1. CURRENT SITUATION OF FOOD LEGUME CROPS PRODUCTION IN TAIWAN, THE REPUBLIC OF CHINA

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Foreword

Legume crops have long been consumed in various forms as the main source of protein in the diet of Chinese and other Orientals. In China, the history reveals that soybean culture was first recorded in 2838 B.C. together with other cereals.

Currently, peanut and soybean are the two leading legumes produced in Taiwan. They were introduced from the China mainland by Chinese immigrates at the end of the fifteenth century. However, full attention for their production was only given during the last two decades.

Since the amount produced is still lagging behind the domestic demands, both technical and institutional efforts have been extended for boosting its production in recent years.

In Taiwan, the most distinctive feature for the production of soybean, peanuts and other field crops is the practice of a specific rotational pattern—the multiple cropping system—which will be discussed in this text for each of the concerned crops.

Production and Improvement of Leading Legume Crops

I. Soybean

A. The Production

Prior to 1945, soybean (*Glycine max*) production in Taiwan was very limited and its cultivation was largely for use as green manure. During that period, soybean for human consumption was mainly depended on imports. In order to self-produce soybean as much as possible, both varietal and cultural improvements were started at 1953 and followed with acreage expansion thereafter. Table 1 shows the increasing trend of soybean production in Taiwan since 1945.

1. Time and location of planting: Taiwan is favoured with three planting seasons for soybean, i.e. spring, summer and fall; and the seeding times fall on mid-February to mid-March, June to July and mid-September to mid-October, respectively.

As for the annual planting acreage, fall-sown soybean is even more than those for the other two seasons. Of the annual acreages of 40,151–59,582 hectares during the period of 1961–71, fall-sown crops always took the lead and it occupied over 75% of the total acreage in 1971.

The planting was concentrated in the southern part along the west coast of the island, and practically all the planting took place in Pingtung and Kaohsiung prefectures.

The spring and summer crops often suffer from the attacks of diseases, insects, drought, typhoon and heavy rainfall, thus resulting in the small and scattered plantings in Taipei, Hsinchu, Taichung, Tainan and Kaohsiung districts along the west coast and the Hualien district in the east.

2. Cultural practices: The leading fall soybean crop in southern Taiwan is multiple-cropped with two rice crops in paddy field within a year. Its growing period falls between

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Table 1. Soybean Production in Taiwan

(1945–71)

Year	Acreage (ha)	Production (M.T.)	Yield (kg/ha)
1945	7, 405	1, 957	264
1946	8, 454	4, 113	487
1947	7, 818	4, 691	600
1948	20, 362	12, 440	611
1949	20, 284	12, 052	594
1950	20, 300	12, 543	618
1951	23, 251	13, 412	577
1952	24, 315	14, 627	602
1953	28, 225	17, 426	617
1954	30, 048	20, 310	676
1955	34, 510	24, 151	700
1956	37, 505	26, 442	705
1957	41, 029	33, 054	806
1958	47, 894	41, 682	870
1959	53, 785	44, 451	826
1960	59, 665	52, 653	882
1961	59, 582	53, 900	905
1962	55, 008	53, 011	964
1963	53, 924	52, 645	976
1964	50, 904	57, 616	1, 132
1965	53, 156	65, 709	1, 236
1966	51, 323	63, 271	1, 233
1967	52, 291	75, 226	1, 439
1968	49, 461	72, 995	1, 476
1969	45, 270	67, 111	1, 482
1970	42, 749	65, 174	1, 525
1971	40, 151	60, 990	1, 519

Source of data: Taiwan Agricultural Yearbook.

October and January when dry weather prevails. It is right between the harvesting of the second rice crop and the transplanting of next year's first crop.

When the rice harvest is over, a small hole is dug right beside each rice stubble with a small spade. Then 2–3 soybean seeds are put into each hole without the need of land preparation. For each hectare it needs 100–120 kg of seeds.

