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# Production of vegetable green soybean for the domestic market and trial shipments to Japan

**VG433**

**Dr Q V Nguyen**
**NSW Agriculture Gosford**

VG433

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# 1. SUMMARY

## 1.1 INDUSTRY SUMMARY:

Vegetable green soybean is one of the most important vegetable crops imported into Japan. For example, in 1994 Japan imported 4,411 t and 56,700 t of fresh and frozen green soybean, valued at ¥11,866 million which is equivalent to A$161 million. Most imported green soybean came from Taiwan and more recently, China.

If production in Japan decreases and Taiwan and China cannot supply more frozen green soybean for early markets from January to March at a reasonable cost, Japan will be forced to look at other countries to fill the already existing demand which is believed to be approximately 10,000 t and valued at approximately A$23.5 million (A$ = ¥74 - 1994).

In addition, to cover domestic growing of green soybean, there is a need for more than 100 t of certified seed, valued at almost A$1 million, to satisfy this market every year.

Australia is in a very sound position to fulfil the demand in both vegetable green soybean and seed for Japan. After five years of research (1991/93: Development of vegetable green soybean for domestic and Japanese markets, HRDC Project No. V/0130/RD and 1994/96: Production of vegetable green soybean (Edamame; *Glycine max* (L.) Merr.) for the domestic market and trial shipments to Japan, HRDC Project No. VG433 and RIRDC Project No. DAN-113A), it is evident that vegetable green soybean can be grown in New South Wales for the January to March markets. November, December and early January are the best times to grow green soybean for highest pod yield which is comparable to average yield of 8 t/ha in Japan.

For the eastern Australian domestic fresh market, which is very small, ie. approximately 150 kg. per week, the fresh attached type which is marketed in bundle form of stem branches and pods was most preferable because of its fresh appearance. Detached type, marketed only in pods in plastic nets or plastic bags, attracted little interest due to the similar form of the frozen product, although its flavour and freshness were as good as the attached type. The wholesale prices for fresh green soybean in the eastern Australian domestic market would be at approximately A$6.00 per kg.

To produce frozen green soybean by using Individual Quick Frozen (IQF) technology, both carbon dioxide ($CO_2$) and nitrogen liquids produced satisfactorily high quality frozen pods. Commercial application for large-scale production is now dependent on production costs.

This project achieved high recognition from Japanese markets regarding potential of the Australian green soybean industry. The cultural postharvest package and IQF freezing technology were developed for commercial purposes but would also be useful for the Australian horticultural industry. Three Japanese trading companies have expressed their interest in negotiating with Australia for export of fresh and frozen green soybean to Japan.

## 1.2 TECHNICAL SUMMARY:

The major objectives of this project were achieved within one year (1994/95) according to design time frames and within budget. The second year (1995/96) has been expanded with the assistance of the Hunter Valley OLMA (Office of Labour Market Adjustment) in order to establish some basic information which will allow for development of a plan for future expansion of green soybean for export to Japan.

### 1.2.1. Cultivars suitable for Japanese and New South Wales fresh markets:

Fresh market green soybean can be produced on the Central Coast and in the Hunter Valley of New South Wales from January to March. The pod yields of cultivars GSB-1 and GSB-4 achieved more than 9 t/ha on the Central Coast in the December planting. The average yield in Japan is 8 t/ha. The planting time is from November to early January. Sowing from mid January is not recommended due to risk of unfilled pods caused by cool weather in April. The tested cultivars which were used in this study were unsuitable in the Murrumbidgee Irrigation Area.

### 1.2.2. Specific cultural requirements:

Tested cultivars GSB-1 and GSB-4 were harvested within 81-86 days depending on planting time.

- **Planting density** - is desirable at 0.15-0.20 m x 0.9 m (55,555 ~ 74,000 plants/ha) to a produce higher proportion of marketable pods which contain two and three seeds each.
- **Fertilisation** of green soybean should be the focus in order to promote early growth of plants to form good plant height and to have maximum pod number. The combination of N:P:K at the rate of 78 kg. N:104 kg. P:64 kg. K per ha as a basal dressing. However, to maximise the marketable pod yield, one side dressing of potassium nitrate at the rate of 100 kg. per ha (13N:46K) at flowering stage is desirable. Lack of nutrition at reproduction stage could lead to an increase in unfilled and/or one-seed pod number.
- **Irrigation** - Green soybean requires a large amount of water for growing, particularly at vegetative stage, for flower bud formation and pod development. Insufficient water during flowering to pod growth stage reduces flower number and caused pods to drop.

- **Weed control** - Very important for growing green soybean as weeds badly affect yield and pod quality. The herbicide that was successfully identified for green soybean at the Somersby Research Farm was Linuron® (pre-emergence, 3 kg./ha).
- **Diseases and Insects** - The most common diseases and insects that were found on the Central Coast of New South Wales were Sclerotium Crown Rot (fungus *Sclerotium rolfsii)* and caterpillars of budworms (*Helicoverpa armigera*) and cutworms (*Agrotis* spp.). Warm and moist weather favours these diseases and insects.
- **Harvesting** - Green soybean should be harvested when 90% of the pods become filled and have a fresh green colour. Green soybean can be harvested three days earlier and/or later, but the pod yield could be lost at the rate of 0.5 t/ha/day.

  Pod yield of cultivars GSB-1 and GSB-4 growing on the Central Coast achieved as high a yield as 9 t/ha in the December plantings.
- **Mechanical harvesting** - The fresh bean harvester does a very good job in harvesting vegetable green soybean, removing approximately 76% of beans and separating foliage and stalks. Harvest time, using the single row machine, is approximately a quarter hectare per hour. Approximately 7% beans which were harvested by machine were bruised.

### 1.2.3. Specific processing requirements:

- With IQF technology, both carbon dioxide ($CO_2$) and nitrogen liquids produced satisfactorily high quality frozen pods.
- Blanching at 95°C constant for two minutes could easily produce "popped" frozen green soybean.
- After blanching and cooling the bean's temperature is approximately 16°C which is desirable.
- Freezing immediately after blanching is recommended to avoid build up of temperature within the beans which would cause a high percentage of undesirable dark and bruised pods.

# 2. TECHNICAL REPORT

## 2.1. INTRODUCTION:

Vegetable green soybean (*Glycine* max. [L.] Merr.) is one of the most important high protein vegetable crops in Asia. Immature soybeans have long been consumed as a vegetable (Table 1) as long as soybean has been eaten (Lumpkin and Konovsky, 1991). The soybean has been cultivated for a long time, probably 4,000-5,000 years ago in China (Sato *et al.* 1977; Sunada *et al.* 1986) for food and medicines (Iwao and Kobayashi, 1987; Izawa and Izawa, 1987). The first mythological historical reference to soybean is in the description of *Shen Nung* Botanical

Book (*Shen Nung Bin Chao Jin*) in 2737-2705 BC (Togari and Tsuga, 1975). *Shen Nung* is believed to be one of the three Sages, as well as rulers of ancient Chinese history, who first cultivated the five grains, invented the plough and established the markets (Encyclopaedia Britannica, 1982).

**Table 1. Local names for green vegetable soybean. G. Vinning, 1995.**

| Country/language | Name |
|---|---|
| English | Green vegetable soybean, vegetable soybean, edamame |
| Chinese | Mao dau ("hairy bean"), wong dau ("yellow bean") |
| Indonesian | Kedelai, kacang jepu, kacang bulu, dele, dekeman, gadele, kedele |
| Japanese | Edamame |
| Korean | Poot kong |
| Malaysian | Kacang bulu rimau, kacang soya (whole bean), tange (sprout) |
| The Philippines | Utau, balatong |
| Thailand | Thua lueang, thura phra lueang, thua rae |
| Vietnamese | Đậu nành rau |

The cultural practices of vegetable green soybean are identical with ordinary soybean except that the green pods are harvested at the mature green stage when the pods are almost filled (Fehr *et al.* 1971). 'Wash the pods, mix them with some salt, boil them for approximately eight minutes and pop the beans out of the pod into the mouth' is the way Asian people eat green soybean. The beans have a nutty taste with nutrition superior to other beans and peas. They are rich in protein, cholesterol-free, potassium, phosphorus, calcium, iron and vitamins (Anon. 1984).

In Japan, green soybean is one of the most important vegetable crops imported, particularly in the processed (frozen) form. For example, in 1993 Japan grew 14,000 ha of green soybeans to produce 52,800 t of fresh-market green soybeans, valued at approximately A$521 million. However, in the same year Japan imported 56,867 t of fresh and frozen green soybean, valued at more than A$150 million. Importation of fresh and frozen green soybean in 1994 was increased again to 61,111 t, valued at more than A$160 million (Table 2).

**Table 2. Domestic production and importation of green soybean in Japan, 1985-1994[1].**

| | 1985 | 1990 | 1991 | 1992 | 1993 | 1994 |
|---|---|---|---|---|---|---|
| **A. Domestic production:** | | | | | | |
| Total production (t) | 115,500 | 102,700 | 99,200 | 99,800 | 81,600 | N/A |
| Consignment (t) | 80,300 | 68,400 | 65,000 | 65,000 | 52,800 | N/A |
| **B. Importation:** | | | | | | |
| 1. Fresh: | | | | | | |
| i) Quantitative (t) | Nil | 2,828 | 4,348 | 3,634 | 5,617 | 4,411 |
| ii)Value, (Million¥) | Nil | 996 | 1,232 | 1,173 | 1,402 | 1,093 |
| (A$Million[2]) | Nil | 14 | 17 | 16 | 19 | 15 |
| 2. Frozen: | | | | | | |
| i) Quantitative (t) | 31,044 | 40,071 | 42,621 | 44,063 | 51,250 | 56,700 |
| ii)Value,(Million ¥) | N/A | 12,942 | 10,101 | 10,487 | 10,301 | 10,773 |
| (A$Million[2]) | N/A | 175 | 137 | 142 | 139 | 146 |
| **3. Total Importation:** | | | | | | |
| Quantitative (t) | 31,044 | 42,899 | 46,969 | 47,697 | 56,867 | 61,111 |
| Value, (Million ¥) | N/A | 13,938 | 11,333 | 11,660 | 11,703 | 11,866 |
| (A$Million[2]) | N/A | 189 | 154 | 158 | 158 | 161 |

1) Source: Ministry of Agriculture, Forestry and Fisheries, Japan
Ministry of Finance, Japan 1995
Otsubo, M. 1995. What the Japanese market needs. Seminar "Vegetables to Asia", Gosford
Pan, C. 1995. RIRDC Technical Report
Shokuhin Ryutsu Kenkyukai, 1994. Shokuhin Seisan Yunyo Shoki 1994 (In Japanese)

2) Based on 1994's exchange currency: A$ = 74 ¥

**Imported fresh-market green soybean:**

Imported fresh-market green soybean mainly came from Taiwan. China, Thailand and the Philippines also supplied fresh-market green soybean to Japan but occupied a very low proportion - only 10% of whole imported market. In 1993, Japan imported 5,617 t of fresh-market green soybean. Of this, 850 t was sent into Tokyo markets, which is shown in monthly imported volumes and landed prices in Table 3.

