoil can promote soybean growth. As the farmers say, "Timely spading and hoeing make the seedlings grow fast and strong, and the leaves will grow early."

Experiments conducted in Yu-shu Hsien by the Institute of Forest Soils of the Chinese Academy of Sciences have proved that the supplementary application of phosphorus fertilizer during the young seedling stage can increase soybean output by 10-15%. Proper supplemental application of nitrogen fertilizer prior to blossoming can increase output by 21-32%. Timely spading and hoeing in conjunction with proper supplemental applications of fertilizer promote vigorous soybean growth in the early stages. Earlier agriculturists proved that in the cold and humid black earth region in the north the vigor of soybean growth is proportional to output.

In addition, the selection of good seeds and improvement of seed strains can also exert a positive function on the unit yield of soybeans.

"CH'IN-CHOU YELLOW" MILLET

Chung-kuo Nung-pao
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"Ch'in-chou yellow" millet is a well-known product of Ch'in-chou, Shansi Province. The oily cooked millet is delicious and soft, and a favorite of the local residents. The millet is small but heavy, has an oily golden color and shines in the sun. The local masses say: "The golden, transparent, and oily millet is the best; the golden and transparent but non-oily millet is next; and the white, non-oily millet comes last." Both in the past and at present the price of this millet has usually been double that of ordinary rice, and supplies fall far short of the demand. The local residents say: "Better to eat a bowl of 'Ch'in-chou yellow' millet than a bowl of good noodles."

"Ch'in-chou yellow" millet is produced in the T'an-shan area in Chin Hsien where the elevation is around 1000 meters. The main production area lies in a 20-li circle around the T'an-shan mountains in which are located eleven villages such as Tung-chuang, Wang-chao, and Shang-ts'un. Approximately 2000-3000 mou in the valley are suited to the cultivation of "Ch'in-chou yellow" millet; in this area, the highest annual output is 200,000-300,000 chin. The millet is restrained by the topographical and soil conditions, so the product is strictly regional. In the past, many people have attempted to plant "Ch'in-chou yellow" millet in other areas, but all attempts to date have been unsuccessful. This is the reason why the millet is becoming more and more valuable.

"Ch'in-chou yellow" millet is a good strain, suited to the soil characteristics which was selected long ago by local farmers and carefully bred for thousands of years. The millet bears grain in the spring, and is harvested at the normal time after a growth period of

about 120 days. The millet is drought- but not flood-resistant, and may be grown only on the local infertile slopes. Planted in more fertile land, the millet's quality drops even though output is increased. During the young seedling stage, the millet leaves are yellowish-green and the stalks light green. In the mature period, the stalks and leaves are yellowish-white and between 100-120 centimeters in height. There are twelve to fifteen heads per stalk; tassel lengths range from 15-20 centimeters, and the long, spindle-shaped tassels with short stiff fibers range in diameter from 1.5-1.6 centimeters. If the stalks grow higher and the tassels longer, the quality will decrease. The ratio of hulled to unhulled "Ch'in-chou yellow" millet is 5-10% higher than that of ordinary millet, and the protein and fat contents are also higher. The starch particles of the millet are very fine, and it is easily cooked. This is another reason why the consumers are so fond of the millet. According to the experiences of the local farmers, the best-quality millet comes from areas where the per-mou yield is less than 100 shih-chin. Millet from areas with unit yields of less than 150 shih-chin is of moderate quality, but quality is appreciably lowered when per-unit yields exceed 200 shih-chin.

This millet strain is usually planted on the most infertile mountain slopes. The plant thrives on sunny red clay slopes, does well on sunny red loam slopes or in any soil on slopes facing east or west, and poorly on shaded white earth slopes. The strain is not suited to planting in fertile lowlands near streams; more fertilization is undesirable. Although the per-mou yield may reach over 500 chin in fertile soil, the quality is inferior, the millet being no better than ordinary millet.

Techniques of cultivating "Ch'in-chou yellow" millet are generally similar to those used to grow ordinary millet, but there are some special features: (1) Since most of the millet is planted on infertile slopes with low water retention capacity, and millet grains and seedlings are small, the land must be carefully harrowed. In autumn, deep plowing and moisture retaining are required, and in summer it is necessary to harrow early and plow shallow to retain soil moisture. The seeds must not be sown too deep lest they be unable to tap the soil moisture content. The soil must be compacted two or three times with stone rollers or by foot after sowing. In the farmers' experience, "Ch'in-chou yellow" millet grows best in compacted soil; loose soil causes loss of moisture and root breakage. (2) The sowing period is generally five days earlier than that of ordinary millet; thus it is said that "Ch'in-chou yellow" millet must never be planted late. (3) The valleys in which "Ch'in-chou yellow" millet is planted usually do not require fertilization. The crop is alternated with soybeans or planted on sheep grazing land. The best fertilizer is 10-20 tons of sheep, mule, or horse dung per mou; night soil and hog dung must not be used. (4) During the period from the three-leaf to the five-leaf stages, the seedlings must be thinned and weak plants removed. Shallow secondary plowing is required before node sprouting to loosen the roots and thus control sprouting. After node

sprouting, one secondary plowing with banking of earth is made. Before tassel sprouting, one shallow secondary plowing is made, and the fields are weeded and banked. (5) "Ch'in-chou yellow" millet may be densely cultivated with roots 8 ts'un and stalks 2-3 ts'un apart; the number of stalks is more than double that of ordinary millet, being 25,000-35,000 stalks per mou. The quality will be lowered if the number of stalks is less than this amount, as larger stalks promote greater tassel growth.

ON PROBLEMS OF ARRANGING PRODUCTION
OF VEGETABLE VARIETIES

Chung-kuo Nung-pao
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The problem of arranging production of vegetable varieties in recent vegetable production practice needs more and more to be discussed as an important topic. The present article is mainly a presentation of the opinions of the author regarding this problem in vegetable production in the suburbs of Shanghai.

In production operations, the concept of variety arrangement consists mainly of the three following points (the term variety in this article is to be taken in its broader sense, i.e., as including both variety and species): first, the matching of varieties for planting; second, the planting of specific varieties in specific fields; and third, the arrangement of preceding and succeeding crops. This problem is an extensive one, and one which concerns municipalities, hsiens, communes, and production brigades to a greater or lesser degree. The aspect of the problem discussed here is mainly the arrangement of vegetable varieties by the production brigade.

Variety Matching

The rational matching of vegetable varieties must be analyzed and studied from two standpoints: coordination of variety cultivation characteristics and production conditions, and coordination of production feasibility and consumer requirements.

A. Coordination of Variety Cultivation Characteristics and Production Conditions

Many vegetable varieties have different cultivation characteristics.

In order to match the selected varieties to production conditions, the vegetable varieties must be analyzed from the standpoint of labor, fertilizer, soil, and cultivation technique requirements.

Considering the varieties from the standpoint of labor, vegetable crops generally require the expenditure of considerable amounts of labor. The amounts of labor required for different vegetable varieties are different. Vegetables can generally be grouped into the three following categories according to the amount of labor required: (1) those requiring considerable labor, such as tomatoes, loofah gourds, cucumbers, Vigna sinensis Hassk., tender cabbage, and autumn spinach. Most of these are trellis crops, and require much pruning and fastening of creepers during growth stages. The planting densities of some vegetables such as tender cabbage are high, and some, such as, spinach require several thinnings of seedlings; thus more labor is required. In addition, some vegetable varieties such as Celosia cristata L. (consumed during the seedling stage as short growth period greens) require considerable labor during their short growth periods, so these vegetables are also included in this category. (2) Vegetable varieties requiring a medium amount of labor, such as turnips, green vegetables (such as leaf cabbage), kohlrabi, savoy cabbage, Amarantus mangostanus L., scallions, and leeks. (3) Those vegetable varieties requiring little labor, such as winter melons, Cucumis conomon Thunb., lettuce, onions, soybeans, and short-stalk four-season beans.

Obviously, if these three categories are arranged in different proportions, the total labor requirement will differ. If more labor-consuming varieties are planted, more labor will be required. If more varieties requiring little labor are planted, less labor will be required.

From the standpoint of fertilizer consumption, as with labor consumption, different varieties of vegetables require different quantities of fertilizer. The vegetables may be divided into three categories according to per-unit fertilizer requirements: (1) varieties requiring considerable per-mou quantities of fertilizer, usually those vegetables with long growth periods, high yields, high planting densities, and multiple harvests. Typical varieties are Ipomoea aquatica, beets, Amarantus mangostanus L., spinach, eggplant, kohlrabi, savoy cabbage, celery, Capsella bursa pastoris Meonch., and April cabbage (leaf cabbage). (2) Those varieties consuming medium quantities of fertilizer: typically, tomatoes, capsicum, cucumbers, turnips, greens, tender cabbage, and scallions. Scallions require considerable amounts of fertilizer, but since row spacing is larger due to soil banking, the per-mou fertilizer requirement is not too high. (3) Those varieties requiring little fertilizer, including two subcategories: Leguminosae, which solidify ionized nitrogen in the atmosphere through bacterium radiciala, and which therefore require relatively little fertilizer; and some melons, which require considerable amounts of fertilizer but have a low per-mou requirement due to the unique method of cultivating melons (planting in holes, several

hundred per mou, with fertilizer concentrated in the holes. In this subcategory are Cucumis conomon Thunb., winter melon, and pumpkin. Using fertilizer requirement per unit area as the standard of classification differs from the usual classification according to the fertilizer requirements of individual stalks seen in other papers. For example, spinach is a vegetable with low fertilizer absorption, but due to close planting and many harvests the actual fertilizer requirement per mou is high. In addition, the growing period of the short-period greens is short, and yield is low, as is generally the per-mou fertilizer requirement. However, when this vegetable is planted, the number of crops per year is high, and so is the fertilizer requirement. Thus greens should still be included among those varieties of vegetables requiring large quantities of fertilizer.

When the three categories have different ratios in variety arrangement, it is obvious that the total fertilizer requirement will be different. If more varieties of the first category are planted, the total fertilizer requirement will be increased, and if a greater percentage of vegetables belonging to the third category is planted, the total fertilizer requirement will be reduced.

From the standpoint of soil and cultivation technique requirements, the vegetables may again be grouped into three general categories: those requiring better soil conditions and cultivation techniques, such as cucumbers, tomatoes, spring Amarantus mangostanus L., green vegetables, and Kwangtung tender cabbage; those requiring medium soil conditions and cultivation techniques, such as winter melons, Cucumis conomon Thunb., taro, round turnips, carrots, and potatoes; and those with lower soil condition and cultivation technique requirements, such as soybeans, Ipomoea aquatica, autumn Amarantus mangostanus L., tender kohlrabi, onions, and lettuce.

As mentioned above, more vegetables of the first category may be planted in areas with good soil conditions and high technical levels. Vegetables of the latter two categories can be planted in areas where soil conditions and technical levels are less adequate.

In short, comprehensive consideration must be given to cultivation characteristics and production conditions of the varieties in arranging vegetable varieties so that the requirements of the varieties planted may be satisfied by production conditions and yields increased.

B. Coordination of Production Feasibility and Consumption Requirements

In selecting vegetable varieties, consideration must be given not only to concrete production conditions, but to the gradual increase of vegetable production as well, in order to coordinate, if possible, production feasibilities and consumption requirements. Here the vegetable

production level includes output, variety, quality, and market supply equilibrium. Experience has shown that matching varieties so as to facilitate the incessant increase of both yield and quality for the gradual increase of vegetable varieties and the increase of supply during low production seasons is a very important problem.

In regard to the relationship between variety match and yield, different varieties have different yields. Some varieties such as cabbage, long turnips, winter melons, and Ipomoea aquatica have high yields, often over 10,000 chin per mou; while other varieties such as soybeans, Vigna sinensis Hassk., and four-season beans have very low yields, only around 1,000 chin per mou. Vegetable varieties may be grouped into three categories of high, medium, and low yield. The high-yield varieties are cabbage, beets, April cabbage, May cabbage (leaf cabbage), Ipomoea aquatica, green vegetables, kohlrabi, and winter melons. Medium-yield varieties are cucumbers, spinach, lettuce, tender kohlrabi, and Kwangtung tender cabbage. Low-yield varieties are soybeans, French beans, Vigna sinensis Hassk., and capsicum. Obviously, these three categories must be properly matched if a certain level of output is to be ensured.

As for the relationship between variety match and market supply equilibrium, there are two seasons of vegetable supply yearly in the Shanghai area: the hot growing seasons is advantageous to cold low season supply, but will affect the market supply in September and October. Conversely, increasing varieties with short growing periods and decreasing those with long growing periods can increase the market supply in September and October but will decrease the market supply during the cold low season. Matching of varieties should be viewed from an overall standpoint in order to facilitate production equilibrium and increase market supplies in low seasons.