After sowing is done, rice straws are spread over the soil surface to prevent moisture loss and meantime to control the growing of weeds. Some farmers are also in the practice of burning the covered straws immediately for the same purpose. Under this condition, the spacing of soybean is almost the same as for rice, i.e. 22.5 cm × 22.5 cm. Sometimes, however, every tenth row is left blank for facilitating other field operations. No further tillage is practiced for this "rice-stubble-soybean" cultural method.

The cultural practices for spring and summer crops are done in a conventional way. Land is usually plowed twice. Compost and fertilizers are applied at the second plowing and followed by harrowing and leveling. The planting spacing vary with seasons and types of plant. Generally, the row distance is 40 cm and the distance between plants

is 10–15 cm with a seeding rate around 60 kg/ha. First weeding is usually done about two weeks after germination; second weeding and tillage is practiced within two weeks. Relay-interplanting is another specific cultural method. The pady field is drained about 15 days before the rice harvest, and then soybean seeds are planted along the rice rows 10–15 cm apart. When the rice is harvested, the germinated soybean plants are fertilized and weeding/tillage operations followed. This method of relay-interplanting has enabled soybean plants to gain more growth time for making intensive use of the land which are otherwise impossible to fit into the existing multiple cropping system.

3. Fertilization and irrigation: For soybean cultivation, the rate of fertilizer application is largely deepndent upon crop seasons and soil types. The currently recommended rates, kg/ha, are: 20–40 for N, 40–90 for P_2O_5 and 30–75 for K_2O and sometimes together with 10,000 kg of compost. Usually, the whole amount of phosphorus and potassium and a half amount of nitrogen are used as base before seeding, while the other half of nitrogen is applied as top-dressing during the blooming stage of the plants.

As for irrigation, since the leading fall crop is planted in the paddy field immediately after the harvest of the second rice crop, sufficient moisture is still kept in the soil, so no more irrigation is necessary for the early growing stage. However, irrigation is needed when the blooming stage is over and the soil becomes dry at the podding stage. Irrigation is necessary during both the early stage and the pod formation stage for soybeans growing on dryland in the spring. No irrigation is required for the summer crop because it is right in the rainy season.

4. Maturity and harvest: Most of the existing soybean varieties for spring and fall crops in Taiwan mature in 85–95 days after seeding and with about 10 more days for the summer crop. The actual harvesting date varies with each crop season, variety and location. Beans planted as green vegetable may be harvested about ten days earlier. Harvest is mostly done by hand, plants are dried on drying ground immediately after harvest and then threshing is done by means of bamboo flails. Recently, the use of power threshers became popular in the south. The matured and dried plants are cut and then threshed by machine right in the field.

B. The Soyben Improvement Program

1. Breeding for superior varieties: The soybean varietal improvement program was started in 1953. The preliminary work was focused on the development of better varieties to replace the inferior ones through conducting pure line selection, introduction and acclimatization. Several promising varieties were thus selected and released during the period of 1957–71 (Table 2).

When the soybean varietal characteristics required under the natural conditions of Taiwan were fully known and breeding materials were available, hybridization was begun in 1955. The breeding targets set included: a) wide adaptability with less sensitivity to both photoperiod and temperature, b) early maturity to fit into the multiple cropping pattern, c) rust (*Phakopsora pachyrhizi*) resistance, and d) high yielding ability. The released hybridized varieties are listed in Table 2. Although breeding through treatments of X-ray and neutrons was also tried, the results were only partially successful.

Since rust once reached epidemic proportions in the spring of 1964, the rust resistance breeding program was reinforced. Screening for resistant material from among 2900 entries of the Soybean World Collections had been made by the Taiwan Agricultural Research Institute. Only two entries, PI-200451 and PI-200492, were found to be highly resistant to rust. Then they were crossed with other desirable entries and eventually two new lines, Tainung No. 3 and Tainung No. 4, with considerable resistance were released in 1968 and 1970, respectively.