**Table 3. Monthly imported fresh green soybean into Tokyo Market 1993.**

| Month | Taiwan | | China | | Thailand | | Domestic | |
|---|---|---|---|---|---|---|---|---|
| | Volume (t) | Price (¥/kg.) | Volume (t) | Price (¥/kg.) | Volume (t) | Price (¥/kg.) | Volume (t) | Price[1] (¥/kg.) |
| January | 4 | 484 | - | - | - | - | - | - |
| February | - | - | - | - | - | - | 11 | 1,645 |
| March | 7 | 648 | - | - | - | - | 18 | 2,070 |
| April | 296 | 378 | 9 | 407 | 1 | 380 | 67 | 1,594 |
| May | 347 | 312 | 5 | 292 | <1 | 402 | 105 | 2,261 |
| June | 147 | 254 | 8 | 104 | <1 | 455 | 819 | 1,515 |
| July | - | - | - | - | - | - | 2505 | 898 |
| August | - | - | - | - | - | - | 2038 | 892 |
| September | - | - | - | - | - | - | 832 | 1,098 |
| October | - | - | - | - | - | - | 233 | 978 |
| November | 12 | 276 | 1 | 282 | - | - | 27 | 1,280 |
| December | 9 | 341 | 1 | 412 | - | - | 20 | 1,361 |
| Total | 823 | 329 | 25 | 273 | 2 | 403 | 6,583 | 691 |

1) Showed only the highest price which was paid for Shizuoka green soybean.
Source: Seikabutsu ryutsu nenpo : Yasai hen. Tokyo Seikabutsu joho centa, 1995 (In Japanese).
A$ = 74 ¥, 1994

The landed prices varied monthly but the peak occurred in March and was 648 ¥/kg. However, average prices for the five years period (1990-1994) showed that January, February and March are the best times for green soybean with February being the peak time in the Tokyo market (Table 4).

**Table 4. Quantitative and wholesale prices of green soybean in Tokyo Fresh Market 1994.**

| | 1990 | | 1991 | | 1992 | | 1993 | | 1994 | | Mean | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Volume | Price | Volume | Price | Volume | Price | Volume | Price | Volume | Price | Volume | Price |
| Jan. | 9 | 1797 | 17 | 1178 | 13 | 1523 | 15 | 1238 | 12 | 1618 | 13.2 | 1471 |
| Feb. | 10 | 1803 | 9 | 1918 | 12 | 1904 | 11 | 1645 | 14 | 1338 | 11.2 | 1722 |
| March | 27 | 1628 | 49 | 1149 | 38 | 1313 | 25 | 1668 | 60 | 900 | 39.8 | 1332 |
| April | 147 | 952 | 221 | 700 | 286 | 641 | 374 | 569 | 321 | 531 | 269.8 | 679 |
| May | 341 | 952 | 442 | 799 | 297 | 1025 | 458 | 689 | 396 | 873 | 384.8 | 868 |
| June | 1320 | 721 | 1297 | 754 | 802 | 1035 | 871 | 949 | 1372 | 720 | 1132.4 | 836 |
| July | 2818 | 536 | 2933 | 567 | 2695 | 551 | 2505 | 583 | 2496 | 558 | 2689.4 | 559 |
| August | 2210 | 650 | 2270 | 557 | 2559 | 581 | 2038 | 630 | 1902 | 688 | 2195.8 | 621 |
| Sept. | 1271 | 553 | 1126 | 610 | 1578 | 567 | 832 | 868 | 984 | 579 | 1158.2 | 635 |
| Oct. | 206 | 739 | 207 | 757 | 237 | 637 | 233 | 709 | 189 | 641 | 214.4 | 697 |
| Nov. | 20 | 1002 | 23 | 1131 | 22 | 1068 | 40 | 925 | 33 | 835 | 27.6 | 992 |
| Dec. | 28 | 948 | 33 | 910' | 26 | 1060 | 30 | 1019 | 36 | 648 | 30.6 | 917 |
| Total | 8407 | 635 | 8627 | 627 | 8564 | 640 | 7433 | 691 | 7805 | 644 | | |

V = Volume P = Price, ¥/kg., Exchange currency 1994 A$ = 74 ¥
Source: Seika butsuryutsunempo: Yasai hen - Tokyo seikabutsu seiho centa, 1994 (In Japanese).

**Imported frozen green soybean:**

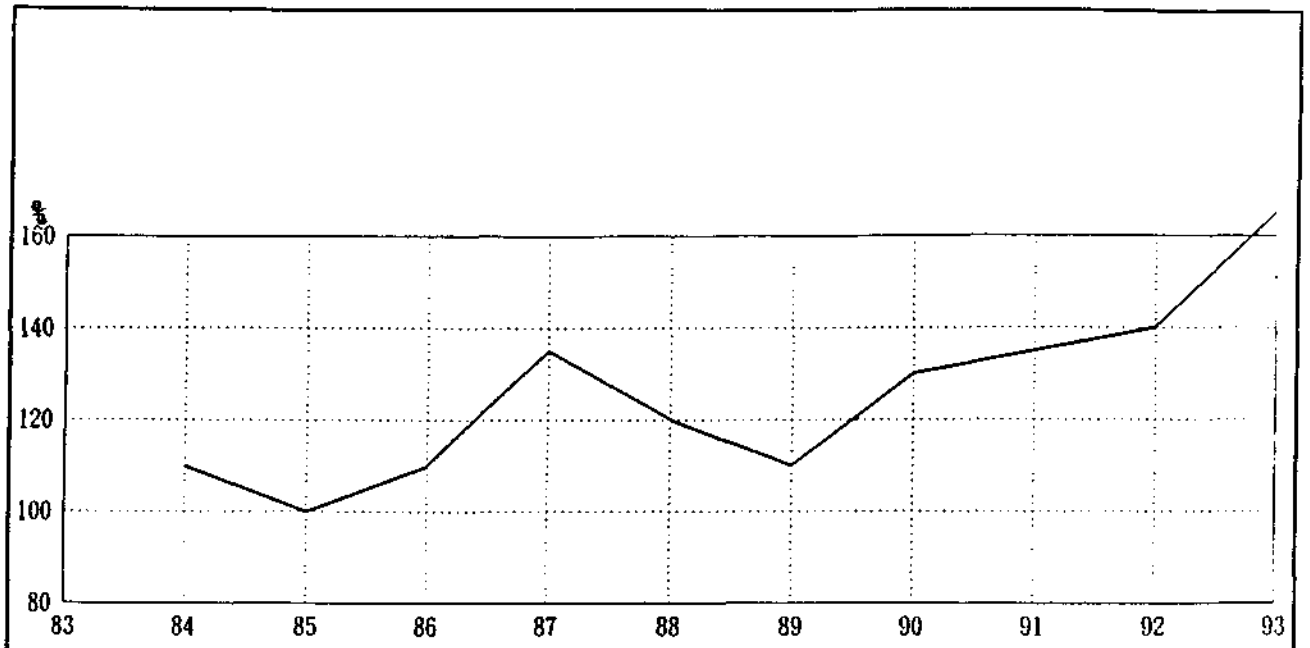
In 1993, Japan imported 51,250 t of frozen green soybean of which 75% or 38,229 t came from Taiwan and 22% or 11,088 t came from China. The remaining 3% came from Thailand (1,805 t), USA (107 t) and South Korea (21 t). Average landed prices from these sources were:

| | |
|---|---|
| Taiwan | 210 ¥/kg. |
| China | 174 ¥/kg. |
| Thailand | 185 ¥/kg. |
| USA | 196 ¥/kg. |
| South Korea | 190 ¥/kg. |

Most of these imports were sold to the food service section at average landed prices of 201 ¥/kg. (Table 5). In the Japanese supermarket, frozen green soybean imported from China is currently being sold at 228 ¥/400 g (or 570 ¥/kg.) while Taiwanese product generally commanded a higher price of 300 ¥/400 g (or 750 ¥/kg.) (C. Pan, 1995). Reasons for the price differential may be due to China's poorer quality. It is said that the Chinese product is expected to improve in quality in the future as Taiwanese companies transfer their processing technology to China.

Although statistics on the demand of green soybean for Japanese markets is unavailable, major supermarket chains and trading houses insist that currently there is approximately a 10,000 t gap between production and demand (Lumpkin and Konovsky, 1991). If production remains stable in Japan and Taiwan cannot supply more green soybean at an earlier time and at a reasonable cost, Japan will be forced to look to other countries to fill the already existing demand. Australia is in an extremely favourable position for supplying such demands, particularly for January, February and March markets which are believed to be approximately 10,000 t, conservatively valued at A$23 and A$63 million for frozen and fresh green soybean, respectively.

**Table 5. Importation of frozen green soybean and landed prices in the period of 1984-1993, Japan[1].**




| | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 |
|---|---|---|---|---|---|---|---|---|---|---|
| Import, ton | 33 818 | 31 044 | 36 231 | 42 682 | 36 842 | 34 241 | 40 071 | 42 621 | 44 063 | 51 249 |
| Taiwan, ton | | 30 959 | 36 178 | 42 404 | 36 771 | 34 001 | 38 825 | 40 629 | 39 128 | 38 229 |
| Landed price, Yen/kg. | | | | 177 | 176 | 251 | 323 | 237 | 238 | 201 |

**Comments:**

- Imports increase every year, and achieved more than 50,000 t in 1993.
- Main suppliers are Taiwan and China.
- Markets for frozen green soybean and the food service sector including drink bars, take-away food and supermarket.
- Retail prices are approximately 650 ¥/kg.

1) Source: 1994 Shokuhin Seisan Yunyu Shoki. Shokuhin Ryutsu Kenkyukai (In Japanese) Tokyo, Japan

It is evident from recent studies that vegetable green soybean can be grown in New South Wales for the January to March markets. November and December are the ideal times to grow green soybean for the highest pod yield which is comparable to the average yield of 8 t/ha in Japan. Green pod from November and December plantings could also be marketed in January, February and March, which would coincide with the most favourable period in Japan. However, since Japanese quarantine restrictions prohibit entry of fresh green soybean from mainland Australia, green soybean targeted for Japan must be in the processed form.