In addition, the matching of varieties is directly related to the increase of the number of varieties. It is necessary to maintain the unique regional characteristics of production of the so-called well-known vegetables. In the range of allowable conditions, however, more varieties should be planted. It seems that more varieties have many advantages such as coordination of farming activities and regulation of labor force. Since different varieties have different growth and harvest periods, production equilibrium and market supply benefit. And since different varieties have different adaptabilities and different resistances, cultivation of more vegetable varieties is advantageous to the prevention of natural calamities in addition to successfully meeting consumer requirements. Therefore, increasing the vegetable production level is an important index.

Planting of Vegetables in Specific Soils

Since ancient times, Chinese farmers have emphasized the adapting of crops to soil conditions, and much valuable information has been handed

down to the present. Ch'i-min Yao-shu (Important Administrative Methods), by Chia Szu-hsieh (3628 1835 0533) of the later Wei dynasty, records soil requirements of many vegetables, such as "soft soil for garlic, soft black sand for caraway, white sand for ginger, and fertile soil near water for taro." Later Chinese farmers made important developments in production practice, adding to the store of information concerning soil adaptation.

The farmers have a relatively comprehensive view of the land. They take into account not only the soil but also the land; not only the land but also the land environment. They usually analyze the conditions of each field according to the six following points: (1) arenaceous or argillaceous soil characteristics, (2) high or low topography, (3) fertility or lack thereof, (4) cold or warm mud, (5) irrigation and drainage conditions, (6) distance from village, and (7) feasibility of fertilizer transportation and application. Controlling the advantages and disadvantages of each field is a prerequisite for planting according to land characteristics.

Different varieties of vegetables have different soil requirements. For example, some varieties with very low resistance to moisture or lack thereof, such as tomatoes and cucumbers, require more management labor. These varieties should thus be planted on elevated plains with good irrigation and drainage conditions for convenient management. Some other varieties such as taro and soybeans with long growing seasons prefer warmth, are flood-resistant, and require little labor; these may be planted on low plains some distance from the village. Other varieties such as long turnips, carrots, and potatoes require soft soil with good drainage, so they are best planted in high arenaceous riverbank soil. Still other varieties such as beans and pumpkins can be planted in infertile or immature soil. And still others such as tender cabbage and winter leaf cabbage with low cold-resistance should be planted in warm soil on sunny leeward slopes. Still other varieties of late-ripening winter vegetables such as highly cold-resistant tender kohlrabi and onions requiring low temperatures may be planted in shady, cold and open land or even in cold sand where soil temperature increases slowly. In addition, some production brigades are close to industrial areas, and vegetables are easily damaged by factory smoke. Under such conditions the planting of vegetables must be arranged with care. As eggplants and melons are easily damaged by smoke, these crops should be planted in fields at a distance from factories. Carrots, green onions, and garlic have high smoke resistance and may thus be planted in fields near the factories.

Each vegetable production brigade generally has scores of field plots and grows a multitude of vegetable varieties. Since planting is carried out several times during the year, there are certain difficulties involved in planting each variety in suitable land each time. Thus in arranging the planting it is necessary to give emphasis to those varieties with high soil condition requirements. In the Shanghai area, there are three major seasons (spring planting, autumn planting and winter planting)

and two minor seasons (summer planting and early spring planting) for vegetable production during each year. In each season are planted varieties which require higher land characteristics as well as varieties which do not. These varieties must be treated separately. For example, during spring planting, cucumbers, Vigna sinensis Hassk., tomatoes, and Amarantus mangostanus L. must be considered prior to making arrangements for planting of soybeans, celery, beets, loofah gourds, and Celosia cristata L. In autumn planting, first consideration should be given to cabbage, long turnips, greens, savoy cabbage, Kwangtung tender cabbage, and spinach, and then to scallions, kohlrabi, turnips, beets, and Amarantus mangostanus L. During winter planting, short winter vegetables with short growth periods such as tender cabbage, winter leaf cabbage and March cabbage should be considered before winter vegetables with long growing periods such as onions, tender kohlrabi, and lettuce. Thus can varieties requiring good land conditions be planted in suitable land.

This traditional experience of planting in suitable land is not only a most economical and effective measure of increasing production, but also provides for three advantages in management, making it possible to (1) better satisfy the different soil condition requirements of vegetable varieties, (2) regulate the labor required for vegetable planting and management, and (3) alleviate or obviate damage resulting from natural calamities such as floods, drought, or freezing. The concentrated manifestations of these advantages are increased output, improved quality, decreased cost, and increased income.

Sequential Planting of Vegetables

Sequential planting of vegetables was emphasized in very early times in Chinese agriculture. Many valuable records may be found in ancient agricultural treatises. The Ch'i-min Yao-shu points out that "melons are best planted after the harvesting of peas, and next after Panicum miliaceum L.; Brassica campestris L. is best planted in fertile land or old cemeteries." Why should the previous vegetable crop be considered? The main reason is because vegetable production is a long, continuous chain, crop closely following crop. In arranging plans for planting, if consideration is given only to variety and not to the preceding crop, the succeeding crop may oftentimes do poorly because of improper soil conditions. This decreases both the degree of soil utilization and the annual per-mou yield of vegetables. Moreover, since each vegetable is selective in its absorption of soil nutrients, and since the root system excretions of different vegetables are different, different varieties affect the soil in different ways, possibly causing changes in the chemical, physical, and biological characteristics of the soil. Such changes may be either advantageous or disadvantageous to succeeding crops. If the proper crop sequence is not considered, the output of the succeeding crop may possibly be reduced. Thus it can be seen that both variety and the preceding crop must be considered because of the relationship of time and soil factors to the preceding crop.

According to the experiences of old farmers, the types of preceding vegetable crops may be divided as follows:

1. Desirable preceding crops: scallions, garlic, melons, and beans. Scallions and garlic are good preceding crops because they have tubular or belt-shaped leaves, because they are planted during seasons with sufficient sunlight, and because the fields planted in these crops are constantly plowed and banked, which facilitates soil maturation. In addition, because these plants contain germicide which restrains the reproduction of bacteria and injurious insects, they leave the soil comparatively fertile and relatively free of weeds and insect pests. Beans are a good preceding crop because their root tubercles solidify nitrogen in the atmosphere by biological methods and also absorb calcium deep in the soil to increase the quantities of effective calcium and nitrogen in the soil after decay of roots and branches, thus improving the soil structure. Melons are good preceding crops because their root systems are relatively developed, with many branches and tendrils. After harvesting, the roots and tendrils decompose at a rapid rate, increasing the amount of effective nutrients in the soil. And since the leaf area of melons is large, the soil is completely covered and the soil structure saved from destruction by rain water. The soil is therefore comparatively loose after melon harvests.

2. Undesirable preceding crops: Ipomoca aquatica, Amarantus mangostanus L., beets, and Capsella bursa pastoris Moench. These vegetables absorb especially great quantities of fertilizer, considerably depleting the fertility of the soil. Farmers refer to these crops as "crops leading to infertile soil." As for the seed beds of Rhizoma and leaf vegetables, since considerable quantities of nutrients are absorbed during the blossoming and seed-bearing stages, the soil is relatively infertile; thus these vegetables are undesirable preceding crops.

3. Medium preceding crops: eggplant and some Rhizoma and leaf vegetables which produce moderate soil fertility for succeeding crops.

These three classifications are by no means absolute. For example, with greens and Ipomoca aquatica, a preceding crop of greens provides medium fertility, but Ipomoca aquatica provides only low fertility. However, if greens are the succeeding crop, Ipomoca aquatica is a desirable preceding crop. As a farming proverb has it, "Changing the crop is equivalent to applying manure"; i.e., changing the crop is better than continuous cultivation.

The climate in the Shanghai area is warm, and many varieties of vegetables are grown here. In long years of production practice, the variety characteristics and climatic conditions have been well matched and many patterns of crop rotation created. Most fundamental are the three following patterns.

1. Short growth period winter vegetables (such as March cabbage) -- early-ripening eggplant, melons, or beans -- autumn vegetables (kohlrabi, carrots, cabbage, or spinach). This pattern encompasses three major seasons during the year, but in many areas a crop of early spring vegetables (such as April cabbage, May cabbage, spring spinach, or four-season turnips) is planted after harvesting of the short-growth winter vegetables, or a crop of greens may be planted after harvesting of early-ripening eggplant, melons, or beans. This is actually five crops a year. This most fundamental cultivation pattern in the vegetable-growing suburbs of Shanghai not only ensures the yields of the crops of the three major seasons, but also increases the market supply in the two minor seasons.

2. Long growth period winter vegetables (such as tender kohlrabi, onions, or lettuce) -- summer leaf vegetables (such as Amarantus mangostanus L., Ipomoea aquatica, or beets) -- autumn vegetables. This pattern also provides three crops per year, but the market supply of green leaf vegetables is increased in July and August. One similarity of this and the first pattern is that long-growth autumn vegetables (such as kohlrabi, carrots, and salted turnips) are stored in the open or underground in winter so that supplies during January and February will be increased.

3. Long growth period winter vegetables or early spring vegetables -- late-ripening eggplant, melons, or beans -- late autumn vegetables (such as greens or spinach) or winter vegetables. In this cultivation pattern, the major crop is the late-ripening eggplant, melons, or beans (such as late eggplant, late soybeans, winter melons, or melong). Crops preceding late eggplant or late soybeans are generally early spring vegetables, and winter melons and melons are frequently planted between rows of lettuce, tender kohlrabi, or greens. Subsequent crops may be late autumn vegetables or winter vegetables.

Of course, vegetable rotation in the Shanghai area does not follow only those patterns mentioned above, but is very flexible and complex. The three patterns of vegetable rotation described here are the most fundamental and stable patterns.

Why are these vegetable rotation patterns generally adopted? Because of the necessity of proper coordination of vegetable climatic requirements and local climatic characteristics for planting specific vegetables at the proper seasons to make full use of natural conditions and exert the production potentials of the various vegetables. These vegetable rotation patterns are not only advantageous to cultivation management but also to the maintaining of balanced production.

Discussion of Several Problems

1. Comprehensive Analysis of Variety Characteristics

Every variety has its advantages and shortcomings, and only when

all of the characteristics of a variety are understood can its advantages be properly employed. A concise analysis of several examples will be given presently. The yields of leaf vegetables such as Ipomoea aquatica, beets, and Amarantus mangostanus L. are as high as 4,000-5,000 chin per mou, and may sometimes reach a peak of 10,000 chin per mou. Cultivation techniques are simple, and the plants are very hardy; Ipomoea aquatica is flood-resistant, Amarantus mangostanus L. and beets are drought-resistant, and all are resistant to heat and heavy rainfall. However, the leaf vegetables also have their drawbacks, such as large fertilizer requirements, which create poor conditions for subsequent crops if crop rotation is not properly arranged. Therefore, it is necessary to arrange certain cultivation areas to increase the green leaf vegetable supply during August and September. If too great a quantity of these vegetables is planted, consumer requirements will not be met and vegetable production will suffer. Bean vegetables undeniably have many short-comings such as low yields and long growth periods, but most beans do not require much labor or fertilizer for good-quality crops welcomed by the consumers. In addition, the fertility of the soil after cultivation of bean vegetables benefits subsequent crops. If consideration is given only to one field and one crop, and the saving of labor and fertilizer, production increases on other plots, and promotion of increase in subsequent crop yields are neglected, it will be difficult to properly evaluate bean vegetables. If the advantages of some varieties are overemphasized and their shortcomings neglected, cultivation areas will frequently be improperly expanded. Conversely, if the shortcomings of some varieties are overemphasized and their advantages unheeded, the areas planted in such vegetables will be improperly decreased. Either result is inadvisable as far as increasing the level of vegetable yields is concerned.

2. Correct Estimation of Production Conditions

The rational arrangement of varieties is based not only upon a comprehensive understanding of variety characteristics but on the correct estimation of production conditions as well. Some production brigades follow other brigades in planting certain varieties of vegetables without making any proper selection, and as a result, production is decreased because of improper production conditions. Soil conditions, for example, are complex, and there are considerable differences in soil maturation. According to the experiences of old farmers, land planted in vegetables for less than three years is referred to as new vegetable plots; semi-new vegetable plots are those areas planted in vegetables for three to ten years; and old vegetable plots are those areas where vegetables have been planted for more than ten years. New and old vegetable plots differ considerably in regard to fertility. For example, one of two vegetable plots planted with autumn kohlrabi at Hu-chia-chai Production Brigade, Chin-p'u Farm, Chiang-wan Commune, Pao-shan Hsien in the suburbs of Shanghai, is a new vegetable plot which has been planted for only one year, and the other is a semi-new plot planted for five years. The per-mou yield of the new vegetable plot is only 1500 chin with the application

of 20 tan of night soil and 30 tan of hog manure, but the per-mou yield of the semi-new vegetable plot is 2300 chin with 20 tan of night soil. This indicates that a maturation process is necessary for a vegetable plot, and also that the number of years a plot has been planted and the fertilizer source must be considered in variety arrangement. The technical conditions of vegetable plots also differ. In production brigades with more old farmers and higher technical levels, high-grade vegetables may be properly cultivated, but in production brigades with many inexperienced farmers and low technical levels, high-grade vegetable cultivation can only be developed gradually through the course of raising cultivation techniques and accumulating production experiences. It can be seen that the change of production conditions must be gradual, as must the change of variety arrangement.