Table 2. The Leading Soybean Varieties in Taiwan

Variety	Source	Characteristics
Sankuo	Introduced from Japan in 1952, selected and released in 1956	Late maturity, better for summer crop, susceptible to rust
Palmetto	Introduced from U.S.A. in 1953, selected and released in 1957	Adaptable to various crop seasons, susceptible to rust
Shih-shih	Introduced from Japan in 1954, selected and released in 1957	Adaptable to various crop seasons, early maturity
Wakajima	Introduced from Japan in 1952, selected and released in 1960	Adaptable to various crop seasons, late maturity, susceptible to rust
NTU-KS No. 5	Greenbean×Wakajima released in 1963	Wide adaptability, early maturity, highly susceptible to rust
Chung Haing No. 2	Huangpaochu×Greenbean released in 1965	Better for autumn crop
Tainung No. 3	PI-200492×Nungshi H-11 released in 1968	Early maturity, tolerant of rust
Tainung No. 4	PI-200492×Nungshi H-11 released in 1970	Tolerant of rust, better for spring crop
Kaohsiung No. 3	PI-200492×Shih-shih released in 1971	Tolerant of rust, wide adaptability

However, being less sensitive to photoperiod and temperature, early maturing and high yielding and because it can be planted as spring, summer and autumn crops, the variety Shih-shih is still popular among the farmers under the threat of possible yield loss due to rust infection.

2. Cultural improvement: Prior to the release of improved varieties, soybean production in Taiwan was roughly done in a limited area by broadcasting of seed without land preparation. However, cultural experiments were undertaken to keep abreast with the progress made in the varietal improvement program. Through years of painstaking efforts, cultural practices for soybean production under different crop seasons and locations were standardized and successfully applied to the fields. These include proper methods of land preparation, seeding, spacing, weeding, tillage, harvesting, fertilization, irrigation, disease/insect control and even the development of a special "rice-stubble —soybean" cultural method.

3. Supporting researches and activities: In Taiwan, the soybean research and improvement work was first carried out by the Department of Agronomy, National Taiwan University and continued by the Taiwan Agricultural Research Institute, National Chung Hsing University, and the Kaohsiung District Agricultural Improvements was mainly attributed to the undertaking of the following studies: flowering habit, crossing techniques, heritability, analysis of yield components, inducing of polyploidy, interspecific hybridization, photoperiodic responses, water reqquirements, responses to fertilization, plant population density, etc. Many reports on the research findings have been published.

For maintaining the genetic purity of of each extended variety, a soybean seed multiplication system was established after the release of the first improved variety in 1956. The foundation, stock and extension seed farms were operated by the breeding stations (DAISs), prefectural farmers' associations and township's farmers' associations, respectively. Field inspections and seed testings are carried out by the Seed Laboratory of the Provincial Department of Agriculture and Forestry.

In addition, a Soybean World Collection consists of 2,906 entries originated from 39 countries is maintained by the Taiwan Agricultural Research Institute. These entries

can be used for breeding and other purposes. A book entitled "A Monograph of Introduced Soybean Varieties in Taiwan" was published by TARI in 1965, in which the morphological and agronomic characters and maturity of each introduced entry were briefly described.

II. Peanut

A. The Production

Peanut (*Arachis hypogaea*) is one of the important field crops produced in Taiwan. Prior to 1945, its annual acreage remained below 30,000 ha with a total annual production less than 30,000 M.T. Since 1946, owing to the increased demand and accompanied by achievements in peanut improvement programs, its planting acreage was expanded, ranging from 86,314 to 103,983 ha with an annual yield of 37,380 to 137,000 M.T. in the period of 1946–71. The highest acreage (103,983 ha) and production (137,000 M.T.) were recorded in 1958 and 1967, respectively (Table 3). However, a decreasing trend of the labor-consuming peanut industry prevailed in the last decade. It was mainly caused

Table 3. Peanut Production in Taiwan

(1945–71)