**Objectives:**

The research program "Production of vegetable green soybean (Edamame, *Glycine max* [L.] Merr.) for domestic markets and trial shipments to Japan" had the following objectives:

1) Commercial production of vegetable green soybean in January, February and March, 1995 on small-scale (pilot farms) ;
2) Samples of fresh vegetable green soybean were distributed to domestic markets, and particularly to Sydney, Brisbane and Melbourne's Japanese restaurants for appraisal and comments;
3) With the co-operation of Parle Foods Pty. Ltd. freezing techniques were studied with the aim of producing samples which retained high quality pods for export purposes;
4) With the co-operation of Unico-op (Japan) trial shipments of frozen vegetable green soybean were organised for export to Japan in January, February and March of 1995 to promote Australian edamame into Japanese markets;
5) Calculation of gross margins to ensure price competitiveness; and
6) Products were to be further refined and industry would be assisted in finding export markets.

## 2.2 MATERIALS AND METHODS:

**Genetic Materials:**

Two breeding lines of green soybean that were selected from the previous project (HRDC Project No. V/0130/RO: Development of vegetable green soybean for domestic and Japanese markets, 1990-94) have been used as genetic materials in this study. They are GSB-1 and GSB-4.

**Field Techniques:**

- Somersby Research Farm (1994-95):

  The seeds were inoculated with *Bradyrhizobium japonicum* strain CB1809 and sown by seeder (Precision Garden Seeder, Model 1001B, Earthway Products, Britain) in single raised beds in rows 0.9 m apart and 0.2 m between plants. Irrigation was by T-tape (emitters at 0.2 m intervals). Planting area was approximately 1000 $m^2$ per trial and fertiliser was applied as a basal dressing at the rate of 78N:104P:64K (kg./ha). Only one side dressing of potassium nitrate was applied at the flowering stage at the rate of 13N and 46K (kg./ha). The herbicide Linuron® was applied at the rate of 3 kg./ha of commercial product and incorporated into the soil after the sowings. In 1994/95, four experimental trails were conducted at the Somersby Research Farm (Latitude 33°22'S; longitude 151°21'E, yellow earth with sandy loam, Chairman 1978) of the Gosford Horticultural Research and Advisory Station on the New South Wales Central Coast in a replicated and incomplete block design. The aims of the experiments are shown in Table 6.

**Table 6. Experimental trials at Somersby Research Farm 1994-95.**

| Experiment | Sowing date | Harvesting date | Aims |
|---|---|---|---|
| Experiment 1 | 1st Nov. 1994 | 25th Jan. 1995 | • Postharvest treatments |
| Experiment 2 | 22nd Nov. 1994 | 8th,10th and 12th Feb. 1995 | • Harvest time Vs yield<br>• Freezing techniques<br>• Promotion into domestic fresh market |
| Experiment 3 | 14th Dec. 1994 | 8th March, 1995 | • Promotion into Japanese market (frozen) |
| Experiment 4 | 16th Jan. 1995 | Failed due to cool weather in April, 1995 | Seed was collected for further uses. |

At the Somersby Research Farm trials, all plants were cut by hand at ground level when 90% of green pods reached the green, almost-filled (seed), mature stage. The pods were removed from stems, washed and graded by selecting only two and three seed pods. These pods were then used as material for either fresh-market or processing.

- MIA (1994-95 and 1995-96):

  Two field trials, which were sown on 15th December, 1994 and 25th January, 1995, were organised at Parle Foods' farm in Griffith and one field trial which was sown on 15th November, 1995 were organised at the Griffith Centre for Irrigated Agriculture.

  At the Parle Foods' farm, seeds were inoculated with *Bradyrhizobium japonicum* strain CB1809 and sown by planting equipment which dropped seed at 0.15 m spacing on 1.8 m width raised beds. There were four rows planted on one raised bed 250 m in length, the planting area being approximately 0.5 ha per trial with trickle irrigation.

  At the Griffith Centre for Irrigated Agriculture, seeds were inoculated with *Bradyrhizobium japonicum* strain CB1809 and sown by hand at 0.15 m spacing in rows 0.9 m apart with trickle irrigation.

- Osborn Farm, East Maitland (1995-96):

  The objectives of the trials which were organised at Osborne Farm, East Maitland, were to establish some basic commercial information which would allow development of a plan for future expansion. These trials were assisted by OLMA. Three field trials were organised for production for freezing only and cultivars GSB-1 and GSB-4 were used as materials.

The seeds were inoculated with *Bradyrhizobium japonicum* strain CB1809 and sown with maize planting equipment which dropped seed at a spacing of 20 cm and a depth of 3 mm without the need for adjustment. Twenty-four raised beds of 340 m in length in rows 0.9 m apart, which was equivalent to 7344 $m^2$, were used in each experiment for green soybean production in 1995/96. Irrigation was by overhead system.

Fertiliser was applied as a basal dressing at the rate of approximately 80 N:35 P:66 K (kg./ha) (No.17 Hunter Special). One site dressing of potassium nitrate was applied at flowering stage at the rate of 13 N:43 K (kg./ha). In 1995/96, there were three experimental trials which were conducted at Osborne Farm, East Maitland (latitude 32°45'S, longitude 151°30'E, alluvial black soil with sandy loam) in the Hunter Valley of New South Wales. The three sowing dates were 30th October, 15th November and 20th December, 1995.

The first planting germinated, but did not grow to its full potential due to cool and overcast weather. The second planting also failed due to 150 mm rain which fell on the planting and subsequently no crop emerged.

The third planting grew reasonably well and was harvested mechanically by a fresh bean harvester. Harvested pods were washed and graded by selecting only two and three seed pods and these beans were used as materials for processing product.

## 2.3 RESULTS:

- Somersby Research Farm:

### 1. Experiment One - Postharvest treatment:

The detached beans were packed in plastic bags with a 300 g net weight. Sixteen bags were then packed in a wax carton with a top covering of either wet newspaper, a plastic layer or a newspaper and plastic layer to determine the shelflife of the beans under conditions of 1°C room temperature and 85% R.H. Fresh weight loss was measured at weekly intervals.

The results in Table 7 showed that the control carton without wrapping lost up to 11% of fresh weight after 46 days of storage in a coolroom. The carton with either plastic wrap or newspaper and plastic kept beans in good condition losing only 1.72% and 1.26%, respectively. However, pod colour started to turn from green to light green and then yellow after two weeks of storage at 1°C and 85% R.H.

**Table 7. Post harvest treatment of green soybean after 46 days stored in 1°C and 85% R.H.**

| Treatment | Fresh weight loss | 95% confidence |
|---|---|---|
| Control (No wrap) | 11.03 | 2.23 |
| Wet newspaper wrapper | 5.87 | 1.49 |
| Plastic Wrap | 1.72 | 0.28 |
| Newspaper and Plastic | 1.26 | 0.13 |

2. **Experiment Two - Harvesting time versus pod yield:**

Vegetable green soybean are identical to ordinary soybean except that the pods are harvested at the mature green stage when they are almost filled. However, due to critical harvesting time, which is believed to affect pod yield, three harvests were organised at this experiment to investigate relationship between harvest time versus pod yield.

Results in Table 8 show that early and late harvesting could produce low yields due to a high proportion of immature (early) and overmature (late) pods.

Early and/or delayed harvest may cause a loss of approximately 0.5 t per ha/day. Vegetable green soybean must be harvested within six days.

**Table 8. Pod yields (t/ha) of green soybean at different harvesting time at Somersby site, 1994-95[1].**

| | GSB-1 | | GSB-2 | |
|---|---|---|---|---|
| | Pod yield, t/ha | Different, % | Pod yield, t/ha | Different, % |
| Harvest 1[2] | 4.6 | -26 | 6.3 | -19 |
| Harvest 2[3] | 6.2 | 100 | 7.8 | 100 |
| Harvest 3[4] | 5.9 | -5 | 6.0 | -23 |

Note:
1) Sowing date: 22nd November, 1994
2) Harvesting date: 8th February, 1994 - 79 days after sowing
3) Harvesting date: 10th February, 1994 - 81 days after sowing. This is considered a traditional harvesting time.
4) Harvesting date: 12th February, 1994 - 83 days after sowing.

## 1. GREEN SOYBEAN PRODUCED AT THE GOSFORD HORTICULTURAL RESEARCH & ADVISORY STATION (1994/95):

**Photograph 1: Green soybean grown at Somersby Research Farm, an annexe of the Gosford Horticultural Research & Advisory Station (1994/95). The December planting produced high quality pod yield of approximately 9 t/ha.**

## 2. Experiments 2 and 3 - Fresh and Frozen Products:

In these experiments, three types of products were produced, namely the attached-type and detached-type for fresh and the detached type for frozen product.

Fresh Attached Type: The leaves and second grade pods of the upper plant were removed. Product with stems and first grade pods, including two and three seed pods, were washed and packed into plastic bags with approximately 300 g net fresh weight. There were sixteen bags in each wax carton which were subsequently cooled to $1^0$C and 85% R.H for 24 hours before being presented to the fresh markets in Sydney.

Fresh Detached Type: The first grade pods, including two and three seed pods, were removed from the plants, washed and packed into plastic bags with approximately 1,000 g net fresh weight. These bags were then packed into a wax carton and pre-cooled at $1^0$C and 85% R.H for 24 hours before being presented to the fresh markets in Sydney.

Frozen Detached Type: The first grade pods, including two and three seed pods, were removed from the plants, washed and stored in a plastic container at $1^0$C and 85% R.H for 24 hours before processing at either the laboratories of the Gosford Horticulural Research and Advisory Station, Air Liquid Pty. Ltd., Medowie or the CSIRO, North Ryde. There were six experiments to investigate the following:

1. Blanching conditions;
2. Time from blanching to freezing; and
3. Freezing liquids.

The frozen beans were packed in plastic bags of approximately 500 g net weight.

Both the fresh and frozen green soybeans were promoted into Australian domestic markets including Sydney [Tokyo Mart, Sakura, Japan Food Corp (Aust.) Pty. Ltd., Marubeni and Unico-op, Japan], Melbourne (Austwinds International Pty. Ltd.) and Brisbane ( Japan Mart). The samples that were sent to Japan (Unico-op, Japan, Tokyo, Japan) were the frozen type only.

1. Pod yields:

This study has confirmed the previous research program (Development of vegetable green soybean for domestic and Japanese market. HRDC Project No. V/0130.RO) that vegetable green soybean can be grown on the Central Coast for January to March markets. November and December are the preferred times for growing producing high pod yields of up to 9 t/ha

(Table 9) which is comparable to the average yield of 8 t/ha in Japan. Mid-January planting would be risky as low temperatures in April could result in unfilled pods.

2. Freezing Technologies:

i) Freezing at a constant temperature of 100°C for two minutes will result in split pods, ie. 10%. However, when reduced to one minute of 100°C constant, blanched pods were difficult to open. At a constant temperature of 90°C for two minutes, pods were also difficult to open. Blanching pods at a temperature of 95°C for two minutes produced the best quality in terms of tenderness and easy "popping" to open the pods.

Blanching beans in boiling water for approximately 5-8 minutes produced an acceptable pod quality. However, this is not a desirable commercial technology.