3. Proper Coordination of Land Utilization and Fertility

Variety arrangement is related to land utilization and fertility. The degree of land utilization should be raised if possible in order to satisfy current requirements. Moreover, the fertility of the soil should be maintained or raised to create conditions for the incessant increase of production. Recent years have seen considerable increases in vegetable field utilization in the suburbs of Shanghai, and though this has undoubtedly had a certain effect on the increase of annual per-mou vegetable yields, not enough attention has been given to land fertility. With the present scientific level, the main measures of maintaining soil fertility are the application of more organic fertilizer, rational crop rotation and cultivation, and the planting of green fertilizer crops or beans. All of these measures with the exception of the application of more organic fertilizer are related to variety arrangement. Furthermore, rational arrangement of crop rotation patterns falls within the scope of Chinese farmers' traditional experiences concerning the maintenance of soil fertility by crop rotation. For example, rotation of deep- and shallow-root crops prevents the depletion of nutrients in the topsoil caused by continuous cultivation of shallow-root crops. Alternate cultivation of leaf vegetables requiring more nitrogen and fruit and root vegetables requiring more potassium and phosphorus avoids excessive consumption of effective nitrogen in the soil which is the case when green vegetables are cultivated continuously. Rotating beans and other vegetables not only increases the supplies of nitrogen and calcium in the soil but also leaves considerable quantities of organic matter therein, improving the physical and chemical characteristics of the soil. That the arrangement of varieties is related to cultivation means that during the rotation of crops, proper overturning, sunning, and freezing of the soil are required. The frozen soil can be prepared for the planting of early-ripening eggplant, melons, or beans. The soil can be loosened after sunning and freezing to allow for conversion of nutrients, reduction of insect damage, and increasing the ventilation of the soil. These are advantageous to the growth of the roots, stalks, and vegetables.

EXPERIENCES OF THE MASSES IN RECLAIMING SALINE-ALKALINE
SOIL IN SHANG-CH'IU SPECIAL DISTRICT

Chung-kuo Nung-pao
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Honan's Shang-ch'iu Special District is a large, level plain formed by the deposition of sediments from the Yellow River. Nearly half of the soil in the special district is arenaceous or arenaceous-argillaceous. Streams criss-cross the district, drainage is not smooth, and underground runoff is also slow. The Yellow River to the north flows at ground level; the river water is constantly supplied to the special district through streams or as underground water. The district is situated in a semi-arid area; the evaporation quantity (annual amount from 1641.3 to 2069.1 mm) is more than double the amount of precipitation (from 525.3 to 964.9 mm annually). Under these conditions, water constantly ascends to the topsoil, so the saline content of the groundwater gradually accumulates on the surface of the ground, turning good soil into saline-alkaline soil. The several changes that the Yellow River has made in its course have also created many closed depressions in this area in which water accumulates readily. In addition, the water is shallow, and saline return easy. The old saline-alkaline soil is distributed in these depressions, and it is difficult to reclaim. In addition, since the area is dry in spring (April, May and June) and evaporation great, the saline accumulation is serious. The rainy season in July, August, and September leaches the saline content. The degree of damage caused by saline-alkaline soil is slight to medium. Only through proper agricultural measures can the productivity of the saline-alkaline soil be considerably increased. On the other hand, the climatic characteristics of alternate flooding and drought and the lack of effective water conservation control lead to unstable productivity on the saline-alkaline soil in this district.

The varieties of saline-alkaline soil in this area are complicated. Below, the saline-alkaline soils are divided into four types according to the experiences of the masses.

1. Slightly saline-alkaline soil, also called "Shui-chien," "Sha-chien," or "Hua-kou-chien," is distributed over large lowland areas. This soil contains many chlorine ions. The surface of the ground is greyish-brown and moist in appearance, and usually has a thin crust. The saline content of 6-cm solum is 0.2-0.3%; the saline content of the topsoil (5 cm deep) is around 0.5-2.5%. The activating characteristic of the topsoil saline content is high, so seedlings sown at the proper time bud easily but then find growth difficult. The masses say that "rain at hoeing time" is inadequate for the soil, but the salt can be suppressed by "four fingers [about two inches] of rain."

2. Solonetz, also called "Mien-chien," "Hsiao-chien," "Pai-mien-chien," or "Hsueh-hua-chien," distributed in higher depression areas or in areas with inadequate irrigation, contains more sulfate, has a deep water table, good drainage, and a deep layer of colloidal clay. In winter and spring a layer of tannin as loose as flour is formed on the surface. The water content in 60-cm solum is approximately 0.15-0.25%, causing light damage to crops.

3. Tile-crust solonetz, also called "Niu-p'i-chien," "Pai-pan-chien," "Pai-wa-chien," "Wa-chih-tzu-chien," "Shih-tzu-t'ou-chien," "Ch'en-chieh-chien," or "Yu-chien," is distributed mostly on secondary slopes. Its sodium carbonate (soda) content is higher than those of other soils, but there is no surface accumulation of alkali. A tile-shaped crust is frequently formed on the surface, and there is generally a firm layer of sediments beneath the cultivation layer. The saline content in 60-cm solum is approximately 0.1-0.2%; of the four types of saline-alkaline soil, this type has the lowest saline content, only 0.2-0.5% in the cultivation layer. Thus light crop damage results. Crust formation must be prevented to ensure seedling growth.

4. Black alkaline soil, also known as "Hui-chien," "Hei-chien," "Ma-niao-chien," or "Pu-hao-chien," is found mostly in the depression areas mixed with slightly saline-alkaline soil. The hardpan is usually in solum of less than 50 cm in depth. The surface of this soil has a reddish-brown surface and a crust with a high sodium carbonate content (0.04-0.07% in 20 cm solum). Crop growth is difficult, as the water content in 60 cm solum is 0.25-0.4%. This soil has the highest saline content of the four types.

MEASURES USED BY THE MASSES
TO RECLAIM SALINE-ALKALINE SOIL

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Accelerating Saline Leaching and Restraining Saline Return

1. Overturning and sunning of soil and accelerating of saline leaching: In order to meet insufficiencies of human and animal labor, summer plowing and saline leaching are conducted by the masses and water is left in the fields in summer in certain saline-alkaline soil areas to create good conditions for the sowing of wheat. According to experiences at Hsin-chuang, Ch'i-t'ang Production Brigade, Ch'eng-kuan Commune, Min-ch'uan Hsien, a 130-chin increase in per-mou wheat yield can be obtained by sunning and overturning saline and saline-alkaline soils. The income from one harvest is now more than that from two harvests earlier. If green fertilizer plants are grown on the sunned and overturned earth, the output increase will be even more significant. The method of leaving water in the fields for saline leaching includes sunning and overturning of the soil after wheat harvest. No harrowing is conducted after plowing, and the fields are plowed after each rainstorm. In the beginning, plowing is shallow, with the depth gradually increasing and then decreasing back to shallow plowing in order to create a gap between the overturned and deeper soils and thereby prevent saline return. Plowing is not conducted after the beginning of autumn due to the little rain at this time. Harrowing is conducted after rains to leave the field uneven for moisture retention for timely wheat sowing. In some cases, water ditches of different widths are plowed after the wheat harvest in order to hold the summer rain and promote saline leaching. The fields are plowed after each rain, and are plowed three or four times to make partition and water discharge ditches for desalinization of the soil. After the beginning of autumn, the soil is harrowed when it rains to keep it uneven for timely sowing.

2. Timely plowing and restraining of saline return: Barley and wheat can be planted on dry overturned soil and also on autumn crop fields in the saline-alkaline soil area. For rapid wheat-seedling growth, early sprouting and root growth, and increasing the saline resistance in winter and spring, early autumn plowing and deep plowing to loosen the cultivation layer and block the capillaries should be emphasized. With spring-sown crops such as cotton and sorghum, deep winter plowing, piling up snow in furrows, and leaving water in the fields for saline leaching must be stressed so that all of the seedlings will grow. Since the tile-crust solonetz, especially, has a surface crust 2-3 ts'un thick and non-salinified colloidal mud layer, black sand, or red sediments below 4-5 ts'un, all cotton seedlings next to water ditches will grow strong after deep plowing. Winter plowing of furrows is usually followed by spring harrowing to loosen the plowed furrows. The seeds are sown in the desalinized plowing layer to increase the rate of seedling growth. The masses have emphasized the problem of restraining saline return in plowing and harrowing. Slightly saline-alkaline soil is usually plowed deep and harrowed little or not at all in order to maintain field unevenness. The tile-crust solonetz is plowed deep and harrowed many times in order to prevent unevenness. Seeds should be sown in dry, not moist, solonetz. For black alkaline soil, seeds should be sown after furrows are opened, holes dug to change the soil, or fertilizer heavily applied to alleviate saline-alkaline damage. Prior to sowing, the soil compaction should be noted; as the masses say: "Plant in compacted soil, not loose soil." This means that within half a month before wheat sowing the land should not be plowed -- even when it rains, the land is harrowed, not plowed -- so that the soil above the seed layer will be loose and that below the seed layer compact. This prevents intensive evaporation and ensures seed water absorption for rapid and uniform seedling growth.

3. Crop rotation according to soil and seasonal characteristics: The two-year, three-crop pattern of rotation is usually adopted with alightly saline-alkaline soil (which the masses call "Sha-chien-ti" or "Shui-chien-ti"). In the first year the rotation pattern is wheat -- soybeans or *Clycine hispida* Maench var. -- sorghum, *Panicum miliaceum* L. (glutinous or non-glutinous), in the second year, the pattern is wheat -- interplanted corn -- sorghum, *Panicum miliaceum* L. (glutinous or non-glutinous). Cotton is usually grown in the tile-crust solonetz or medium black alkaline soil. The seedling survival rate is less than 50% in black alkaline and saline-alkaline soils, so the land is usually allowed to remain fallow in the summer and plowed at this time to retain water or saline leaching in order that the seedling survival rate in the autumn sowing be high. The system of crop rotation employed in the saline-alkaline soil area is not fixed; planting often fluctuates due to changes in weather. During the spring sowing period, for example, if not all the sorghum seedlings survive because of rainstorms, non-glutinous or glutinous *Panicum miliaceum* L. is planted in some plots. If this is also damaged by rainstorms, alkaline-soil millet is planted, or spring millet is planted again. Due to the difficulty of estimating the seedling

survival rate, sorghum and non-glutinous and glutinous Panicum miliaceum L. are sometimes sown together in the same field to take advantage of the proper sowing season.

4. Diligent hoeing of strips, especially after rains: As the masses put it, "If plowing is not conducted in the preceding season, crop growth in the next season will be poor"; "the soil should be overturned in the summer, and it is best to plow once more in autumn"; and "hoeing is the most important in saline-alkaline soil, even when there are no weeds." This shows that the masses have a high regard for secondary plowing. Especially during the seedling period when cotton plants are short, surface cover sparse, and evaporation intense, early and diligent hoeing can restrain evaporation and saline return and also raise the soil temperature for better plant growth. After rains, timely secondary plowing should be conducted to break the crust and capillaries. Cotton fields are usually given five to seven secondary plowings, until the cotton plants have covered the entire plot.

5. Other measures: Deep overturning in tile-crust solonetz; scraping saline from black alkaline soil or other heavily saline-alkaline soil; replacing the black alkaline topsoil with ventilatory sediments in order to improve the structure of the black alkaline topsoil and increase the looseness of the ventilatory sediments -- these are methods by which saline-alkaline soil may be improved. In other cases, ditches are plowed to lower the water table and restrain saline return. Although these methods are effective in reducing and preventing alkali, they nevertheless have their limitations. Their effectiveness can be exploited only if they are applied in accordance with natural conditions.

Seed Selection and Cultivation of Saline-Resistant Crops or Varieties

According to the complex characteristics of the local saline-alkaline soils, the masses have selected and grown many saline-resistant crops or varieties which may be planted in slightly saline-alkaline soil. Among these crops are sorghum, peas, and green lentils. Some other saline-resistant varieties such as Lagenaria vulgaris Ser., red-tasseled rice, cucumbers, san-pa white wheat, oily wheat, P'ing-yuan #50 wheat, barley, "Szu" cotton, "Tai" cotton, beets, Kochia scoparia Schrad., pumpkins, alkaline-soil buckwheat, alkaline-soil wheat, and black-tasseled and red-tasseled alkaline-soil millet can be planted in soil with relatively high saline-alkaline content. Tamarix chinensis Lour. and Ligustrum lucidum can be planted in highly saline-alkaline soil and virgin alkaline soil. The Second Production Team of Min-ch'uan-lin Farm has cultivated wheat (such as Hsu-chou #438 or Pi-ma #1) seven years in a row in saline-alkaline soil; seedling survival rate increased by 19.8-22.9% and per-mou yield by 138-140 chin. This proves that planting saline-resistant varieties in saline-alkaline soil has a significant effect in regard to yield increase.