Year	Acreage (ha)	Production (M.T., unshelled)	Yield (kg/ha, unshelled)
1945	24, 626	11, 565	470
1946	50, 797	37, 379	736
1947	65, 106	46, 572	715
1948	73, 387	53, 348	727
1949	77, 059	53, 284	691
1950	83, 387	57, 110	685
1951	84, 889	61, 158	720
1952	80, 975	60, 037	741
1953	82, 580	60, 104	728
1954	94, 025	65, 868	701
1955	96, 034	66, 572	693
1956	98, 258	81, 847	833
1957	103, 584	93, 714	905
1958	103, 983	96, 423	927
1959	99, 135	97, 042	979
1960	100, 497	102, 167	1, 017
1961	98, 615	104, 644	1, 061
1962	96, 304	95, 496	992
1963	94, 542	91, 438	967
1964	100, 775	115, 727	1, 148
1965	103, 621	125, 817	1, 214
1966	98, 026	114, 995	1, 173
1967	97, 906	137, 000	1, 399
1968	95, 317	106, 489	1, 117
1969	91, 385	100, 764	1, 103
1970	87, 477	122, 198	1, 397
1971	86, 314	97, 519	1, 130

by labor shortage in the rural areas as a result of rapid industrialization and for lack of a comprehensive farm mechanization program.

1. Time and location of planting: Peanuts, dominated by Spanish type varieties, can be grown in all parts of the island. However, about 80% of the planting are in the three-year-rotation rice area and its neighboring dryland which are classified as sandy loam or loam soils. The other 20% are scattered over sandy soils of riverbeds and coastal land.

Regionally speaking, peanut cultivation in Taiwan is concentrated in the southwest part of the west coast and also in the middle part of the east coast. Of the 86,314 ha of peanuts planted in 1971, Yunlin, Hualien, Chiayi, and Changhua prefectures occupied 35,961, 9,050, 7,970 and 5,914 ha, respectively. They constituted approximately 68% of the total acreage.

Two peanut crops are planted each year in Taiwan. The seeding time for the spring crop falls between January to March, while that for the autumn crop is from July through September. Of the total annual planting acreage, about 70% is for the spring crop and only 30% for the autumn crop.

The wet and dry seasons can be easily distinguished in central and southern Taiwan along the west coast where peanuts are grown. Of the 1,500–2,000 mm annual rainfall, 90% falls in the period from May to September, whereas the rest drops from October to next April with the monthly rainfall rarely exceeding 20–30 mm.

As to the temperature for the peanut-producing area, the warmest months are July and August with a maximum temperature of 32°–33°C, and the coldest months are January and February with a minimum temperature of 11°–12°C and even with occasional frost. Under the climatic conditions, pre-irrigation or rainfall for the spring peanut crop is necessary before sowing. It also takes a longer time, 12–15 days, to germinate the seed and the early growth of plants is rather slow. Later on, the weather would become favorable for plant development and pod-setting. However, a long spell of rain at the harvesting time would bring about a heavy loss to the matured pods due to sprouting or rodding in the soil. And a long-drawn-out rainfall also affects post-harvest drying. On the other hand, warm and wet weather prevails in the early and mid-growth stages, and cool and dry weather dominates the maturing stage of the autumn crop, thus serving to hasten the growth and pod formation of the peanut crop.

Peanut production in the Pescadores (Penghu islands), lying in the middle of the Taiwan Strait, deserves special mention. Its annual planting acreage is around 3,000 ha, next only to sweet potato. Peanuts are usually sown immediately after the first rain of the year, which takes place in late March or early April. Virginia type varieties commonly grown in this area need 160–180 days to mature. Because of its poor soil condition, the yield is usually low.