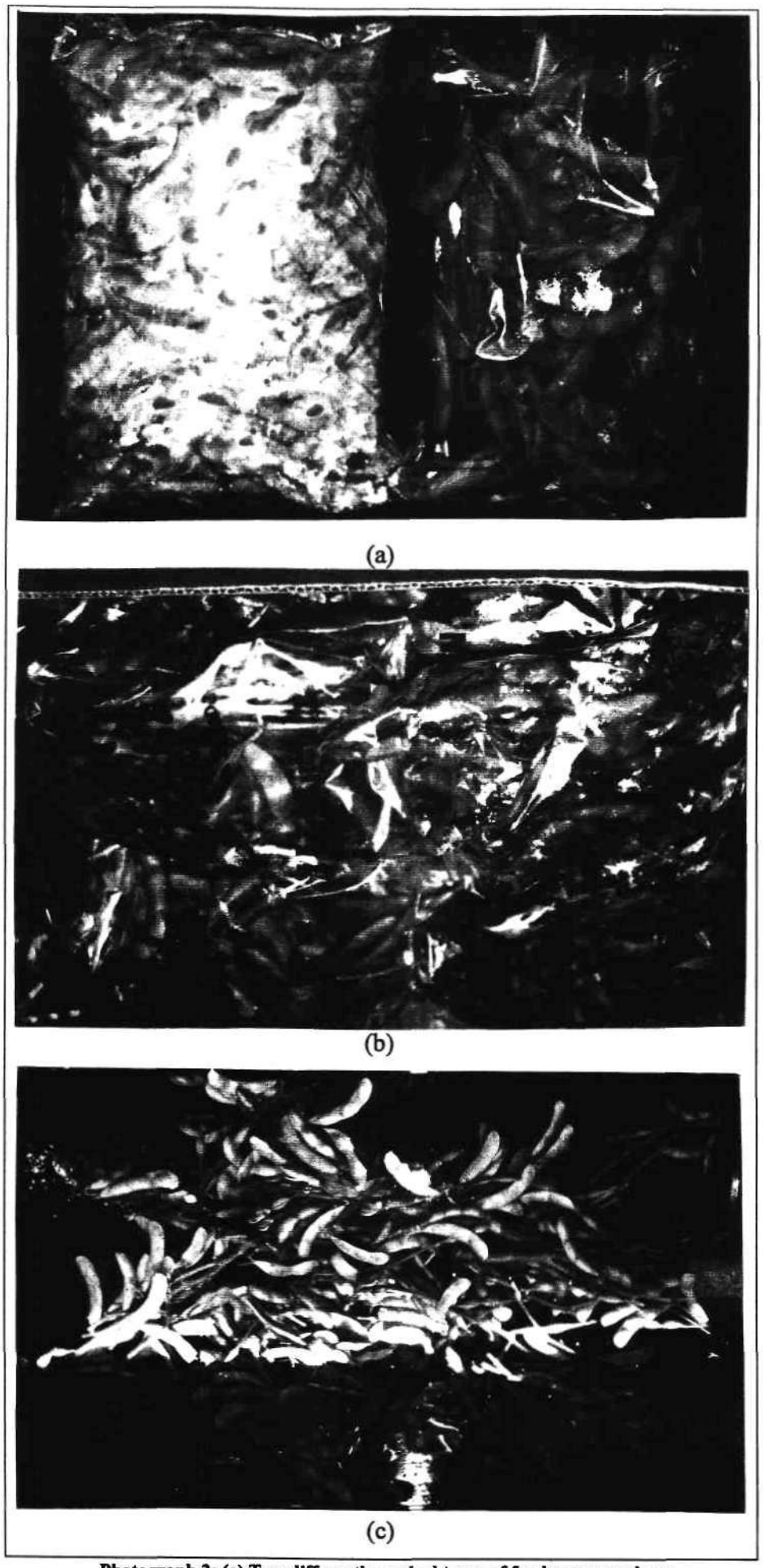
**Table 9. Performance of Green Soybean at the Somersby Research Farm, 1994-95.**

| | GSB-1 | | | | GSB-4 | | | |
|---|---|---|---|---|---|---|---|---|
| | Exp1 | Exp2 | Exp3 | Exp4 | Exp1 | Exp2 | Exp3 | Exp4 |
| 1. Maturity, day (sowing, harvesting) | 86 | 81 | 85 | - | 86 | 81 | 85 | - |
| 2. Plant height (cm) | 43 | 77 | 61 | 40 | 41 | 70 | 56 | 43 |
| 3. Fresh pod yield (t/ha) | 5.7 | 6.2 | 9.2 | - | 5.2 | 7.8 | 9.9 | - |
| 4. Pod size and freshweight | 5.7 mm x 1.3 mm, 3.7 g | | | | 5.5 mm x 1.3 mm, 3.5 g | | | |

Note: 1) Sowing Date: 1st November, 1994; Harvesting Date: 25th January, 1995
2) Sowing Date: 22nd November, 1994; Harvesting Date: 10th February, 1995
3) Sowing Date: 14th December, 1994; Harvesting Date: 8th March, 1995
4) Sowing Date: 16th January, 1994; Harvesting Date: Failed due to cool weather

ii) When the beans are frozen after blanching and cooling (to reduce bean temperature to 16°C), pod colour is green and bright. The freezing procedure which takes place after blanching, ie 3-4 hours, could produce a very high proportion (5%) of bruised pods, which is probably caused by warmer temperatures building up within the beans during storage time.

iii)There was no difference in terms of pod colour and taste quality of beans which were frozen by either $CO_2$ or Nitrogen liquids.




**Photograph 2: (a) Two differently packed types of fresh green soybean, ie. detached type (top left) and attached type (top right). The attached type is packed in cartons (b) while the others (c) are marketed as fresh stems in bundle form (two and three-seed pods), which is more desirable than the frozen product for domestic fresh markets.**

3. Marketing:

- Domestic Market:

  i) Domestic markets prefer fresh attached type of soybean rather than the detached type. However, this is not because of quality in freshness and taste but simply for psychological reasons. Japanese customers believe it is fresh when beans are attached to the fresh stems.

  ii) Fresh green soybean in either detached or attached forms could bring a wholesale price of approximately A$6.00/kg.

  iii)The size of Japanese domestic markets is very small. For Eastern Australian markets including Brisbane, Sydney and Melbourne, the demand for fresh green soybean is believed to be only 150 kg. a week.

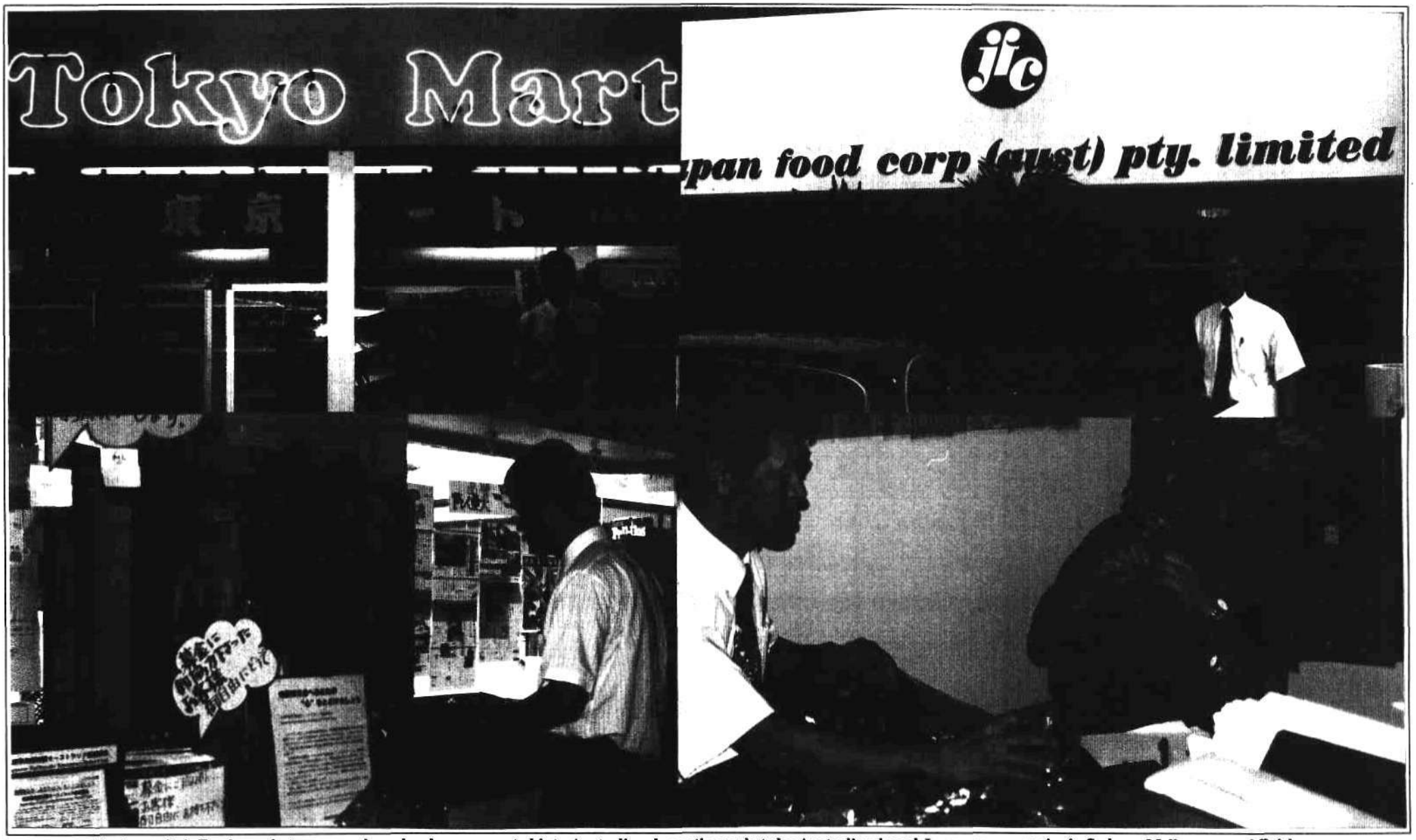
  iv)There is a potential to promote the fresh green soybean into the Australian community.

- Overseas Markets:

  Frozen green soybeans that were produced in Australia were sent to Unico-op Japan, as samples on 20th February and 20th March, 1995.

  i) The first samples which were produced at Medowie (Air Liquid Pty.. Ltd..), New South Wales were sent to Japan on 20th February, 1995 did not receive a positive response from Japan, as the product contained approximately 5% of bruised pods (Table 10).

  ii) The second samples which were produced at the CSIRO, North Ryde (BOC Gas), New South Wales were sent to Japan on 20th March, 1995, recieved good responses from Japan (Appendix 1). Japan have requirements that commercial products from Australia are to be in printed bags which are packed in cartons.