Increasing Applications of Organic Fertilizer and Raising Soil Fertility

The process of gradual reclamation of saline-alkaline soil is also a process of raising the fertility of the soil. Analysis shows that the content of organic matter in the saline-alkaline soil in this district is less than one per cent, and that the nitrogen content is as low as 0.035-0.075%. As a result, the soil is infertile. The application of organic fertilizer, therefore, has a significant effect in regard to yield increase. However, there is a shortage of human and animal labor in this district, and thus it is difficult to make use of large quantities of animal manure. These conditions make it necessary to cultivate more green fertilizer crops. Historically, farmers of Shang-ch'iu Special District customarily utilized green lentils as green fertilizer. According to experiments conducted by scientific research departments, the utilization of Melilotus suaveolens Ledeb. as a green fertilizer crop in the saline-alkaline soil in this district will increase other crop yields by ten per cent. Rape turnips and Tecoma grandiflora, two plants recently brought into the area, grow well and should be planted extensively. How to rationally fit such green fertilizer crops into the local crop rotation system remains an important research problem, one awaiting solution by scientific research organs and related organizations.

Separation and Prevention of Saline to Promote Seedling Survival and Growth

The critical period of production in saline-alkaline soil is the period of seedling growth and the young seedling period. For example, although the period after wheat has grown is a time of vigorous saline return, if the saline resistance of wheat is high and the humus is also good, it is still possible to maintain wheat yield. In recent years, an abundance of experiences regarding how damage from saline and alkali to young seedlings may be avoided have been obtained by the peasant masses of this district.

1. Opening of furrows and sowing of seeds: Before sowing, the fields should be plowed so that there is a shallow ditch after every three furrows, the furrows being 1 ch'ih and 8 ts'un wide. Cotton seeds are sown in the furrows and fertilizer is applied. The saline content at the furrow bottoms is low, and the alkali ascends not to the furrows but to the strips between them. Thus seedling growth is facilitated. If several light rains follow sowing, the saline will flow into the furrows, damaging the young seedlings. This is another problem which must be dealt with.

2. Digging holes and replacing soil: For planting cotton (or other crops with wide row spacing such as pumpkins) in highly saline-alkaline soil, holes of 8 ts'un in diameter and 5-6 ts'un in depth may be dug and filled with good soil. Cotton, melons, or tree seedlings may be planted in this manner to ensure seedling growth. Chang Wen-pin

(1728 2429 1755) of Yen-tui Ts'un, Shang-ch'iu, used this method in 1955 to plant cotton on 32 mou of virgin alkaline land for a per-mou yield of 62.5 chin of unginned cotton.

3. Late spring sowing, early autumn sowing, and sowing when there is water in summer: In the experiences of the masses, since the saline-alkaline soil is cold and pasty, crops should be sown one season later on saline-alkaline land than on ordinary fertile land. Some regard late sowing as necessary because growth on saline-alkaline land is slow and inadventagous to wintering, while others hold that sowing is related to the law of saline return and perhaps to underground insects. In short, this problem must be further investigated to determine the underlying scientific basis.

4. Soaking seeds and accelerating budding and early seedling growth: This method has been adopted by T'ai-p'ing Hsiang and Kao-lou communes for wheat cultivation. The seedlings sprout one day earlier and are strong; output is increased by 11 chin compared to wheat not given budding acceleration treatment.

5. Increasing quantity of seed sown to facilitate seedling management: One of the experiences of the masses is that sowing quantity can be increased by 40-100% in planting cotton; the cotton seedlings grow easily with a greater percentage of erect upright seedlings.

6. Interplanted cultivation, mixed cultivation, and cultivation of more than one crop on a plot: The masses say, "Plant a variety of crops on alkaline soil in order to be rich." Planting any crops which can grow is very effective in regard to seedling protection and covering of highly saline-alkaline soil.

Opinions on Propagating the Experiences of the Masses

The experiences of the masses are effective measures which may be learned easily and rapidly. In ordinary years they develop saline-alkaline soil and convert slightly saline-alkaline land into good fertile land. But since the experiences of the masses deal only with saline suppression, separation, and transfer of the saline content rather than the total elimination of saline, resalinization is a constant problem. To solve this problem it will be necessary to build rational drainage and irrigation systems, especially the latter.

Under present conditions, however, agricultural measures should predominate in the reclamation of saline-alkaline soil, with water conservation measures playing a secondary role. The experiences of the masses must therefore be thoroughly summarized.

Many years of practice have shown that adapting to local and seasonal conditions is of prime importance in applying the mass experiences

concerning the reclamation of saline-alkaline land. For example, while deep overturning is required for reclamation of tile-crust solonetz, this measure cannot be employed for black alkaline soil. In areas where manure and animal labor are scarce, consideration should be given to the reclamation of alkaline soil by reducing the number of crops per year, sunning and plowing the soil in summer, retaining fresh water in the fields, and suppression of the saline. Otherwise, labor will be needlessly wasted. At the same time, however, agricultural measures should be regarded as primary, and the experiences of the masses propagated. In regard to local manpower and material supply conditions, moreover, water conservation measures should be actively adopted. Only thus can the mass experiences regarding alkaline soil reclamation exert a greater function.

ON PROBLEMS OF LARGE- AND SMALL-YEAR
LONGAN FRUITING

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Causes of Large- and Small-year Longan Fruiting

There are three different situations of large- and small-year longan (Nephelium longana Camb.) fruiting: large- or small-year fruiting in an orchard, in a hsien, or throughout an entire district; large- or small-year fruiting of individual trees or in individual groves in an orchard; and large- or small-year fruiting of one portion of the branches or of one-half of the crown of an individual tree.

Large- or small-year fruiting is caused by a multitude of different factors in combination. On a single branch of a longan tree, large- or small-year fruiting is caused by the biological characteristics of the sprouting branch. If an entire tree, an entire orchard, or an entire district is considered, large- or small-year fruiting is caused by undesirable climatic conditions and irrational artificial techniques and management.

1. Relationship between branch sprouting and fruiting characteristics and large-or small-year longan fruiting.

Longan trees bear a great number of small fruits. Trees with characteristics of crown fruiting may bear as many as 250 fruits on a single spike immediately after blossom withering. The 100-day period of fruit growth from May to September is also a period of vigorous branch growth. After sprouting of double cone inflorescence at the crown, no strong sprouting of lateral buds will occur. Young buds sprout after attaining apical superiority until the fruit is picked. Since the growth

period is too short, the branches cannot grow strong. Thus the branches sprouting after autumn picking cannot grow floral buds in the same year, and the tree will be barren the following year. According to our observations, most of the fruit-bearing mother branches of the longan tree are secondary and tertiary branches more than 30 centimeters long and over 8 millimeters in diameter. The size of the mother branches is determined mainly by the size of the summer branches and the number and quality of secondary summer branches sprouting on the spring branches. This in turn determines the quantity and quality of fruiting in the following year. As a result, the greater the number of blossoms on the tree in years of large-quantity fruiting, the fewer and the smaller the summer branches; nutrition branches are even fewer still. Since no mother branches are produced when nutrition branches do not grow well, the tree will bear little or even no fruit the following year. In addition, there are some individual trees whose blossoms and fruits have fallen off prior to the fruit-sprouting period for many years. In such trees, the growth of floral receptacles is incomplete, and most pistillate flowers are abnormal due to regeneration of style and early exposure of pistils. Normal fertilization is therefore impossible, and blossoms and fruits fall early.

2. Relationship between external conditions and large- and small-year fruiting of individual longan trees or groves.

The phenomenon of barren years in the longan tree is related to the tree's branching and fruiting characteristics. It cannot be said, however, that any of the branches of a single tree or of all the trees in a grove will bear fruit in a given year if the tree or trees do not sprout nutrition branches, nor can it be said that the trees will sprout nutrition branches but bear no fruit in another year. Even if such phenomena existed, they would not be normal fruiting characteristics.

The actual fruiting characteristics of the longan tree are that some of the branches will bear fruit and others will sprout nutrition branches in a given year, and that fruiting and branching are uniform in all years. According to experiments conducted by the author in Fukien, 32-50% of the branches blossom and bear fruit, even the branches sprouting in autumn after picking, if fertilizer and irrigation management have been emphasized and if there has been no freezing damage in the preceding year. Professor P.G. Hsi-t'e [transliteration] of the U.S.S.R. has said, "The rule of simultaneous reproductive and nutritional growth is a common biological characteristic of perennial ligneous fruit trees." But since the phenomenon of large- or small-year fruiting has existed a long time, some even consider it to be advantageous to management. In fact, the longan tree will bear a large number of fruit for one year, two to three years after a barren year, but the mean output of the tree is not high. Such variation from year to year is inadventagous in regard to the long-term maintenance of tree vigor. Those fruit trees with a certain proportion of reproductive and nutritional growth will provide stable

yields every year, which not only maintains the tree vigor but also provides for high mean annual output. In the orchards of Sha-wan Commune, Lu-chou Municipality, Yang Ch'uan-hsin (2799 0356 2450) and Yuan Fu-lin (5913 1381 2651), two old farmers with more than 50 years' experience in the cultivation of longan trees, have also proved this rule of longan fruiting through many years of production practice, observations, and comparisons.

That nutritional and fruit-bearing branches grow proportionally in longan groves and that the same crowns bear fruit year after year is easily discerned. However, this normal fruiting characteristic is difficult to maintain over a long period of time. Differences of large and small years will appear if management is less satisfactory and weather is poor. For example, strong mother branches which bear no fruit during one year should fruit the next. If freezing damage occurs during winter or spring, the entire tree will be barren. In the following year, both those branches that should bear fruit and those that were barren in the preceding year due to freezing damage blossom and bear fruit. The nutrition consumption during this year will be high, and in the next year there will be no nutritional branches for fruiting. The original equilibrium between simultaneous reproductive and nutritional growth will thus have been destroyed. In addition, such factors as irrational pruning, fruit picking, and fertilization may disrupt the balanced fruiting pattern and give rise to the phenomenon of a persisting cycle of large- and small-year fruiting.

3. Effects of poor weather on large- and small-year longan fruiting.

a. Radiation and cold damage in winter and spring: The mean temperature in the longan production area in southern Szechwan basically satisfies the temperature requirement of the crop. In normal years, longan trees winter safely. In some years, however, there occur radiation or cold damage, i.e., frost damage. The severe frost damage in 1955 not only caused an abrupt decrease in longan production in southern Szechwan but also killed many of the trees.

According to our observation, although longan blooming is varied, a common characteristic is that the pistillate flowers blossom in a short three-to-five-day period. The most effective time of pollination is one to three days, and since pistillate flowers blossom for only a short time, if there is continuous rain or cold weather in the late growing period, the rate of pistillate flower fertilization will be very low, especially for types whose pistillate flowers blossom first. The instability of the weather in the early growing period is inadventagous to cultivation. Therefore, longan trees whose pistillate flowers bloom early frequently suffer severe falling of flowers and fruits, resulting in a barren year.

b. Damage from yellow sand and white mud: In the production area of southern Szechwan, there is foggy, sultry weather in April and May, the period of longan blossoming. Yellow sand and white dust blow in from the northwest and accumulate on the leaf surfaces in quantities great enough to be seen with the naked eye. This "falling of yellow sand and white mud," as it is called by the local farmers, reduces the effectiveness of leaf photosynthesis, and the dust accumulating on the pistil stigma can dry the stigma secretion, thus hindering pollination and reducing the rate of fruiting.

c. Damage caused by hot, dry weather during the critical longan period: In the production area in southern Szechwan there is heavy autumn rain but little rainfall in spring or summer. In recent years, the weather has been extremely hot in spring and summer, and especially dry. At that time, the sprouting branches and leaves of the longan trees grow vigorously. It was hot in early summer, and the evaporation loss from the leaf surfaces was high. This is also the time of rapid growth for young fruits, which require considerable quantities of water. After water is lost from the newly sprouted branches and leaves, the cell density of the new leaves is high, and water is squeezed from the young fruits, which then fall from the tree. The quantity and quality of the branches sprouted in spring and summer are affected, and this makes the growth of fruit-bearing mother branches more difficult.

4. Effect of artificial factors on large- or small-year longan fruiting.

a. Irrational fertilizer application: Fertilizer is applied irrationally even in production areas with high levels of management. It is improper to employ the method of fertilizing orange trees to fertilize longan trees, or to treat trees sprouting many branches in small years and those with many flower spikes in large years but few leaves and branches the same. In some areas, only the fruit has been picked and no plowing or fertilizing have been done for many years. With such a low level of management, one year of fruiting is followed by several barren years, and the mean output of each tree is very low.

b. Crude fruit-picking techniques: Longan trees are tall, so usually the workers climb the trees to pick the fruit. This is no problem for those with experience, but inexperienced workers usually damage the branches, sometimes picking more than ten compound leaves along with the fruit spike and breaking many branches and cortical layers. The wounds dry in the winter, and there may be no sprouting of new branches for many years. Such withered branches considerably impair the vigor of the tree. Even if the large branches sprout new ones, these are weak and consume great quantities of nutrients. Only one or two years after growth of tender leaves and newly sprouted branches for the accumulation of nutrients does fruiting reoccur.

c. Improper tree spacing and crude pruning: Trees in production areas most commonly have dense roots. In longan groves in the vicinity of Sha-wan, Lu-chou Municipality, the spacing between roots is three to five meters. Due to longan tree branch growth, after more than ten years the tree crowns almost touch each other. The branches on the lower sides gradually wither, and shaded branches may not fruit at all. Longan trees planted too close together may often fruit only on the crowns or on a small portion of the branches, or even the entire tree may not bear fruit.