2. Cultural practices: The first plowing of land usually takes place right after the harvest of the previous crop. The second plowing is done several days before planting and followed by harrowing and leveling. Shallow ditches with depths of 5 cm are dug 30 cm apart on the prepared field by a plow. Then one seed is sown 10 cm apart along the finished seeding-rows. These practices of dense spacing and one seed per hill were recommended in 1956. It makes a total of 333,333 plants per hectare and bad contributed a great deal to yield increment thereafter. Under such a planting population, 110–120 kg of selected seeds are required for each hectare.

Tillage is usually practiced at 15–25 days after plant emergence. In the early flowering stage, i.e., within 20 days after the first flowering, tillage and weeding are done again, and ridging-up or loosing the soils of fruiting zone is carried out at the same time. Herbicides such as Lasso, Tok E-25, Vernam and Treflan are recommended for weed control, but only a small number of farmers are using them up to now.

3. Fertilization and irrigation: Through a series of experiments, the recommended per hectare rates of fertilizer application in peanut field are: 10–20 kg for N, 50–60 kg for P_2O_5 and 40–50 kg for K_2O. In addition, about 10,000 kg of compost are usually applied by most farmers. The fertilizers are either broadcast on the surface of the soil immediately before the second plowing of land or applied beside the seeding-rows before sowing. During the whole growth period of peanut palnts, soil moisture stresses most likely occur during the flowering stage in the spring crop and the podding stage in the autumn crop. A 50–70 mm depth of water is recommended for irrigating the field under each condition.

4. Harvest: The Spanish type peanut varieties commonly grown in Taiwan could be harvested at 120–135 days after planting for the spring crop, while only about 110 days are needed for the autumn crop. Harvesting is considered the most tedious work. In sandy soils, the whole peanut plant is pulled up by hand from the soil, but in heavy/dry soil, a plow is needed to dig up the plants. The matured pods are also picked off by hand. About 30–50 pickers, consisting mostly of teenagers or women, are needed to harvest one hectare of peanut. The freshly harvested pods are then dried under the sun for 4–7 days.

5. Rotation and intercropping: In the main peanut producing area in Taiwan, the following rotation systems are commonly practiced:

a. Two crops a year on dryland field:
   Peanut—sweet potato
   Peanut—soybean—corn (wheat)
b. Three crops within 1½ years:
   Peanut—paddy rice—sweet potato, relay-interplanted
   Peanut—sugarcane (interplanted with peanut or sweet potato)
   Peanut—paddy rice—pulse crops
c. In 3-year-rotation paddy field:
   Peanut—paddy rice—sweet potato—sugarcane, interplanted with peanut
   Peanut—paddy rice—short-growing crops—sugarcane—peanut—sweet potato
   Pulse crops—paddy rice—sugarcane—peanut—jute—sweet potato

Interplanting of peanuts in sugarcane fields is quite common in Taiwan. Two rows of peanuts are simultaneously planted between two sugarcane rows spaced 1.0–1.2 meter apart.

B. The Peanut Improvement Program

During the past two decades, the carrying-out of peanut improvement program in Taiwan was centered at the Taiwan Agricultural Research Institute (TARI) and the Tainan District Agricultural Improvement Station (DAIS). The almost doubled yield increase from 1940 up to the present (Table 3) is mainly ascribed to the successful implementation of this program.

1. Varietal improvement: The peanut breeding work was started around 1949. Several improved varieties (Table 4) had since been developed through introduction, pure line selection and hybridization, and are now occupying over 85% of the total peanut planting acreage. Among them, Tainan Selection No. 9 is the leading variety and its acreage is estimated at 70% of the total.