**Photograph 4: Fresh market green soybean has been promoted into Australian domestic markets by Australian-based Japanese companies in Sydney, Melbourne and Brisbane. The attached type is marketed as fresh stems in bundle form (two and three-seed pods) which is more desirable than the frozen product for domestic fresh markets.**

**Table 10. Processing technologies for frozen green soybean and pod qualities.**

| | Medowie | CSIRO, North Ryde | | | | |
|---|---|---|---|---|---|---|
| | Exp 1 | Exp 2 | Exp 3 | Exp 4 | Exp 5 | Exp 6 |
| Technology: | | | | | | |
| 1. Blanching | Boil water, approx. 5-8 min. | Boil water, approx. 5-8 min. | 100°C constant, 1min. | 100°C constant, 1 min. | 95°C constant, 1 min. | 90°C constant, 2 min. |
| 2. Time from blanching to freezing | 3-4 hours | 3-4 hours | within 30 min. | within 30 min. | within 30 min. | within 30 min. |
| 3. Freezing technology | IQF, Air Liquid | IQF, BOC Gas | IQF, BOC Gas | IQF, BOC Gas | IQF, BOC Gas | IQF, BOC Gas |
| 4. Freezing liquid | $CO_2$ | Nitrogen | Nitrogen | Nitrogen | Nitrogen | Nitrogen |
| 5. Freezing temp. | -45°C | -35°C | -35°C | -35°C | -35°C | -35°C |
| Quality: | | | | | | |
| 1. Pod Colour | Green | Green | Green | Green | Green | Green |
| 2. Bruised Pod | 5% | 5% | 0 | 0 | 0 | 0 |
| 3. Pods "popped" open easily | Yes | Yes | Yes | No | Yes | No |
| 4. Split pod, % | 0% | 0% | 10% | 0% | 0% | 0% |
| 5. Acceptance | No | No | No | No | Yes | No |

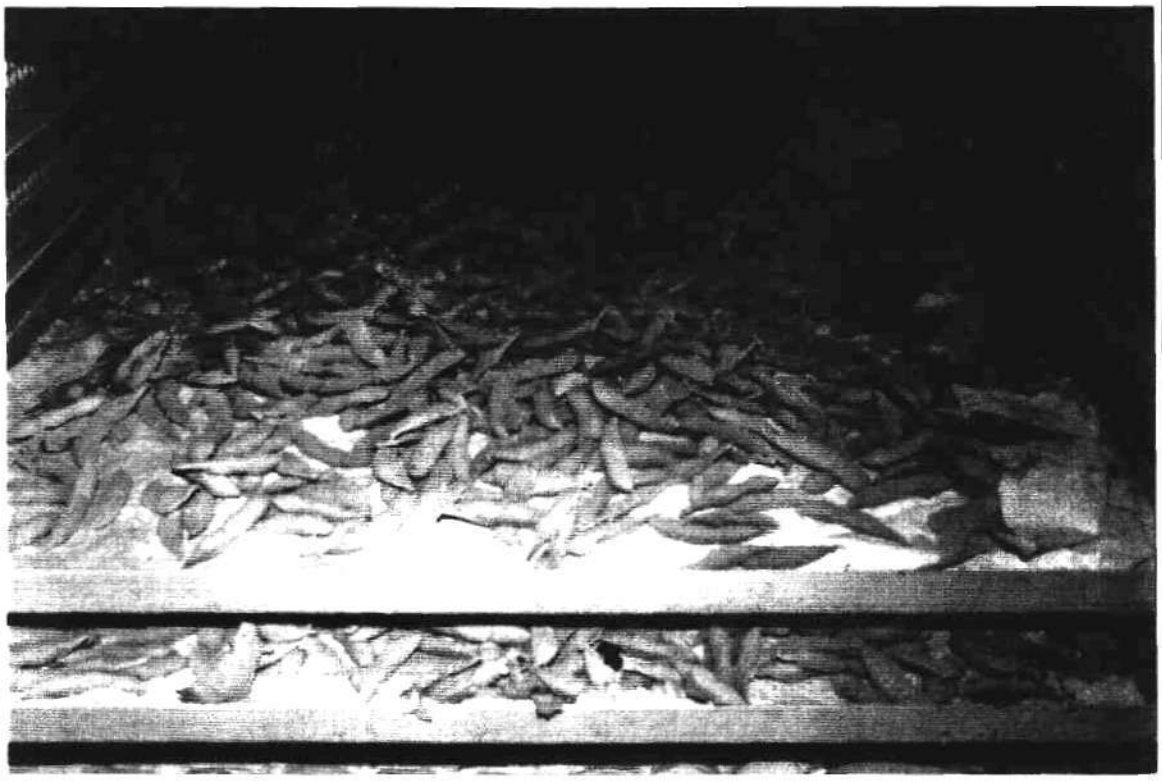
- MIA (1994-95 and 1995-96):

  Trial 1, which was sown on 15th December, 1994 on Parle Foods' farm, failed due to poor germination, probably caused by hot and dry weather in December.

  Trial 2, which was also sown on Parle Foods' farm on 25th January, 1995, germinated and grew reasonably well. Cool weather in April, however, limited crop growth and production. Both GSB-1 and GSB-4 cultivars had approximately 35-40 cm height and carried approximately 10-15 pods, including more than 50% one-seed pods. The beans, therefore, which were not suitable for processing, were harvested by hand and dried for future seed use.

  Trial 3, which was sown on 15th November, 1995 at the Griffith Centre for Irrigated Agriculture, grew extremely well. The crop built up foliage of approximately 60-70 cm in height with large numbers of leaves. However, there were a very small number of pods on the plant, particularly cultivar GSB-4 which had many empty pods.


(a)



(b)

**Photographs 4: (a) Snap freezing by nitrogen and carbon dioxide was organised in co-operation with Air Liquid and CIG (BOC Gas).**
**(b) Samples of frozen green soybean were sent to Melbourne and Tokyo, Japan, for appraisal and comment.**

- Osborn Farm, East Maitland:

  In Trial 1, the first planting which was sown on 30th October, 1995, germinated but did not grow to its full potential due to cool weather and overcast days. The crop set mature beans, which were harvested by hand and dried for future seed uses.

  Trial 2, the second planting, was sown on 15th November, 1995 and irrigated. The following night 150 mm rain fell on the planting and no crop emerged.

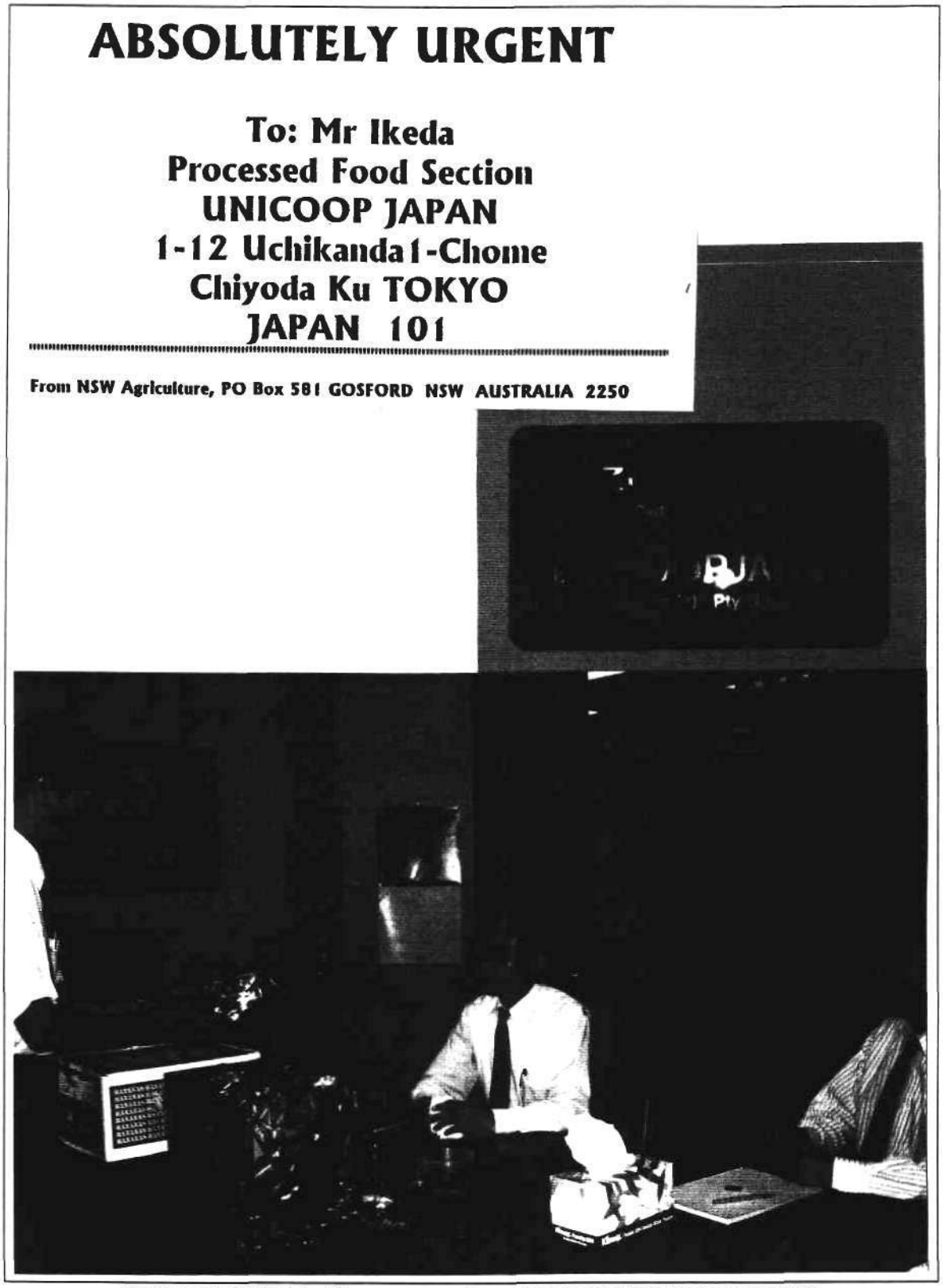
  Trial 3, the third planting, was sown on 20th December, 1995 and grew reasonably well in the preferred growing period for this region. Cool weather and lack of sunlight, however, limited crop growth and production. Approximately 37 pods formed on plants rather than the expected 50-60 pods.

  Desirable two and three-seed pods occupied only 47% of total pod number/plant rather than the 80% achieved in previous trials at Somersby Research Farm (Table 11). Bacterial disease, Brown spot (Bacterium *Pseudomonas syringae*), caused by showery weather, was also found on the plants and beans.