Although longan trees fruit readily on sunny branches, pruning branches beneath the surface layer and leaving only a thin crown layer is irrational. In heavy pruning, all of the branches whose diameters are close to three centimeters are cut and piled on the ground. But if sunlight can penetrate the surface layer even a little to reach the branches beneath, these will still bear fruit, and thus should not be completely pruned. Conversely, no pruning is conducted in other areas for many years. This results in withered branches all over the tree and stifles new branch growth, the tree crown becomes thinner and thinner and the tree will have a barren year.

d. Other factors: Falling of flowers and fruit due to insect damage, or improper concentration of sprayed chemicals or growth hormones which stunt the leaves and cause the tree to be barren for several consecutive years.

Methods of Preventing Large- and Small-year Fruiting

1. Prevention of frost damage: Smoking or spraying 10% lime solution on the crown can protect the tree against cold for small area, high output or excellent mother tree area. Large-area production should begin with the selection of orchard topography, i.e., open land or land near rivers. Depressed trough valleys should be avoided. Cold-resistant varieties should be selected. At present, the large-leaf-type longan in this area is a cold-resistant variety; "Yu-t'an-pen" and "Wu-lung-ling" of Fukien are also cold-resistant varieties. These varieties have been brought in for trial cultivation.

Strengthening annual management and maintaining strong longan tree vigor are basic measures of positive cold protection. The application of warm-characteristic organic fertilizer in winter can have an appreciable effect on both cold prevention and wintering.

2. Prevention of yellow sand and white mud: Fruit growers have adopted a method of spraying the tree crowns with water to increase the atmospheric humidity near the crowns, thereby avoiding the drying of stigma secretions and facilitating pollination. Yellow sand and white mud dust may disappear together with the water drops. The trees and leaves may also be shaken with a bamboo pole to remove dust, but this

method is relatively insignificant.

3. Protection against hot, dry summer weather: During vigorous growth of branches, leaves, and young sprouts in June, the coordination of irrigation and fertilization may have a significant effect in protecting the longan trees against hot, dry summer weather. Observations and research conducted by the Lu-chou Institute of Horticultural Research in 1959 show, that there are differences between trees of the same variety planted close to each other when compost is spread under the crown of one tree during the summer to provide a uniform supply of organic fertilizer and water, and when the other tree receives no water and fertilizer. Comparison of the two is made in the following table.

type	number of fruits on fruit spikes of 30 branches		average length (cm) of monopodial branch growth	average diameter (mm) of monopodial branch	in the branches			fibrous root sprouting
	total number of fruits	average number of fruits per spike			number of fruiting branches	number of branches from which fruits and blossoms have fallen	number of nutritional branches	
trees dressed with compost and irrigated	1,698	65.6	30.8	8.5	21	0	9	white new roots in topsoil
unfertilized and unirrigated trees	228	7.6	17.1	6.6	6	6	18	few new roots in topsoil

Longan trees dressed with compost and given sufficient water in early summer not only bear great quantities of fruit in the same year, but most of the branches, especially the summer branches, also grow large and become fruiting mother branches. In the following year, the trees continue to bear fruit, and new root growth is good. This has a considerable influence on continuous and relatively stable output and reduces the amplitude of large- and small-year fruiting. Trees planted on lower topography where the soil retains water in the summer have borne more fruit in recent years than those planted on higher ground where water and fertilizer are less plentiful. Old farmers Yang Ch'uan-hsin and Yuan Fu-lin of the orchards of Sha-wan Commune, Lu-chou Municipality, have acquired good experiences regarding the irrigation and fertilization of longan trees in early summer. They consider that postponing the pre-blossoming fertilization in the early spring until the time of seed-sprouting fertilization in early summer produces a much greater effect (pre-blossoming fertilizer should still be applied). In the orchards of Ho-feng Commune, Lu Hsien, there is a high-ld longan tree which, in addition to pruning and insect elimination, receives heavy applications of seed-sprouting fertilizer in early summer. Though this tree is 150 years old, its yield of fruit is greater than those of ordinary mature longan trees.

Shallow secondary plowing and weeding in summer also provide for the retention of water in the soil, relieving of drought, and are advantageous to growth and fruiting.

4. Improving methods of fertilization and pruning for individual treatment of trees with large- and small-year growth and fruiting characteristics: The application of secondary fertilizer (organic fertilizer and water) in the spring during a large year should be postponed until April, and the application of seed-stabilizing fertilizer (organic fertilizer and water) in the early summer should be moved up to early June. This will result in the simultaneous growth of a large quantity of summer branches and the bearing of a large quantity of fruit; in other words, an equilibrium between reproductive and nutritional growth will result. Advancing the application of autumn fertilizer to August promotes the early sprouting of autumn branches as well as the differentiation of floral buds at the end of a large year. After picking of fruit, delayed-effect organic fertilizer is applied in October and November to restore tree vigor for protection against cold in winter. Since tree vigor during the winter after a large year of fruiting is relatively poor, the tree is more subject to freezing damage. Thus pruning in a large year should be restrained as much as possible with no green-leaf branches receiving scattered light, but only those branches which are withered or damaged by insects being pruned. All available assimilation areas of the tree should be utilized for the accumulation of as great a quantity of nutrients as possible. A portion of the branches with low blossoming rates may be pruned in the summer of a year of large fruiting, because the number and quality of fruits are low on these branches, and there may

even be severe falling of flowers. Moreover, branches with low blossoming rates prevent those branches beneath them from becoming nutritional branches. Pruning of branches with low blossoming rates in the early summer does not cause a decrease in yield in a large year; it hastens the sprouting of strong summer and autumn branches. According to our experiments, most of the summer and autumn branches sprouting after pruning will blossom and fruit in the following spring. Pruning of spikes with low blossoming rates is different from and should not be confused with the thinning of flowers and fruits.

During small-year fruiting, the application of spring pre-blossoming fertilizer should be moved up to February or March in order to provide for the growth of a limited number of floral buds and strike a balance between reproductive and nutritional growth. Seed-stabilizing fertilizer applied in the early summer should contain abundant water for the leaves, branches, and young fruits to prevent water deficiency. It is especially important that a limited quantity of nitrogen fertilizer be applied to avoid excessively vigorous nutritional growth. A third application of fertilizer (delayed-effect organic fertilizer) in autumn may be made in September or October in conjunction with cold-resistant winter fertilizer. The nutritional growth during a small year is vigorous: four to five branch sproutings are possible in the longan tree, and the number of branches sprouted is also high. Thus less pruning is required in a small year than in a large year; shaded branches and interlaced branches left unpruned earlier may be pruned at this time. Buds should be removed in early summer to avoid excessive nutrient consumption resulting from an overabundance of nutritional branches. In short, comprehensive measures should be adopted in small years to preserve flowers and fruit.

5. Improving fruit-picking techniques: There should be no more than three to five leaves on picked fruit spikes. Branches should be broken smoothly near the dense leaf nodes to avoid damaging the bark or the large branches.

6. Selective breeding of varieties: The phenomenon of large- or small-year fruiting is not as marked with lichees as with longans because, since the former are picked earlier, the autumn branches sprouting in June and July after picking may become fruit-bearing mother branches in the same year and blossom and fruit in the following spring. Because longans are not picked until as late as September, it is difficult for the sprouting autumn branches to continue to fruit after picking. Early-ripening longan trees with simultaneous blossoming of staminate and pistillate flowers have been found in longan orchards, however, and these are picked about a month earlier than ordinary trees. If early-ripening trees are selected and bred to exploit early growth characteristics and allow for picking fifty days earlier, the early sprouting autumn branches may continue to fruit in the following year. Selective breeding of this early-ripening variety has been conducted. We have also found that the axillary buds of the middle and lower portions of longan trees with strong

horizontal branch growth will also sprout flower spikes. Twenty-six flower spikes have been counted on a single axillary bud. We plan to breed longan trees with such blossoming characteristics in order to surmount the problem of fruiting only in the upper portion of the trees and ultimately solve the problem of large- and small-year longan fruiting.

7. Preventing insect damage to longan trees: Reducing the quantity of falling blossoms and fruits due to insect damage is another measure of stabilizing yields and reducing the phenomenon of large- and small-year fruiting.

WHY THERE ARE "LARGE AND SMALL YEARS" OF FRUIT TREE YIELDS

Chung-kuo Nung-pao
(Journal of Crops)
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Fruit orchards produce abundant yields in some years but very small ones in years following great yields. These are known as "large and small years." Large and small years often alternate.

Why does a small year always follow a large year? Because embryo buds and floral buds begin to form one year before blossoming in many fruit trees. If a great number of floral buds are formed and growth is good, blossoms in the following year will be more numerous and the yield of fruit greater. Since most of the tree's nutrients are consumed by blossoming and fruiting in a large year, only a small quantity of nutrients is left for formation of floral buds when nutritional conditions are poor, and the following year will therefore be a "small year." Conversely, since little nutrients are consumed by flower blossoming and fruiting in a small year, floral buds are numerous and grow well. This satisfies the prerequisites for a high yield in the following year. Sometimes, however, accidental damage from severe cold, drought, or flood may affect floral bud growth or even kill the buds. In this case, there will be two small years in a row, and the sequence of large and small years will be reversed.

The lower the level of fruit-tree management, the more significant will be the difference between large and small years. On the other hand, if management is good, pruning rational, and the tree not overburdened in large years, the difference between large and small years will be reduced. Still, a better understanding of the secrets of floral bud formation and fruit tree growth processes is required if a fundamental solution to this problem is to be found.

ON DIALECTIC DIAGNOSIS AND TREATMENT IN
CHINESE TRADITIONAL VETERINARY MEDICINE

Chung-kuo Nung-pao
(Journal of Crops)
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Chinese traditional veterinary medicine has a long history and an abundance of experiences gradually developed from long years of actual treatment of veterinary diseases by the working people. This valuable heritage not only contributes a great deal to the people, but is also urgently needed by the masses.

The contents of Chinese traditional veterinary medicine are abundant, including yin and yang, the five primary elements, visceral conditions, nutrition, ch'i and blood, nerves and blood vessels, etiology, symptoms, diagnosis, and treatment. All these aspects have different characteristics both in theory and practice and require different techniques; together these form a uniform and comprehensive system of Chinese traditional veterinary medicine. Veterinary medicine is especially valuable in dialectic diagnosis and treatment, as it includes an abundance of theoretical knowledge regarding clinical diagnosis and treatment. There are two characteristics of the fundamental concept of Chinese traditional veterinary diagnosis: the general concept and the concept of dialectic diagnosis and treatment. This article will treat only the problems of the latter.

I. Definition of Dialectic Diagnosis and Treatment

Generally speaking, dialectic diagnosis and treatment is the fundamental method of clinical diagnosis and treatment in Chinese traditional veterinary medicine. Dialectic diagnosis and treatment have their different characteristics, but are closely related in clinical application. The so-called dialectic diagnosis is a method employing "four diagnoses"

and "eight principles" for systematic and comprehensive observation of sick animals to analyze their symptoms and determine their pattern for the basis of treatment. The so-called dialectic treatment, based on different courses of dialectically determined diagnosis pattern types and disease development, seeks correct treatment principles and methods for early cure.

II. Methods of Dialectic Diagnosis and Treatment

The methods of dialectic diagnosis and treatment in Chinese traditional veterinary medicine are essentially the same as those of Chinese traditional medicine. The main methods of dialectic diagnosis in Chinese traditional veterinary medicine are the application of "four diagnoses" and "eight principles." The so-called "four diagnoses" include "looking, smelling, asking, and feeling." Generally speaking, looking diagnosis encompasses the observation of the constitution, form, mouth, color, urine, and excrement of sick animals. Smelling diagnosis includes listening for sounds, smelling body odor, and smelling excrement of sick animals. Asking diagnosis means asking the owner of the animal about the disease; feeling diagnosis means taking the sick animal's pulse and noting other variations. The so-called "eight principles" include "yin and yang, external appearance and internal condition, cold and fever, and empty and full," all principles of diagnostic classification. The disease situation and symptoms understood from the "four diagnoses" are analyzed and deduced by means of the "eight principles" in order to determine the etiology, disease characteristics and focus, progressiveness of the disease mechanism, and whether normal or evil are strong or weak for the purpose of making a correct decision in regard to treatment.