For maintaining the genetic purity of these improved varieties, a seed multiplication system was established in 1950, while the system of seed testing and field inspection was begun in 1957. The foundation seeds are multiplied annually by the DAISs concerned. Prefectural farmers' associations are responsible for producing stock seeds, while the township farmers' associations grow extension seeds for distribution directly to the farmers. In the whole course of seed multiplication, strict testing and field inspection

Table 4. Leading Peanut Varieties in Taiwan

Variety	Source	Yield pod (kg/ha)	Shelling (%)	Oil content (%)	Wt. of 1,000 seeds (gm)
Tainan No. 7	Java small×Tainan Pai-yu-tao, released in 1956	2,150 (S) 1,610 (F)	67.2	55.7	401
Tainan selection No. 9	Introduced from Vietnam in 1962 released in 1967	2,250 (S)	70.5	55.1	468
Tainung No. 3	Introduced from U.S.A. in 1953, released in 1963	2,260 (S) 1,650 (F)	67.8	57.1	410
Tainung No. 4	Spanish white×Kinorales released in 1971	2,581 (S) 1,789 (F)	66.1	54.2	436
Penghu No. 1	Pure line selection from Yuan-yen-tao (Virginia type) released in 1961	1,900 (S)	63.5	51.8	392

on plant uniformity, seed purity, germination rate, infection of diseases and insects are carried out by the Provincial Seed Testing Laboratory.

2. Cultural improvement: The extension of the successful results of cultural improeemnt programs played the most important role in the uplifting of peanut yield in Taiwan. The experiments on dense spacing and responses to fertilization deserve special mention.

Peanuts in Taiwan were planted at 45 cm × 20 cm with two plants (seeds) per hill before 1958. Through a series of experiments carried out after 1956, it was found that the most adequate planting space was 30 × 10 cm with a single plant (seed) per hill. Under this dense-spacing, the total number of plants per hectare has increased from 250,000 to 333,333, or a gain of 12–17% in yield.

Based on the results of many field trials on N-P-K responses at various locations, 10 kgs of N, 50–60 kgs of P_2O_5 and 40–50 kgs of K_2O were recommended for each hectare of peanut field. During 1945–56, an islandwide fertilization demonstration was in 573 peanut fields. An average of 13% yield increase was obtained when compared with the improperly fertilized fields.

Recently, trials on the use of herbicides have been conducted. Tok E-25 Vernam, Lasso and Treflan were found very effective for weed control in peanut fields. However, wide adaption will depend upon the situation of labor supply and the price of herbicides.

3. Supporting researches and activities: For enriching the germplasm to facilitate the peanut breeding program, a collection of 498 peanut entries originating from 22 countries is kept at the Taiwan Agricultural Research Institute. There are now 290 290 Spanish type ,195 Virginia type and 13 Valencia type varieties in this collection. A book entitled "Catalogue of Peanut Collection in Taiwan" was published in 1964, in which the morphological characters, growth habits, and maurity of each entry were briefly described.

A study on the transfer of the charaacter of seed dormancy from the Virginia type to the leading Spanish type peanuts is being carried out. If the seed dormancy character could be transferred through hybridization, leaving other desirable agronomic traits of the Spanish type intact, then a 10–14% yield loss due to pre-harvest seed germination in the soil during the rainy season could be avoided. The results of preliminary studies indicated that the character of seed dormancy is possible controlled by a single pair of recessive genes.

Other researches such as studies on the pathogen of leaf spot disease (*Cercospora personata*) and other items related to breeding for its resistance, variation of fatty

acids and oil contents of the seeds in different types and varieties, soil-water-plant relationship, a search for relationship between the above- and under-ground plant characters to serve as indicators for selection are all in progress. Several reports have already been in print.

III. Mungbean

Mungbean (*Phaseolus aureus*) is grown either in the spring or in the autumn season in dryland areas of southern Taiwan. The planting acreage and production in the years 1967–71 are shown below:

Year	Acreage	Production (M.T.)	Yield (kg/ha)
1967	13, 296	9, 813	788
1968	13, 845	9, 338	674
1969	11, 795	8, 085	685
1970	9, 704	6, 997	721
1971	8, 066	5, 904	732

The sharply decreased planting area after 1969 is primarily due to labor shortage, unstable yield and harvesting difficulties encountered in the rainy season.