**Table 11. Performance of green soybean, Trial 3 - Cultivar GSB-1, in Osborn farm, 1995-96.**

| | Rep. 1 | Rep. 2 | Rep. 3 | Mean (%) |
|---|---|---|---|---|
| Plant height (cm) | 60 | 62 | 58 | 60 |
| Last number/plant | 27 | 29 | 25 | 27 |
| Pod number/plant | 45 | 31 | 34 | 36.7 |
| Pod fresh weight/plant | 92 | 62 | 78 | 77.3 |
| Pod yield: | | | | |
| First grade pod number pod | 29 | 10 | 14 | 16.7 (47%) |
| fresh weight (g) | 72 | 31 | 48 | 50.3 (65%) |
| Second grade pod number pod | 16 | 21 | 20 | 19 (53%) |
| fresh weight (g) | 19 | 31 | 30 | 26.7 (35%) |
| Estimated yield: | | | | |
| Total pod yield (t/ha) | 4.79 | 3.26 | 4.11 | 4.05 (100%) |
| First grade pod yield (t/ha) | 3.79 | 1.63 | 2.53 | 2.65 (65%) |
| Second grade pod yield (t/ha) | 1.00 | 1.63 | 1.58 | 1.40 (35%) |

Note: 1) Sowing date: 20 December 1995; Harvesting date:29 February 1996,71 days.




**Photograph 5: Fresh and frozen green soybean was promoted into Japanese markets in co-operation with Japanese trade houses.**

## 2. GREEN SOYBEEN PRODUCED AT OSBORN FARM, EAST MAITLAND, NSW - 1995/96.

**Photograph 6: Green soybean grown at Osborn Farm, East Maitland, NSW (1995/96). October planting (right) achieved unsatisfactory yields due to unsuitable weather. The green soybean on the left is the December planting.**

**Photograph 7: Planting in December is believed to be the most suitable time. However, growing technology, yield and pod quality need to be improved.**

Mechanical Harvesting:

The crop was harvested by the mechanical fresh bean harvester belonging to Mr. R. Mudd, a neighbour farmer. This machine had been idle for approximately 10 years and broke down before the end of harvest with a broken chain, bent half shaft and a blown hydraulic line the cause of the breakdown. However, the equipment did a good job in harvesting the bean, removing approximately 74% and separating foliage and stalks (Table 12). The remaining 24% of unpicked beans were at lower levels of plants. The machine would been better if there had been time to spend on fine adjustments to fan speeds, belts and the tractor itself. Rows of soybeans where raised, also created problems. The severely physically damaged beans caused by mechanical harvesting represented approximately 7% (Table 13). Harvest time, using the single row machine, is approximately one quarter hectare per hour.

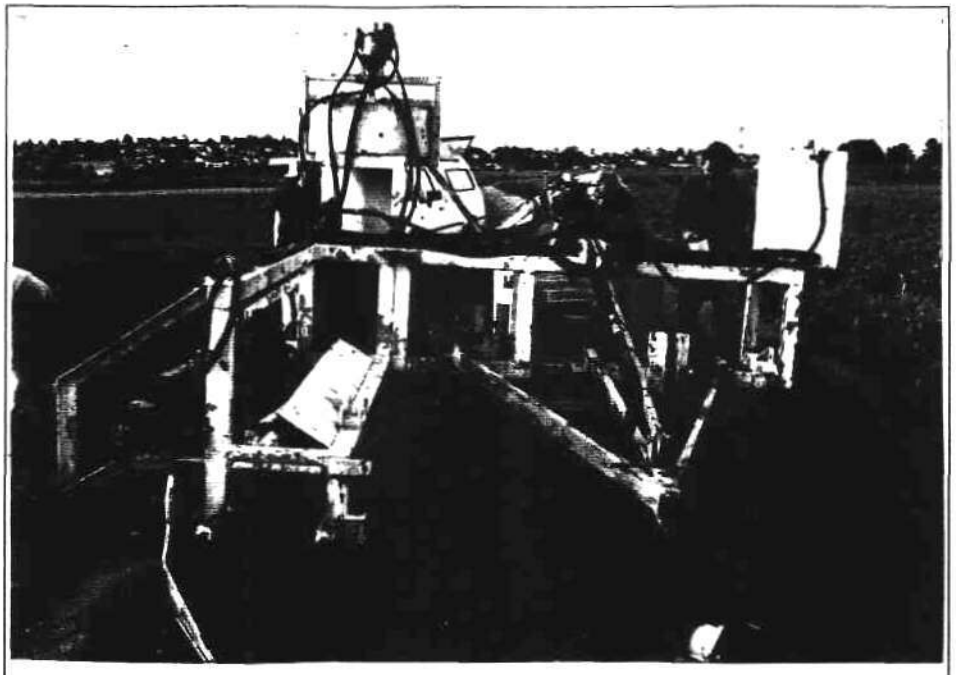
Sorting and Processing:

Green soybeans require sorting and grading, but due to the small volume, (500 kg.) and lack of mechanical grading, most were hand washed and graded. The greatest problem was in processing of the beans. The local IQF factory in Medowie (Air Liquid Pty. Ltd.,) was not operating and the other at the CSIRO, North Ryde (BOC Gas Australia Pty. Ltd.,) required a firm commercial agreement.

A plant in Young (J.D.'s Fruit [Young, NSW] Pty. Ltd.,) undertook the job to freeze by Nitrogen Liquid (at -35$^0$C), pack (250 g net weight) and store the beans at -18$^0$C before shipping to Japan. However, as the freezing equipment had been idle for some time and did not operate correctly until the end of the processing, quality of product was not as good as expected, especially in comparison with product from the CSIRO, North Ryde, in 1994. A total of 100 kg. was finally processed.

Appraisal and taste testing was organised at Unico-op Japan in both their Sydney and Tokyo offices in April, 1996 with results showing that the 1995/96 Australian-produced material would not be accepted into Japanese markets if we were unable to improve on pod appearance (bruises on skins) and pod quality (improper freezing) - Appendix II.

If Australian-produced frozen green soybean is no better than the Chinese product in quality, it would be very difficult for us to penetrate into Japanese markets.

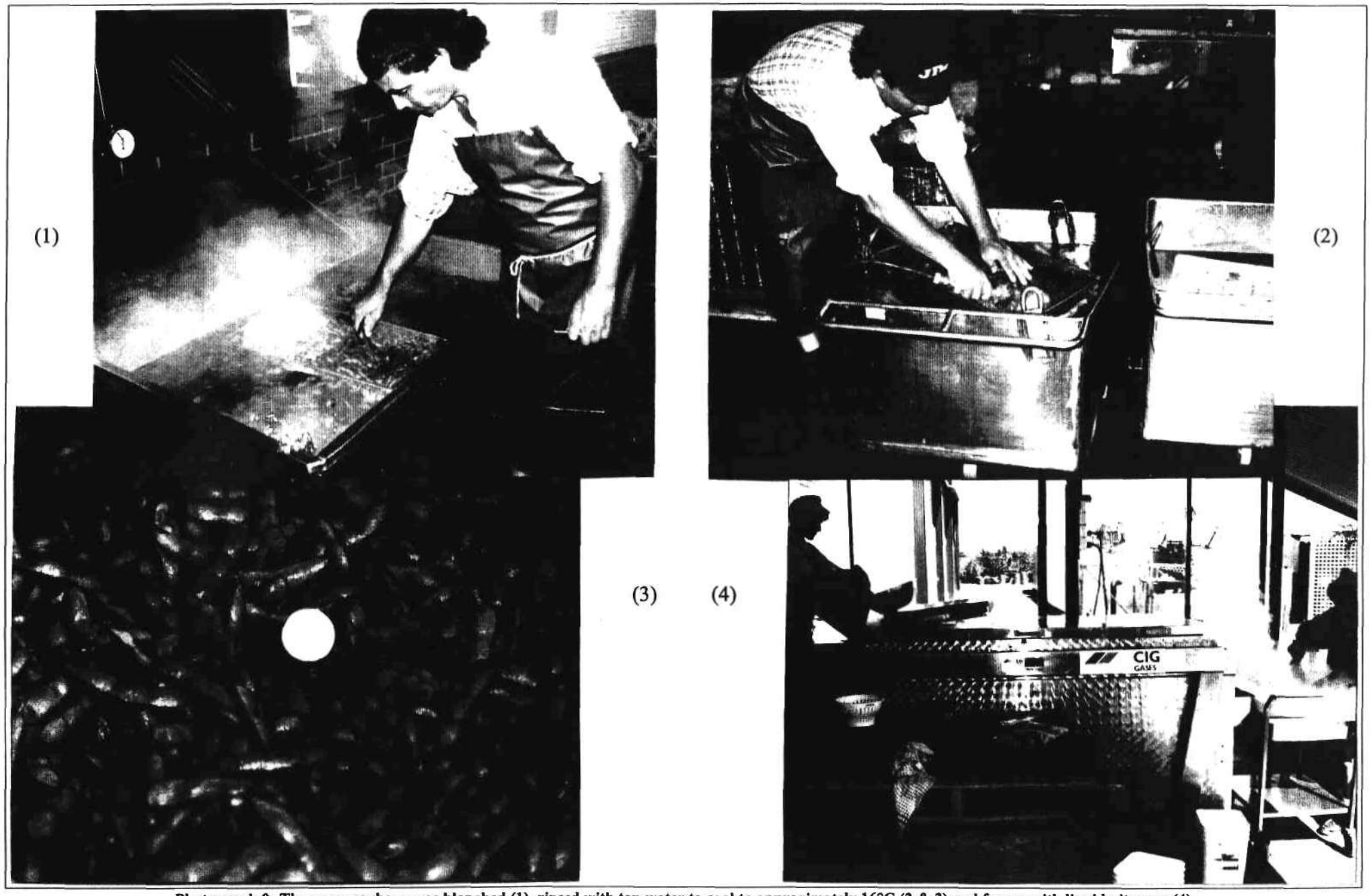


(a)