The "four diagnoses" are obviously a concrete method of understanding the symptoms, and the "eight principles" are theoretical guides for analysis of the disease situation. However, if only the four diagnoses are relied upon to understand the disease situation and the eight principles are not used for analysis and deduction, it will be impossible to control primary and secondary factors and distinguish between real and false causes in complicated illnesses. Therefore, the four diagnoses are closely related to the eight principles in what is essentially a combination of theory and practice.

Methods of dialectic treatment are also very complicated. These include not only the ordinary eight treatment methods and various combinations thereof, direct and indirect treatment, and basic and temporary treatments, but also many different treatment methods employed under different conditions against the constant development of the disease. Animal diseases may not only be etiologically complex but may also have a wide variety of symptoms. In many cases, similar symptoms are due to different disease causes, and different symptoms may result from the same cause. With cold and heat symptoms, the same cold symptoms can be

divided into surface cold, internal cold, empty cold, and full cold. The same heat symptoms may likewise be divided into external heat, internal heat, empty heat, and full heat. Conversely, the same cold symptoms may sometimes have heat symptoms (false heat but real cold), and the same heat symptoms may sometimes have cold symptoms (false cold but real heat). Since the constitution of the sick animal may be either strong or weak, evil or normal, with differences in internal and external causes, the same disease will not necessarily manifest identical clinical symptoms each time. Thus mastering and applying the rules of dialectic diagnosis and treatment in clinical treatment is of cardinal importance.

In employing the dialectical diagnosis and treatment method it is first necessary to differentiate yin and yang, external and internal, cold and heat, empty and full, basic and temporary, primary and secondary, and serious or chronic factors of animal diseases. If there is sickness of the yin and blood but not of the yang and ch'i, vigorous yang can weaken the yin. Conversely, if there is disease of the yang and ch'i but not of the yin and blood, vigorous yin can restrict the yang and ch'i. If the disease is external, the internal disease foci should not be treated, because external evil may enter the body due to emptiness. If the disease is internal, the external foci must not be treated, because this will cause emptiness, leading to much perspiring and destruction of the yang. If there is external cold, pungent and warm herbs should be administered. If there is internal cold, pungent and cold herbs or salty cold herbs should be administered to drain off the internal cold. Tonics should be administered for empty symptoms: yin tonics for empty yin, yang tonics for empty yang, etc. Draining treatment should be given for full symptoms, i.e., draining of viscera for full viscera, draining of bowels for full bowels. As for basic and temporary, primary and secondary, and severe and chronic disease factors, the disease source is the primary factor and the complication the secondary factor; normal ch'i is the basic factor and evil ch'i the temporary factor. Treatment of temporary or basic factors depends on which is the most serious. If basic and temporary factors are all urgent, they should be treated together.

In addition, the occurrence and development of animal diseases not only have different transferring causes but are also closely related to the surrounding environment. Therefore, every disease has different transferring causes, or varies constantly with the environment, manifesting complicated symptoms. In order to correctly diagnose and treat these complicated diseases it is necessary to note the season, climate, and region of the onset of the disease as well as the sex and conditions of nutrition, mouth, and teeth of the sick animal during diagnosis. Through comprehensive and systematic observation and analysis the various rules of variation and development of diseased animals should be mastered in order to provide different treatment methods for different disease situations. Only if this is done can treatment expect to be efficacious. This is the basic method of dialectic diagnosis and treatment in Chinese

traditional veterinary medicine.

In short, the methods of dialectic diagnosis and treatment in Chinese traditional veterinary medicine are not isolated or divorced from the overall concept. The true nature of dialectic diagnosis and treatment in Chinese traditional veterinary medicine means not only observing the animal or treating the disease exclusively, but relating the animal disease on the one hand and infection situations such as season, climate, and region on the other. Not only the internal entity of the animal body but also the close relationship between the external environment and the animal disease may thus be clearly understood. Actual conditions provide reliable and objective reference data for dialectic diagnosis and treatment.

III. Significance of Dialectic Diagnosis and Treatment in Clinical Practice

Since dialectic diagnosis and treatment cannot be divorced from the concept of entity, the treatment of the disease must be accompanied by relating the internal cause of the veterinary disease on the one hand and factors of the external infection environment such as season, climate, and region on the other for comprehensive and systematic observation and analysis of symptoms prior to treatment. This indicates the uniqueness of the diagnosis and treatment system of Chinese traditional veterinary medicine. Dialectic diagnosis and treatment also places special emphasis on symptom characteristics, advocating the correct principle of similar treatment for different diseases with similar symptoms and different treatment for similar diseases. Experience proves that although there are different etiologies and symptoms, in the treatment principle, herbs to warm the nerves and remove cold should be considered as primary in the treatment of similar cold symptoms. For cold in the spleen and stomach, regardless of the cold symptoms or etiology, regardless of whether there is external or internal infection of cold yin, and regardless of whether symptoms are diarrhea or abdominal pain, a satisfactory effect may be obtained by following a treatment principle of administering herbs for strengthening the spleen, warming the stomach, and removing the cold. In the case of similar treatments for different diseases, there are different etiologies and symptoms for empty spleen and empty lungs, but good treatment effect may be obtained by using tonics such as pu-chung i-ch'i (body- and ch'i-nourishing) powder or shih-ch'uan ta-pu (perfect tonic) powder. The treatment method for empty lungs is "nourishing of 'earth' to grow 'metal.'"

Sometimes, however, different methods are used to treat similar diseases. With coughing of phlegm or diarrhea in a horse, there are different etiologies with symptoms of coughing of phlegm. In normal clinical practice, coughing of phlegm may be caused by lung heat or pulmonary tuberculosis. If the pulse is irregular, the mouth a bright red color, and the coughing sound distinct, after infection, lung heat is

indicated. Herbs which clear the lungs and reduce heat should be used, as coughing of phlegm can be stopped after removing of heat. If the sick animal has a slow and indistinct pulse, white mouth, emaciated body and low coughing sound with phlegm, pulmonary tuberculosis is indicated. The main treatment is the administration of pu-hsu li-fei (empty tonic for clearing the lungs) powder to fill the lung ch'i and stop the coughing of phlegm. For equine diarrhea there are similar symptoms but different causes. In ordinary clinical practice, there are cold diarrhea and yellow bowel (heat diarrhea). If the sick animal has a slow pulse, pale yellow mouth and watery stools, cold diarrhea is indicated. If the sick animal has irregular pulse, bright red mouth, and malodorous excrement, yellow bowel is indicated. The cold diarrhea should be treated with chien-p'i (spleen-strengthening) powder. The heat diarrhea may be treated with wei-chin (azure metal) powder.

The same principle is applicable in treating simple diseases. Since there are different transferring processes from the occurrence and development of a disease and these causes are affected by the external environment, methods of treating similar diseases are different. For example, during the initial stages of a cold infection a horse will have fever, irregular pulse, and bright red mouth. These symptoms indicate the presence of external disease evil, so pungent and cool herbs such as ma-hsing (Cannabis sativa L. and Prunus armeniaea L.) powder should be administered. Symptoms such as high fever, dry mouth and tongue, constipation, and a small quantity of reddish urine indicate the deep penetration of the disease evil; so t'ou-hsia (releasing) drugs such as ch'eng-ch'i (ch'i-receiving) powder should be employed for treatment. If the disease evil is neither external nor internal but in the middle, the symptoms will be mostly alternate cold and fever, chest and rib pains, weak pulse, and bright red or pale yellow mouth. These symptoms indicate a semi-external, semi-internal disease, so harmonizing herbs should be administered, generally with ch'ai-hu (Bupleurum falcatum L.) powder. The above-mentioned are only ordinary examples of clinical dialectic diagnosis and treatment in Chinese traditional veterinary medicine.

In addition, in examining symptoms, particular attention should be paid to the real or false disease cold or heat and to some special and complicated situations in the treatment process. With cold and heat symptoms, in ordinary disease situations, the dialectic diagnosis and treatment method may be used as a basis for correct diagnosis and treatment. However, when the disease situation is complicated, carelessness will lead to confusion and misdiagnosis. We have previously encountered cases whose symptoms -- fever, thirstiness, dry excrement, and salivation -- were indicative of heat, but through comprehensive and systematic observation and analysis of such symptoms as thirstiness without drinking, dry excrement, salivation but no odor, slow pulse rate, pale yellow mouth, emaciation, drooping abdomen, and gaunt appearance, the diagnosis was in the end cold disease (ascites), not heat disease. This is real cold but false heat. Herbs for strengthening the spleen, warming the

kidneys, and nourishing the kidneys and yin, such as tang-kuei huo-lo (Ligusticum acutisilobum S. & Z. for activating the blood vessels) powder should be administered. The fever will recede after the spleen is strengthened. If the disease is misdiagnosed as heat disease and bitter cold and salty cold herbs administered, the animal's condition will deteriorate and death may result. On the other hand, we have also encountered some cases of real heat but false cold. Heat and pain in a horse sometimes resemble the symptoms of cold disease: the sick animal has a cold and shivering body, stiff limbs, backache, and remains lying down most of the time. But after repeated comprehensive observation and analysis, it was found that the sick animal had an irregular pulse rate and bright red lips and tongue, symptoms of heat disease. We consider the cold and shivering body and stiff limbs to be due to intensive internal heat which obstructs the yang and ch'i. The external appearance revealed false cold symptoms. As this "vigorous yang obstructing yin" is a dangerous symptom in the progressive stage of heat disease, herbs to clear the heart, relieve heat, and nourish the kidneys and yin should be administered, generally with hsiang-ju (Elsholtzia patini Garcke) powder. Excessive administration of pungent and cool herbs is not advisable.

Although there is a certain distinction between empty and full symptoms, there often occur phenomena of real emptiness and false fullness, or vice versa, i.e., the so-called "thin symptoms with complete fullness and symptoms with extreme emptiness." These symptoms are the manifestations of numerous phenomena caused by extreme sickness, such as real cold and false heat, and real heat and false cold. Chinese traditional veterinarians should pay attention to these diseases. For example, constipation is frequent among old donkeys and thin horses, and especially frequent among old and thin donkeys. The symptoms are often temporary fever, dry mouth, furred tongue with yellowish-white color, dry excrement, difficulty in moving the bowels, and small quantities of yellow urine. These are phenomena of full heat symptoms. By repeated observation and analysis, it will be found that the sick animal has a slow pulse rate, pale yellow mouth, and very weak and emaciated body. We consider such constipation to be caused by cold viscera and empty ch'i; this is not a full heat disease. Ch'i and blood should be nourished to strengthen bone and sinews. Nourishing the stomach and bowel with administration of ch'i-shang (seven-injury) powder to which honey has been added will provide for a significant treatment effect. If the full and empty symptoms are not distinguished and bitter cold and salty cold herbs administered, the disease will grow more severe, with more and more draining and emptiness.

Another example is stiff neck in a horse caused by external infection of cold. The diseased animal has such symptoms as difficulty in lowering the head, difficulty in turning the neck, and emaciation. From an etiological standpoint, the external evil penetrates first into the skin and muscles of the animal, and then into the nerves and blood vessels. This is a transferring role for the occurrence and development of this

disease. At this time, the diseased animal not only has the above symptoms, but also a gradual loss of appetite and weakening. This is a manifestation of vigorous evil ch'i but empty normal ch'i. These cause both the disease and the emptiness with an appearance of the so-called "thin due to full" symptom. In this instance, we should distinguish between the emptiness and fullness of the disease and avoid being fooled by the false emptiness. Herbs which dissipate cold and activate the nerves and blood vessels, such as lien-ch'iao (Forsythia suspensa Vahl.) powder and tang-kuei huo-lo powder, should be given. If the disease is misdiagnosed as an empty disease, the administration of tonics will make the disease worse and possibly fatal.

In diagnosis there sometimes occur cold symptoms which are not ameliorated but intensified by the administration of warm drugs, and also heat symptoms which do not recede when cool drug treatments are given. In dealing with such especially complicated diseases, we have applied the methods of dialectic diagnosis and treatment to conduct repeated observation of the sick animal, analysis, and deduction to finally determine the disease causes. Generally speaking, it is useless to administer warm drugs for cold symptoms; these are due to insufficient blood in the heart, so the heart should be nourished to produce more blood. If applying cold drugs for heat symptoms proves ineffective, the yin should be nourished, as heat symptoms indicate insufficient kidney fluid. As Yuan-heng Liao-ma Chi (The ABC's of Horse Treatment) puts it, "Blood should grow in the heart before cold is eliminated, and kidney fluid should be nourished for removing heat." Practice has proved that the methods of dialectic diagnosis and treatment of Chinese traditional veterinary medicine are a valuable scientific heritage. They are not only theoretical guides for Chinese traditional veterinarians in clinical diagnosis and treatment, but are also the essence of their experiences.