There are two local leading mungbean varieties: You-li and Mao-li. The spring crop is sown in late February to mid-March, while the autumn crop is planted from late August to mid-September. The seeds are drilled in rows spaced at 30–40 cm apart. Plants are thinned to a space of 5–10 cm within each row. Weeding and tillage are done when the young plants are 10–15 cm in height ,followed by second weeding two weeks later. Mature pods are hand-picked and sun dried. Since mungbean pods on the same plant usually do not mature at the same time due to the extended period of flowering, several harvests are to be made.

Mungbean is mainly for making bean sprouts, cakes, sweet porridge, etc.

IV. Red Bean

Red bean (*Phaseolus angularis*) to the Chinese is the equivalent of adzuki bean to the Japanese. Although it is a minor legume crop produced in Taiwan, yet its economic importance has became increasingly known recently due to its potentiality for export. The planting acreage and production during 1967–71 are tabulated below:

Year	Acreage (ha)	Production (M.T.)	Yield (kg/ha)
1967	1, 500	2, 040	1, 360
1968	1, 900	2, 850	1, 500
1969	2, 400	3, 744	1, 560
1970	1, 986	2, 749	1, 384
1971	2, 655	4, 312	1, 623

Pingtung and Kaohsiung in the south are the two leading areas of red bean production. The sowing time is concentrated in the autumn, and the cultural measures are the same as soybeans.

The annual domestic consumption is estimated at about 3,000 M.T. The red beans are primarily for making confectioneries and sweet gruel.

Peanut and Soybean Consumption and Demand

The current annual consumption of soybean in Taiwan is estimated at around 650,000–700,000 M.T., of which only about 10% is produced locally (Table 1). Thus the bulk of soybean consumption relies on imports (Table 5). A drastic increase in soybean imports was started in 1967 when the government released the import control of such grains in order to hasten the development of the domestic livestock industry.

Table 5. Soybean Imports in Taiwan
(1959–71)

Year	Amount imported (M.T.)
1959	91, 760
1960	143, 542
1961	144, 548
1962	62, 426
1963	182, 458
1964	181, 832
1965	161, 399
1966	164, 503
1967	351, 135
1968	384, 921
1969	472, 212
1970	617, 540
1971	549, 500

Of the total amount of soybean consumption, over 80% are for oil extraction, leaving the soybean-meal for feed, and only less than 20% are used for food in forms of soybean curd, milk, sauce, sprouts and many other uses as a main source of vegetable protein.

Since the livestock industry is still in the stage of expansion and the required amount of vegetable oil is increasing, the demand for soybean will keep on rising at the estimated rate of 10–15% per year. This estimate is based on the following figures:

	1971	1968	1964	1961
Slaughtered Hogs (Head)	4, 378, 000 (100%)	3, 528, 859 (80%)	2, 544, 696 (58%)	2, 429, 503 (55%)
Chickens (Head)	16, 150, 000 (100%)	13, 786, 639 (90%)	8, 494, 171 (52%)	7, 914, 941 (49%)

The per capita vegetable oil consumption was raised from 3.0 kg in 1966 and 4.2 kg in 1968 to 5.6 kg in 1970. Meanwhile, the amounts of vegetable oil extracted locally in the three corresponding years were 38,200 M.T., 59,500 M.T., and 80,000 M.T., respectively. Of the total amount, soybean oil occupied around 80%, peanut oil 16% and others less than 4%.

The amount of peanuts produced in Taiwan so far is sufficient for local consumption. Approximately 46% of the output are for making various kinds of foodstuff such as roasted or salted peanuts, peanut confectioneries, and peanut butter; 36% for oil extrac-

tion as well as for peanut-meal production. The remainder is kept in storage for next year's planting. Since the volume of soybean imports is still expanding and soybean oil continues to be dominant in the vegetable oil market, it is very likely that peanut oil consumption will be decreased in proportion. Therefore, a large quantity of peanuts destined for oil extraction may be used for food when the demand for it is on the increase. Under the circumstances, it seems that making efforts to uplift the per hectare yield of peanuts is more important than acreage expansion at the present moment.