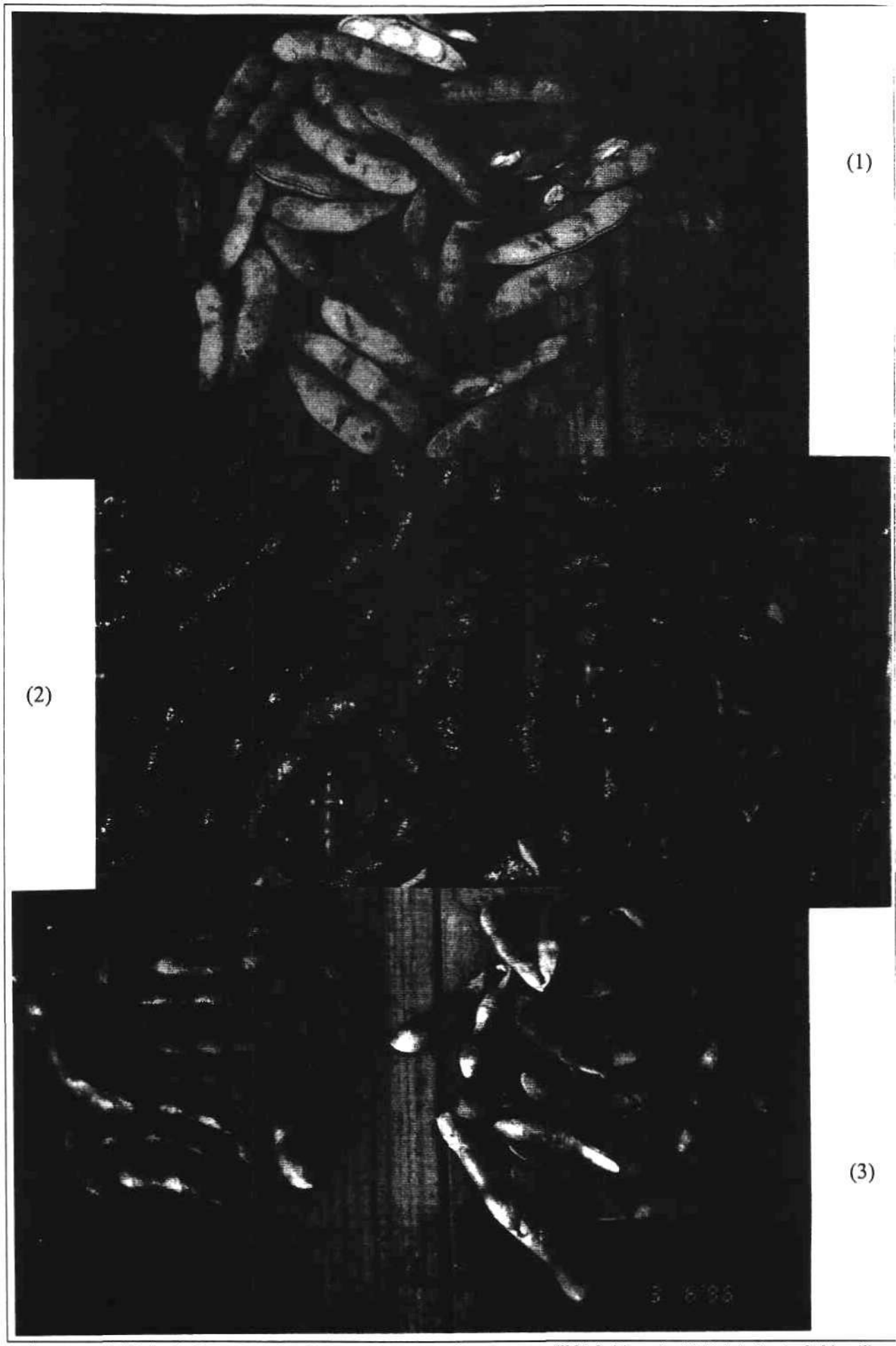
(b)

(c)

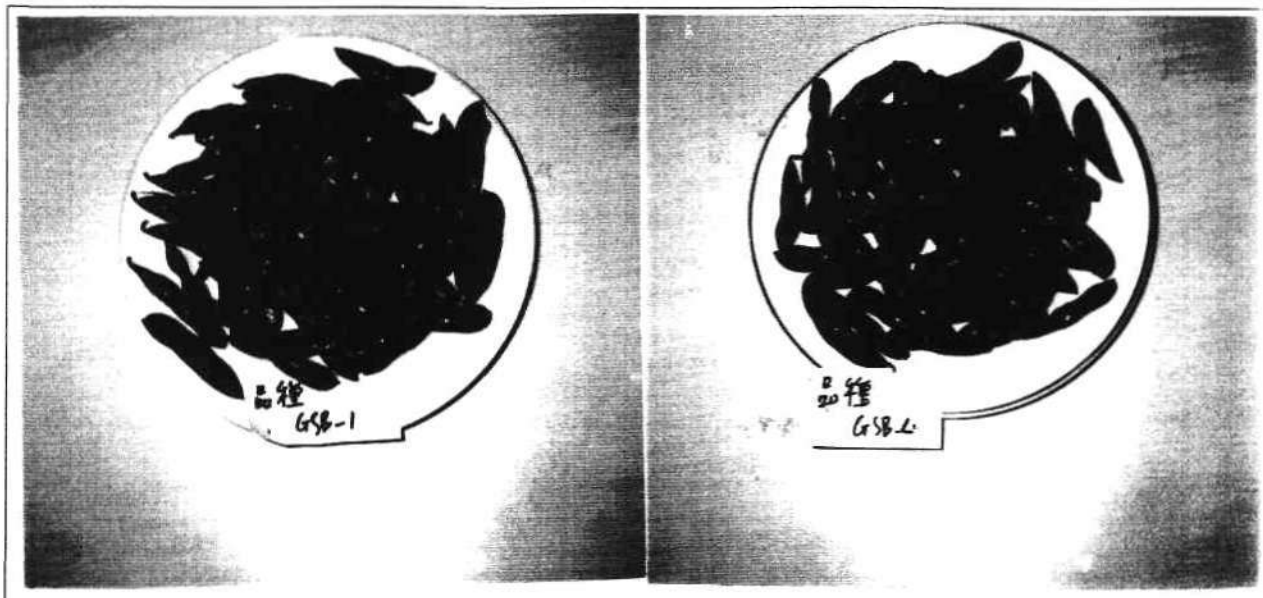
**Photograph 8: (a) & (b) Mechanical harvester used for green soybean harvesting. (c) Mechanical harvester picked up 76% of beans from top of plant with approximately 24% at bottom level being left on plants. In addition, 7% of picked pods were severely damaged.**



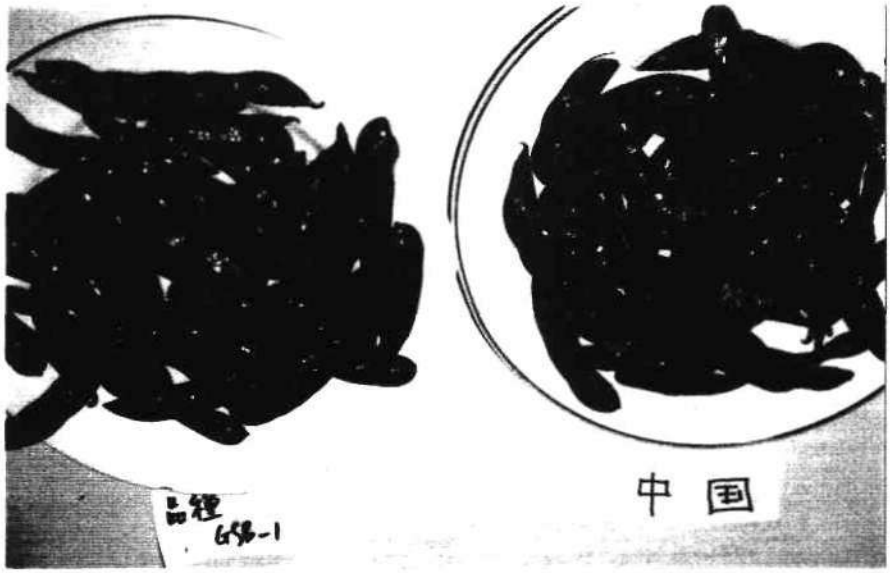

**Photograph 9: The green soybean was blanched (1), rinsed with tap water to cool to approximately 16°C (2 & 3) and frozen with liquid nitrogen (4).**

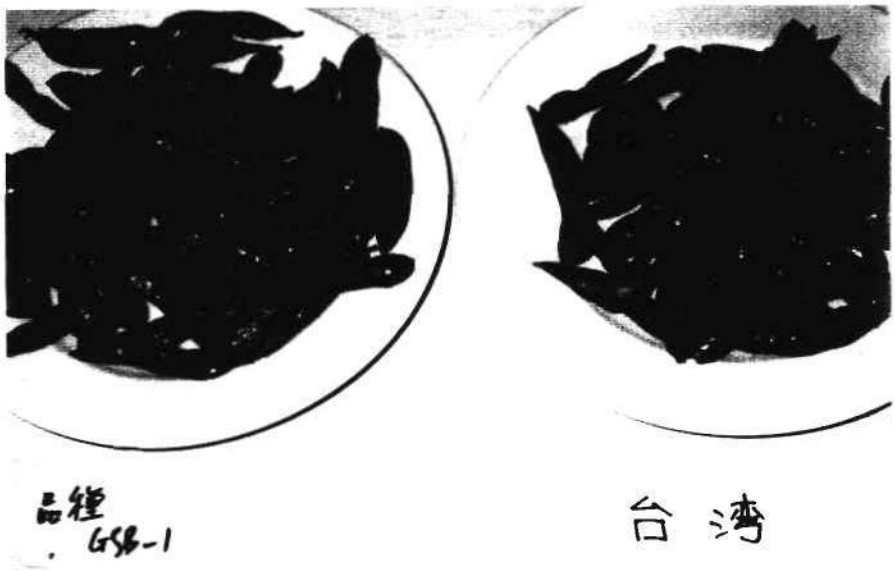



**Photograph 10. Quick frozen green soybean when pod temperature was still high (1), pod with lightly bruised skins (2) and/or inadequate nitrogen liquide (3 - right) contributed to poor quality of product.**




(1)




(2)

**Photograph 11. (1) Frozen Edamame produced in Australia and used for taste testing in Tokyo, Japan and (2) Australian Edamame compared with Chinese (above) and Taiwanese (below).**

**Table 12. Performance of mechanical harvesting on green soybean in Osborn Farm, East Maitland (Trial 3, cultivar GSB-1), 1995-96[1].**

| | $R_1$ | | $R_2$ | | $R_3$ | | Mean | |
|---|---|---|---|---|---|---|---|---|
| 1. Pre-harvest[2]: | | | | | | | | |
| First grade pod/plant | 29 | 72 | 10 | 31 | 14 | 48 | 16.7 | 50.7 |
| Second grade pod/plant | 16 | 19 | 21 | 31 | 20 | 30 | 19.0 | 26.7 |
| Total pod/plant | 45 | 91 | 31 | 62 | 34 | 78 | 35.7 | 77.0 |
| First grade pod (t/ha) | | 3.79 | | 1.63 | | 2.53 | | 2.65 |
| Second grade pod (t/ha) | | 1.00 | | 1.63 | | 1.58 | | 1.40 |
| Total yield (t/ha) | | 4.79 | | 3.26 | | 4.11 | | 4.05 |
| 2. Post-harvest[3]: | | | | | | | | |
| First grade pod/plant | 7 | 20 | 2 | 5 | 3 | 6 | 4 | 10.3 |
| Second grade pod/plant | 4 | 6 | 8 | 11 | 6 | 8 | 6 | 8.3 |
| Total pod/plant | 11 | 26 | 11 | 16 | 9 | 14 | 10.3 | 18.7 |
| First grade pod (t/ha) | | 1.05 | | 0.26 | | 0.32 | | 0.54 |
| Second grade pod (t/ha) | | 1.32 | | 0.58 | | 0.42 | | 0.44 |
| Total yield (t/ha) | | 1.37 | | 0.84 | | 0.74 | | 0.98 |

3. Conclusion:

Loss by mechanical harvest:

- First grade pod yield = 0.54 t/ha (20.8%)
- Second grade pod yield = 0.44 t/ha (30.7%)
- Total pod yield = 0.98 t/ha (23.9%)

Note: 1) Measurement of five plants in each replication

2) Pod yield per plant before harvest

3) Pod left over on plant after mechanical harvest.