HSIANG-YU AND CH'IEN-SUI-TZU [OTHER NAMES FOR PEANUTS] --
A DEBATE WITH WAN KUO-TING (5502 0948 7844)
FROM "THE HISTORY OF PEANUTS" TO THE MIGRATION OF POTATOES

Chung-kuo Nung-pao
(Journal of Crops)
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Wan Kuo-ting's article entitled "The History of Peanuts," appearing in the No. 6-1962 issue of this journal, stated that "in the Ming dynasty, the peanut was called hsiang-yu, and Wang Sheng-tseng (3769 4164 2582) included the peanut in his book Chung-yu Fa (Methods of Planting Hsiang-yu), which he wrote around the year 1530." I consider it debatable whether or not the hsiang-yu was actually the peanut at that time. In Nung Cheng Ch'uan-shu (Agriculture and Administration), written by Hsu Kuang-ch'i (1776 0342 0796) in 1628, the hsiang-yu was mentioned in conjunction with methods of planting taro. In chapter 27 of this work, on horticulture, Hsu wrote: "The hsiang-yu looks like the t'u-tou (Dioscorea sativa L.) and has a good flavor The t'u-yu is also called t'u-tou or huang-tu; it grows on tendrils, has leaves like bean leaves, round roots like eggs, yellow skin, and a white tuber. The t'u-yu may be steamed or boiled." In the early years of the Ch'ing dynasty, Ch'en Fu-yao (7115 2105 2280) wrote in his book Hua Ching (Gazetteer of Flowers), around 1688: "The peanut, also called hsiang-yu, has small white flowers growing from the leaves. When the flowers fall, the root is fully grown. . . . At the end of winter, the hsiang-yu may be dug up, boiled and eaten." Thus I consider that hsiang-yu may possibly have grown small white blossoms during the seedling stage, but did not bear fruits. The misconception that "the flower became a full-grown root when it fell to the ground" was no more than a superstition. In some areas, peanuts are called "lo-hua-sheng" (literally, "falling flower leading to growth"). (Author's note: The peanut has yellow flowers, and after blooming the ovary falls to the ground to grow into a nut.) However, the quote "The root is as round as an egg; after it is dug up it may be boiled

and eaten," makes no mention of removing any shell. Thus we know that the hsiang-yu of that time was not the peanut. In Chih-wu Ming-shih T'u-k'ao (Illustrated Gazetteer of Plants), Chapter 6, Vegetables, written by Wu Ch'i-chun (0702 0366 3449) in 1848, the potato was given the name yang-yu. Wu mistakenly considered yang-yu to be huang-tu. From these writings it is evident that hsiang-yu, t'u-tou, yang-yu, or even huang-tu were other names for the Solanaceae potato and not the Leguminosae peanut. Wu also mentioned the distribution situation of the potato in addition to its botanical characteristics and the method of boiling it. We wrote: "There are potatoes in Kweichou and Yunnan In Shansi, potatoes are grown in fields and have large roots and white flowers; these are usually called shan-yao-tan large areas near Chung-nan and Shan-min are planted in potatoes; some well-to-do farmers can harvest hundreds of piculs annually." This is evidence that potatoes were widely cultivated in East China.

Thus we know that the potato was brought into China after the Ming dynasty. Following the invasion of China by the imperialist nations, the colonialists, especially the missionaries, brought potatoes to China. During the middle of the Ch'ing dynasty, large areas came to be devoted to potato cultivation.

As for the history of the peanut, some say that the peanut was brought into Kwangtung from abroad around the end of the Sung dynasty or the beginning of the Yuan dynasty. Others say that it was brought into Fukien and Kwangtung from islands in Southeast Asia during the Ming. According to scholars' research, the ancient name for the peanut was ch'ien-sui-tzu*. This name appeared for the first time in San-fu-huang-t'u (Atlas of Local Products). During the Southern Sung dynasty, the ch'ien-sui-tzu was briefly described in Kuei-hai Yu-heng-chih (South China Gazetteer) (1175) and Ling-wai Tai-ta (Questions and Answers on the Area South of the Wu-ling Mountains) (1178). Part II of Nan-fang Ts'ao-mu-chuang (Plants of South China), written during the Western Chin dynasty by a person using the name Chi Han (1518 0698), stated that "ch'ien-sui-tzu grows out of the soil with tendrils; the seeds are in the roots, with green root hairs. A bract usually contains more than 200 nuts whose shells are pale yellow. The nut inside the shell tastes like the chestnut. When dried, the shell and nut separate, and the nut rattles when shaken. Ch'ien-sui-tzu are grown in Vietnam, as is Jou-tou-k'ou (Myristica fragrans Houtt.)." According to the description, the characteristics of this plant are identical to those of the peanut. San-fu-huang-t'u describes how in the sixth year of the Yuan-ting reign of Han Wu-ti (111 B.C.) Vietnam was invaded and the Fu-li Palace constructed for planting the strange plants brought back from Vietnam, among them ch'ien-sui-tzu.

* From Hsin Shu-fan (6580 2885 1581): Wu-kuo Kuo-shu Li-shih ti Yen-chiu (Research of the History of Fruit Trees in China), page 114, and Wu Te-lin (0702 1795 6775): "Notes on Plants of South China," Tsai Chih-wu Hsueh-pao (Journal of Plant Cultivation), No. 1-1958.

According to this report, peanuts were first planted in China over 2,000 years ago. Ancient relics excavated at Hsiao-ho Mountain in Hangchow, Chekiang, in 1958 contained the seeds of various crops, including peanuts. These ancient relics were possibly neolithic, and thus China might have been one of the original peanut-producing areas. However, information on the history of the peanut in Southeast China is lacking, and the history of peanut cultivation must be studied further.

AGRICULTURE IN GUINEA

Chung-kuo Nung-pao
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The Republic of Guinea, a country of beauty and bountiful resources situated in the western portion of Africa near the Equator, is bordered by the Atlantic Ocean on the west, Ivory Coast on the east, Senegal and Mali on the north and northeast, and Sierra Leone and Liberia on the south. The area of the Republic is approximately 245,000 km². The topography of Guinea is high, with dense forests and many rivers. The well-known rivers in western Africa such as the Gambia, the Senegal, and Niger originate in the mountains of Guinea. The Republic is long in the latitudinal and short in the longitudinal direction. The north-eastern and southeastern portions are plateau areas; the central portion is mountainous and hilly; and the western portion is an area of hills and plains. The population of the Republic is approximately 2.7 million, of which 92 per cent are farmers. The arable land of the Republic totals approximately three million hectares, or about twelve per cent of the total area, for an average of 1+ hectare per capita. One million hectares of the Republic's arable land are under cultivation, for an average of 0.4 hectare for each person.

Natural conditions in Guinea are suited to agricultural production. According to meteorological records, the annual mean temperature is 26.3°C; the maximum difference in monthly mean temperature is 4.7°C; the absolute maximum temperature is 35.5°C; and the absolute minimum temperature is 17.2°C. Since the Republic is near the Equator, it has a summer climate the year round. Morning and evening temperatures are mild; it is hot at noon, and there is plentiful sunshine. Under such climatic conditions, ordinary plants and crops may be grown throughout the year.

Since Guinea is affected by the hot Sahara winds and the Atlantic climate, it is hot with abundant rainfall, which averages more than 2,000 millimeters annually. However, there are considerable regional differences in rainfall: the annual rainfall in some regions is above 3,000 millimeters, and in others, about 1,500 millimeters. The rainfall distribution is uneven, and thus there are rainy and dry seasons. In most areas, the rainy season is from April to November, and the dry season from November to March. Characteristic of rainfall during the rainy season are numerous thunderstorms and abrupt changes from rainy to sunny weather or vice versa. The dry season is characterized by low rainfall, high temperatures, and dry atmosphere. According to data from the Macenta forest area, the annual rainfall is 2,416 millimeters. There are eight months during the rainy season when the monthly rainfall ranges between 133-528 millimeters. During the four-month-long dry season, total rainfall is only 67 mm. Since the rainfall is concentrated and the dry season long, under the present lack of water conservation facilities, planting and harvesting of crops is carried out mostly during the rainy season. The harvest is generally completed during the dry season.

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The Republic of Guinea may be divided into four regions according to topography and product distribution: Lower Guinea, Central Guinea, Upper Guinea, and the forest region.

Lower Guinea, situated in the western portion with an area of approximately 35,000 km², is mostly plains. The topography of the region is low and level, and the soil is fertile. The main crops in this region are rice, corn, peanuts, bananas, and pineapple. Central Guinea, located in the central portion of the Republic, is mountainous and hilly, with elevations of between 600 and 1,000 meters. The region has an area of more than 80,000 km², and mostly upland crops such as African millet, yams, peanuts, and oranges are grown here. Upper Guinea, with an area of more than 60,000 km², lies in the east. The major agricultural crops in this plateau region are rice, peanuts, yams, and oranges. The forest region, located in the southeastern portion of the Republic, has an area of more than 50,000 km². Most of the region is covered by expanses of dense forests; elevations range generally from 500-1,200 meters. Here there are many basins and small intermontaine plains where rice, peanuts, yams, coffee, bananas, pineapple, palm seeds, quinine sulfate, and livestock are produced.

As mentioned above, the main food crops of Guinea are rice, African millet, yams, potatoes, corn, and peanuts. The area planted in these crops comprises approximately 80% of all cultivated land. The economic crops -- bananas, pineapples, oranges, coffee, palm, and coconuts -- will be described in the following.

Rice is the main staple of Guineans. The area devoted to rice cultivation is approximately 300,000 hectares, two-thirds of which are planted in upland rice. Since natural conditions, sowing periods, and methods of cultivation differ, differences in unit yield are considerable. Unit yields range from a high of 1,700 kilograms to a low of 500 kg, usually averaging 700-800 kg. Methods of cultivating upland rice observed by the author in the Macenta area include the use of shell tools or spades to loosen the soil prior to sowing, or the use of tractors for plowing. The sowing period ranges from April to June, with approximately ten chin of rice per mou being hand-sown. Field management during the period immediately after sowing consists of keeping birds away from the fields and one weeding when the seedlings reach a height of 6-8 ts'un. Sometimes the fields are weeded twice, and fertilizer is normally not applied. Harvest may be begun at any time from August to November.

The main area of African millet production is Central Guinea. In cultivation, certain areas of land are allowed to remain fallow each year. The millet is sown in May and June and harvested in September and October. Yield is 300-700 kg per hectare.

Yams are woody plants and one of the main staples of the populace. The root tubers of yams contain much starch, and may be eaten either raw or cooked, or they may be dried and ground into powder. Yams are commonly cultivated in mountainous areas, where stem grafts have a high survival rate. Yams are generally planted during the period from April to June and harvested -- either once or several times -- from September to October, yield is 15-20 tons per hectare. Planting of sweet potatoes and potatoes is scattered. The sweet potato cultivated has a white core and yellow meat. The sweet potato seedlings are planted in February, transplanted in April or May, and harvested in September or October; yields are around 15 tons per hectare.

Peanuts, one of Guinea's agricultural exports, are planted throughout the Republic. This crop may be planted on level ground or on slopes or hillsides. Peanut varieties are the tendril growth and upright cluster varieties. In the latter, the nuts are smaller and have a high oil content, and the skin is reddish-purple. Peanut growing is quite popular. Peanuts are generally grown one or two years after upland rice or yams, being sown during the period from March to May in holes or broadcast. The early harvest is in June and the late harvest in September or October. Yields range from 500-1500 kg per hectare.

Coffee is another of Guinea's important agricultural exports, and is also a favorite drink of Guineans. Major coffee-producing areas are in the forest region, but the crop is cultivated in other areas as well. The coffee trees are planted in the forests, as the tall trees provide shade for the coffee plants and allow for the best growth. Coffee varieties cultivated are mostly the large bean variety which produces a strong flavor. The coffee harvest begins in November or December,

with yields being 700-800 kg per hectare. The annual output of coffee beans is 20,000 tons, most of which is exported. Thus coffee ranks as Guinea's greatest agricultural export.

The annual output of bananas is approximately 75,000 tons. Pineapples are commonly grown, and palms are cultivated mainly in the coastal and forest areas. These are also among Guinea's important agricultural exports.

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Pastures are thick in Guinea, especially in the natural grazing areas in the mountains, because of the country's abundant rainfall. This is advantageous to the development of animal husbandry. Sheep and cattle herds are often seen along the highways; in fact, sheep often block motor transportation. Most Guineans are Moslems, and most of the sheep and cattle are raised for food.

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One crop a year is usually grown in Guinea, and in many areas fields are still allowed to lie fallow in alternate years. In some areas, crop rotation is practiced. Crop rotation patterns seen by the author were the following:

First Year	→	Second Year	→	Third Year
upland rice	→	peanuts	→	upland rice
yams	→	yams	→	peanuts
upland rice	→	fallow	→	upland rice

The peasants regard peanut cultivation and leaving the land fallow as good methods of maintaining soil fertility.