Problems Encountered and Future Outlook

Taking all the food legume crops produced in Taiwan as a whole, their production is lagging far behind the demands for food, feed and edible oil; and it would be a herculean task to attain self-sufficiency in these crops. However, it is justified to make efforts to self-produce this crops as much as possible so as to cut down the amount of imports as well as to bring about maximum land productivity on a populous island with limited natural resources.

To gain this end, efforts should be exerted to solve the following problems: (1) Farmers' profit margin from growing the legume food crops should be guaranteed under the sharp competition of the lower-priced and enormous quantity of such imports. A government-initiated "Grain and Feed Development Foundation" was established in July 1972. An amount of NT$40 will be surcharged on each metric ton of imported grains for this purpose. The funds thus raised are to be used for establishing a guaranteed price for locally produced feed grains and for the development of feed industry. (2) Legume food crops production is labor-consuming, and it is especially true of peanut cultivation. Under the pressure of farm labor shortage, large-scale demonstrations are under way to bring down the cost of production through using appropriate farm machinery either introduced or developed locally. Several such programs being tried out are showing satisfactory results. (3) There is plenty of room for per hectare yield increase of the legume food crops production in Taiwan. It could be realized through conducting a well-organized and reinforced breeding program to develop varieties with desirable traits such as high-yielding ability, better quality, disease resistance and wider adaptability which can very well fit into the multiple cropping system. In addition, the basic physiological studies also need to be strengthened for guidance to future improvement of cultural practices.

Only when the afore-mentioned key programs are successfully carried out, can the farmers' reluctance to grow soybean and peanuts be removed to pave the way for a better and more profitable legume food crops production in the future.

Discussion

T. Yamamoto, Japan: Your data indicate that the yield of soybean crop in Taiwan shows a gradual increasing tendency from 264 to 1,519 kg/ha 1971. Your data also show that soybean is cultivated in fall season in large part, and mature in 85–95 days after seeding. I think the fall season in Taiwan is almost similar to that of Hokkaido and maturing days is shorter than that of Hokkaido, in which maturing days are about 130 days. The average yield in Hokkaido keeps the same level with that of your country. This is very interesting to me. Do you think what is the main reasons to level up the average yield to 1,500 kg per hectare in Taiwan. Please tell me the main cultural practises which affect to level up the yield.

Answer: The factors contributed to the increment of soybean yield have already been stated in the text. They can be summarized as follows: The use of improved varieties, the practices of improved cultural measures such as proper fertilizer application, irrigation and the adoption of "rice-stubble-soybean" method.

Arwooth N. L., Thailand: In Table 3, last column, I would like to ask the data given in shelled or unshelled weight?

Answer: All the figures concerning peanut yield in my paper are unshelled pods.

H. K. Jain, India: In your multiple and relay cropping patterns involving rice and soybean, do you mostly have transplanted rice, or also direct seeded rice?

Answer: Rice seedlings are transplanted in Taiwan.

H. Akemine, Japan: It is an important problem to breed the varieties adaptable to various crop seasons. Have you any particular breeding method to breed such type of variety?

Answer: Not for the present. The selection in soybean breeding program in Taiwan is concentrated for the autumn crop which occupies almost 60–70% of the total planting average per annum.

G. W. E. Fernando, Sri Lanka: May I learn from the speaker (1) whether the soybean crop is inoculated and whether responses to inoculation are adequate in Taiwan. Is there any need to add additional fertilizers? (2) whether the incidence of virus in soybeans is a serious problem in Taiwan?

Answer: (1) Except for the newly planted soybean field the soil is not inoculated. However, the current recommended fertilizer rates for soybean are:

N 20–40, P_2O_5 40–90, K_2O 30–75 kg/ha.

(2) Virus is not a serious problem for soybean production in Taiwan so far. Only scattered occurrences were found.

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