The following three forms of agricultural management are employed: management by individual farmers, plantations with hired labor, and state-operated farms. Ninety per cent of the farming households engage in individual management. Agricultural production cooperatives, now being established in various areas, are organized by volunteer farmers for collective exploitation of virgin land under government approval. The state provides material and economic support to the cooperatives. More than twenty agricultural production cooperatives have been organized in the Macenta Administrative District. The state-operated farms employ machinery for large-area cultivation, but at present these farms are few. We visited a mechanized farm in the Macenta area which utilizes large tractors to cultivate more than 100 hectares of upland rice and obtain yields 50-100% greater than those from manual cultivation.

* * *

Guinea's potential for agricultural production is great because of her excellent natural conditions and vast reaches of fertile land as well as the diligence of her people. By either increasing unit yields, expanding the cultivated area, or increasing the number of crops per year, the crop output can be considerably raised. The former French colonialists ruled Guinea for more than 60 years, ruthlessly exploiting and plundering the people and profiting enormously. Thus Guinea is poor and backward. Agricultural cultivation is crude, unit yields low, and the country is not self-sufficient in grain. In 1958, the Guineans gained their independence by driving out the French colonialists. Following independence, the government nationalized the land and forbade land transactions. The government also made loans to the peasants, provided means of production, and vigorously supported production. It may be expected that agriculture in Guinea will achieve significant development in the future.

HOW TO ESTIMATE WATER CONTENT OF SNOW

Chung Kuo Nung-pao
(Journal of Crops)
12 (260) 1962, page 30

It is common knowledge that snow melts into water, and that the quantity of water can directly affect spring plowing. How much water can be obtained from a given amount of snow? According to meteorologists' research, the density of newly fallen snow is 0.05-0.1 the density of water. In other words, ten or twenty centimeters of snow will melt into one centimeter of water. Snow passes through a series of changes after falling, and is affected by climatic and environmental conditions. After about five days, the snow becomes much more compacted, having a density of approximately 0.25. In other words, ten centimeters of such snow would be equivalent to 2.5 centimeters of water. Snow is often preceded by a fall of soft hail whose density is greater than that of snow, being about 0.75. In other words, ten centimeters of soft hail will melt into 7.5 centimeters of water.

NUNG CHENG CH'UAN-SHU (AGRICULTURE AND ADMINISTRATION)
BY HSU KUANG-CH'I (1776 0342 0796)

Chung-kuo Nung-pao
(Journal of Crops)
12 (260) 1962, pages 31-33

Wan Kuo-ting
(5502 0948 7844)

Hsu Kuang-ch'i (1562-1633) was an outstanding agriculturist in China's history as well as a forerunner of modern science and a patriotic statesman. This year, 1962, is the 400th anniversary of his birth.

Hsu kuang-ch'i was a native of Shanghai who passed the official examinations. He was a talented and knowledgeable intellectual. During middle age, he made contacts with Western science, enthusiastically studying astronomy, mathematics, and calendric calculation. He was a leader in the modification of calendric calculation, made instruments, and translated many books on astronomy and calendric calculation. Hsu emphasized agriculture and water conservation to a great extent. For defense requirements, he studied military intelligence and trained soldiers, and also took part in the defense of Peking. Generally speaking, the things he emphasized after middle age can be grouped into three major categories: warfare, agriculture, and modification of calendric calculation. He said that "Economy should be emphasized to make the nation wealthy, and warfare must be stressed to make the nation strong."

The reason for his giving special emphasis to agriculture was that he inherited a wealth of Chinese traditional farming theories which pointed out that farming is a must for strengthening the national defense. Since childhood Hsu had also been close to agricultural production and had suffered from famines. At the time when he received appointment to a government post, the Ming dynasty was moving rapidly toward collapse. In Hsu's opinion, only the restoration and development of agricultural production could have stabilized the people's livelihood and reversed the decline of the Ming.

His contribution to agriculture is to be found mainly in his book Nung Cheng Ch'uan-shu, the most widely read of all his works.

This work of more than 500,000 words contains sixty chapters and is divided into twelve parts, including three chapters on agricultural fundamentals, two on field systems, six on agricultural operations (management, cultivation, seasonal operations and forecasting), nine on water conservation, four on farm implements, six on horticulture (grain, ramie fibers, vegetables and fruits), four on sericulture, two on general sericulture (cotton, ramie fibers and flax), four on cultivation (bamboo timber, tea and medicinal herbs), one on animal husbandry, one on manufacture, and eighteen on famine administration. Ch'i-min Yao-shu (Important Administrative Methods) is like an agricultural encyclopedia, but Nung Cheng Ch'uan-shu covers a greater range of topics: the sections dealing with agricultural fundamentals, farm systems, water conservation, and famine administration total 32 chapters, or more than half the entire book. Unlike Ch'i-min Yao-shu, Nung Cheng Ch'uan-shu does not confine itself to agricultural production techniques. Nung Cheng Ch'uan-shu reveals the main points of agricultural policies during Hsu Kuang-ch'i's time.

The present version of Nung Cheng Ch'uan-shu was revised by Ch'en Tzu-lung (7115 1311 7893), who deleted approximately 30% of the original text and added 20%. However, the mistaken proof that locusts were transformed from shrimp eggs was obviously added by Ch'en, et al.

Nung Cheng Ch'uan-shu consists largely of lengthy quotes from ancient works and works contemporary with the author; only a little over ten per cent was written by Hsu himself. This small portion nevertheless reveals the author's understanding and grasp of the material. Hsu annotated relevant materials which he quoted; thus Nung Cheng Ch'uan-shu is not merely a book of classification.

Nung Cheng Ch'uan-shu concerns itself with many topics. In the present article, only the more important ones will be briefly introduced and analyzed.

1. Water conservation and farm cultivation: Cultivation and water conservation are often closely related in Hsu's writing and in his excerpts of other papers in Nung Cheng Ch'uan-shu. Hsu placed a great deal of emphasis on concrete problems in a certain area, mostly water conservation in Southeast China (focusing on water conservation in Soochow and Sung-chiang), a well-known grain-producing area. Because of unrepaid water conservation facilities and heavy levies of taxes and corvee labor, however, the farmers there deserted their fields. Hsu wrote that "I was born in a rich area, but now there are hardly any farmers left." This gives a general idea of the problems of the time and of his concern for them. Next came water conservation in the Northwest (actually including the middle and lower reaches of the Yellow River). Hsu emphasized

increasing the grain output in North China in order to alleviate the grain-tax burden on South China.

Hsu studied China's traditional techniques of water conservation at an early time. He wrote Liang-suan Ho-kung chi Ts'e-ven Ti-shih Fa (Methods of Calculating River Irrigation Facilities and Topographical Surveying) in 1603 at the behest of Magistrate Liu (0-91) of Shanghai. In 1612, in cooperation with Hsiung San-mei (3574 0005 2653), he translated six chapters of T'ai-hsi Shui-fa (Water Conservation in the West), and later quoted two-thirds of the translation in Nung Cheng Ch'uan-shu. Hsu also drew from Wang Chen's (3769 4394) Nung Shu (Agriculture) in describing irrigation tools. But that Hsu made brief introductions to and evaluated excerpted material shows the extent to which he researched these problems.

The section on water utilization (known as "Han-t'ien Yung-shui Shu" [Water Utilization in Upland Fields] in Nung Cheng Ch'uan-shu) in his book T'un-yen Shu (Farming and Salt Production), which he wrote in his later years (1630), is actually a concise and systematic theory of water utilization. In T'un-yen Shu and Isai-ho I (On Canals), two earlier works, Hsu advocated the coordinating of water and field management: if water reservoirs were to be constructed upstream for water storage and supply during different seasons, no floods would occur even in large rivers. Hsu also pointed out the value of using topographical surveys as the basis for water utilization. In general, his water utilization and management theories are of great value.

2. General farming experiences and advanced farming techniques: Whenever the opportunity arose, Hsu visited experienced farmers and gardeners. He wrote: "I traveled widely to study and investigate when I was young, so I know a great deal." He experimented with plantations in Shanghai and fields in Tientsin, and tested his ideas concerning water utilization in fields east of Peking. He also conducted experiments using herbaceous and ligneous plants for soil reclamation. Thus he was able to extensively summarize and improve the experiences of the farmers.

In his book, Hsu wrote more extensively on cotton than on any other crop. His Chi-pei Shu (On Cotton) -- Chi-pei being a transliteration of the Sanskrit word for cotton -- dealt with the various aspects of this plant. He concerned himself with cotton varieties, emphasized the importance of seed selection, discussed seed migration and treatment of seeds prior to sowing, advocated early sowing, and pointed out how the problems arising from early sowing could be solved. He especially opposed excessively dense planting of cotton, having concluded that "There are four causes of poor cotton: immature seeds, excessively dense planting, infertile land, and negligent farming operations." He grouped cotton cultivation techniques into selection of cotton seeds, early sowing, promoting deep roots and short stalks, thinning of cotton plants, and application of sufficient fertilizer. Although Hsu's writings are not entirely

correct in the light of present knowledge, this was more than 300 years ago. Such generalizations of the cotton cultivation experiences of the farmers are valuable.

Hsu also pointed out the importance and methods of making plots and irrigation ditches in the wheat fields of South China. In his commentary on T'ang Pen-ts'ao (Materia Medica of the T'ang Dynasty) he pointed out various misconceptions such as the idea that cabbage when planted in the North changed into red turnips and red turnips when planted in the South became cabbage. He understood both the reason why red turnips had smaller roots when planted in South China and the methods of seed selection and cultivation for growing turnips with large roots in the South. He suggested that winter or spring wheat be planted in the lowlands in the North which were flooded in early autumn. Darnels could be planted along with spring wheat and would be grown after the wheat was harvested. Since darnels are resistant to floods or drought, two crops per year could be harvested. The book includes many summarizations of and suggestions regarding valuable experiences which cannot be listed here due to space limitations.

3. Seed migrations and planting and propagation of new crops by new methods: That Hsu was enthused by the profitable propagation of good seeds to different areas is revealed throughout his work. The most outstanding example of this is in regard to the migration and propagation of the sweet potato, a plant which originally grew in America. In 1593, it was brought into Fukien from the Philippines. Many times Hsu obtained potato seeds from Fukien and attempted to grow them in Shanghai. He created a thousand-li tendril method of transporting sweet potatoes, and wrote Kan-shu Shu (On Sweet Potatoes) disseminating and explaining his planting techniques, citing 13 advantages of planting sweet potatoes and advocating the planting of sweet potatoes in the North. After this, farmers at Sung-chiang quickly gained experience. In his Chun-fang P'u (On Plants), Wang Hsiang-chin (3769 6272 2516) referred to these experiences as the Sung-chiang method.

Hsu also advocated the extraction of oil from Stillingea febrifera and the obtaining of white wax from the planting of Liqustrum japonicum Thunb.; he described the method of planting the latter and the profit thus obtained. He pointed out that since the development of new agricultural techniques was unlimited, good seeds should be disseminated to different areas in order to gain profits. In his writings he again and again criticized the idea of not disseminating crops because of imagined inadequacies of climate and land, and proved the fallaciousness of this misconception with facts. His enthusiasm is clearly shown in his works. His approach of first conducting a trial cultivation and then disseminating a plant after obtaining definite results is both concrete and correct.

4. Range and depth of agricultural knowledge: In regard to the range and depth of Hsu's investigations and research evinced by the

various portions of Nung Cheng Ch'uan-shu, it may generally be said of the section on famine administration and the portions concerning water utilization, horticulture, general sericulture (mainly cotton cultivation) and cultivation that his knowledge concerning locust elimination was extensive, but that he was weak in fruit trees. He was familiar with sericulture techniques, although his writings on sericulture were few. He was especially weak in animal husbandry; that his writing on this subject comprises only one-sixtieth of the space in his book indicates the paucity of his knowledge. He had only a limited knowledge of agricultural fundamentals, farm systems, farming operations, and manufacture. Although he stressed the problems of cultivation and ownership of farmlands in his Ching-t'ien Kao (On the Well Field System), he did not understand class suppression; since he did not seek to suppress the feudal lords, he did not grasp the nub of the problem.

Hsu often made extensive observations of natural phenomena and investigated natural laws for utilization. The cause of smaller red turnip roots and methods of planting this vegetable in South China mentioned above is an example. Concerning white wax, he set forth in great detail methods of collection and treatment of seeds, fertilization of trees, and collection of wax. He was the first to write on the living habits of wax insects in China and state the principle of obtaining wax from the wax insects instead of from their eggs under different conditions based on the phenomenon of migration of wax insect eggs. Hsu was also the first to describe in detail the life of the locust in ancient China. He also studied methods of locust elimination from this standpoint. Although his writings concerning these three examples are not entirely correct, the value of his work lies in the revelation -- more than 300 years ago -- of his scientific attitude and propensity for practical and extensive observation and careful deduction of rules and treatment methods.

Of course it cannot be said that Nung Cheng Ch'uan-shu is entirely free of mistakes or inadequacies. Mistakes can be found even in modern scientific writings, and it is simple to pick out mistakes in an agricultural work written more than 300 years ago. Nevertheless, Nung Cheng Ch'uan-shu is in general an excellent book, and Hsu Kuang-ch'i was an outstanding agriculturist in China's history.