**Table 13. Physical damage by mechanical harvesting of green soybean at Osborn Farm, East Maitland (Trial 3, Cultivar GSB-1), 1995-96.**

| | $R_1$ | $R_2$ | $R_3$ | $R_4$ | Mean |
|---|---|---|---|---|---|
| Physical damaged (pod number/100 pods) | 10 | 4 | 2 | 12 | 7 |

Note: 1) Measurement of 100 pods in each replication.

## 2.4 DISCUSSION:

From this study, it is evident that:

i) Fresh market green soybean can be produced on the Central Coast of New South Wales from January to March. Pod yields of cultivars GSB-1 and GSB-4 were highest in the December planting, ie. 9.2 t/ha and 9.9 t/ha respectively, which were considered high in comparison with those in Japan where average yields of green pods are 8 t/ha. The quality of green pod colour is extremely good with pods measuring 5.5-5.7 mm long x 1.3 mm wide and weighing 3.3-3.7 g per pod.

ii) Fresh market green soybean can be produced in the Hunter Valley of New South Wales at the same time as on the Central Coast. The low yield at Osborn farm in the December, 1995 planting was caused by bad weather. However, for mechanical harvesting it would be better if crops were grown on flat ground rather than on raised beds. There is a need for other varietal screening trials to select the most erect and tallest cultivars that would be better suited to mechanical harvesting. Cultural technology also needs to be considered.

iii) Three field trials which were sown on 15th December, 1994, 25th January, 1995 and 15th November, 1995 and which were organised at Parle Foods and the Griffith Centre for Irrigated Agriculture, Griffith, confirmed that cultivars GSB-1 and GSB-4 were unsuitable for this region as they produce poor quality seed in small amounts of pods.

iv) From the viewpoint of domestic markets, the fresh attached type which is marketed in bundle form of stem branches and pods, was most preferable because of its fresh appearance. For the detached type which is marketed only as pods in plastic net, little interest was shown due to the similar form of frozen product although its flavour and freshness were equal to the attached type.

v) The fresh bean harvester is capable of doing a very good job in harvesting vegetable green soybean, removing approximately 76% of beans and separating foliage and stalks. The machine would have done better if there had been time to spend on fine adjustment to speed of fans, belts and tractor to eliminate the physical damage of pods.

Harvest time, using the single row machine, is approximately one quarter ha per hour. Larger machines, which would improve on this, are available.

Bean quality was good with little trash but not satisfactory with bruising of skins with approximately 7% of beans were severely bruised from the harvester. Mechanical harvesting was seen as a doubtful part of production of vegetable green soybean. These problems can be solved if some improvements are done on the existing bean harvester.

vi) Beans required washing, sorting and grading and due to the small volume, (500 kg.), this was done by hand. This was a relatively simple task, but a moving belt with good grading and a fan to remove the residual trash would be required. Prewashing of the beans in cold water would also remove most dirt and trash and help to decrease bean temperature as this crop respires and temperature rises after harvest.

A method of sorting the single (one-seed) pod and over three-seed beans from the two and three-seed pods would be the use of a brush although it is possible by hand using a conveyor belt.

vii) With the co-operation of Air Liquid and BOC Gas two types of gas, ie. Carbon dioxide ($CO_2$) and Nitrogen (N), have been tested to produce snap-frozen green soybean by IQF (Individual Quick Frozen) technology. Both methods produced satisfactoryly high quality pods.

viii) Blanching conditions and timing from blanching to freezing were found to be extremely important for producing good coloured frozen pods. Freezing at 95°C for two minutes immediately after blanching is preferable in producing high quality pods.

ix) Gross margins for vegetable green soybean growing on the Central Coat of New South Wales has been calculated (Table 14) with total variable costs for frozen vegetable green soybean being estimated at approximately A$7,723.

x) The commercial application for large-scale production of frozen green soybean for Japanese markets is now very much reliant on professional processors who are able to manage the whole system from growing to processing and marketing.

**Table 14. Gross margin for vegetable green soybean growing on the Central Coast of New South Wales.**

| | | |
|---|---|---|
| **ENTERPRISE:** | **Irrigated Green Soybean** | **Central Coast** |
| **UNIT:** | 1 ha | February, 1996 |
| **INCOME:** | 5,000 kg. @ $2.00/kg. | $10,000 |

**TOTAL INCOME**

**VARIABLE COSTS:**

| Tractor: 45 kW. @ 12.61/hr. | **Cost per unit ($)** | **Standard budget ($)** |
|---|---|---|
| Two cultivations - 1hr. | | 25.22 |
| One broadcast (fertiliser) - 0.3 hr. | | 3.78 |
| Bedforming -1 hr. | | 12.61 |
| Sowing: | | |
| Seed - 45 kg./ha | 5.00/kg. | 225.00 |
| Sow - 1 hr./ha | | 12.61 |
| Growing: | | |
| Fertiliser - 30 bags/ha | 17.33/bag | 519.90 |
| Side dressing KNO3 - 4 bags/ha | 48.60/bag | 194.40 |
| Five boomspray - 2 hr. | | 126.10 |
| Weedcontrol Linuron® - 8 kg./ha | 34.00/kg. | 272.00 |
| Spray: | | |
| Two Ambush - 0.1 1/ha | 134.00/1 | 26.80 |
| Two Lannate - 2.1 1/ha | 16.87/1 | 70.85 |
| Dithane M - 0.15 kg./ha | 4.50/kg. | 0.68 |
| Benlare - 1.1 kg./ha | 50.53/kg. | 55.58 |
| Irrigation - 7.5 ml/ha | 35.00/ml | 262.50 |
| Pumping - 7.5 ml/ha | 17.00/ml | 127.50 |
| Harvesting: | | |
| Picking, grading, washing, packaging | 0.35/kg. | 1,750.00 |
| Processing (snap frozen) | 0.30/kg. | 1,500.00 |
| Packaging materials: | | |
| Plastic bag: 24 cm x 12 cm printed: 25,000 bags | 0.0075/kg. | 37.50 |
| Carton: 10kg. @ $2.00 500 cartons | 0.20/kg. | 1,000.00 |
| Transportation to Japan (by sea) | | |
| $4,500 for container of kg. 15,000 | 0.30 | 1,500.00 |
| **Total variable costs:** | | 7,723.00 |
| Gross margin/ha: | | **2,277.00** |

**Table 15. Parametric budget-Effect of yield and price on gross margin/ha.**

| Yield kg./ha | Price ($/kg.) (C and F Japan) | | | | |
|---|---|---|---|---|---|
| | $1.50 | $1.75 | $2.00 | $2.25 | $2.50 |
| 3,000 | -908 | -158 | 592 | 1,342 | 2,092 |
| 4,000 | -566 | 434 | 1,434 | 2,434 | 3,434 |
| 5,000 | -223 | 1,027 | **2,277** | 3,527 | 4,777 |
| 6,000 | 119 | 1,619 | 3,119 | 4,619 | 6,119 |
| 7,000 | 462 | 2,212 | 3,962 | 5,712 | 7,462 |

## 3. RECOMMENDATIONS:

### 3.1 Extension/Adoption by industry:

Discussion with Japanese vegetable importers has confirmed the potential of fresh vegetable green soybean as a cash crop for export from Australia. However, due to quarantine problems, only green soybean which is grown in Tasmania is allowed to be exported to Japan as fresh product.

In a previous study (Development of vegetable green soybean for domestic and Japanese markets - HRDC Project No. V/0130/RO) has shown that many tested cultivars, which are high in yield and pod quality, can be promoted into the Tasmanian vegetable industry, thus providing opportunities to target peak periods for demand of fresh markets in Japan during January, February and March.

For frozen green soybean, investigation of Japanese markets has shown that average wholesale prices have reduced annually since 1990 (Table 4). The price reductions may be due to an increase of Chinese supplies. It should be noted that frozen green soybean from China has achieved lower prices due to its poorer quality. However, Chinese product is expected to improve in quality in the future as Taiwanese companies introduce their processing technology to China. If this is the case, wholesale prices would be fixed at approximately 190 ¥/kg. which is equivalent to A$2.50/kg. (A$ = 74 ¥, 1994).

Cultural and freezing techniques used in this study could very easily be adapted to suit domestic production. Mechanical harvesters, washer machines and graders (separating machines in particular) need to be developed to suit the Australian vegetable green soybean industry.

Due to critical processing procedures in which beans should be immediatelyh frozen after harvest, a factory needs to be developed or located in the area. Equipment is not overly expensive but gas suppliers are careful about their business activities. Therefore, a factory would need to have other requirements to maximise production. Seafood and fruit are also suitable for this process together with other perishable foods.

Discussion with Hunter Valley OLMA was held in 1995 and 1996 for the establishment of a green soybean industry in that area for which OLMA will provide funds. NSW Agriculture will undertake the organisation of growers, a seed producer together with harvesting and packing of crops. Unico-op Japan has been requested to supervise the frozen green soybean product in Japanese market places.

A close working relationship such as the above has been developed between soybean growers, research and extension personnel in NSW Agricutlure and Japanese vegetable importers and research findings are rapidly adopted by the industry.

3.2 Directions for future research.:

Appropriate techniques for growing, harvesting, depodding and freezing have been defined and the next stage of the project should be:

1. Identification of any likely processor;
2. Identification of an area and production methods to achieve the volumes required for a commercial shipment. NKY Line is keen to help (M/O Peter Jones). Reefers cost A$4,600 for 15 t capacity;
3. Develop seed sources to meet requirements of a commercial planting. An average of 50 kg. of certified seed is required for a one ha planting,
4. Develop Quality Management from growth to marketing. Produce a Manual, eg. an Agfact on production of fresh vegetable green soybean;
5. Establish joint ventures with Japanese companies, organise meetings with them to improve movement of product. The following trading companies would be contacted in dealing with green soybean production.

   - Unico-op Japan (Australia) Pty. Ltd.,
     Suite 603, 25 Bligh Street,
     SYDNEY NSW 2000.
     Telephone: (02) 232 5312; Fax: (02) 221 6968
     Contact person: Mr. Shingo Nakatsuka, Managing Director.

   - Sumitomo Australia Ltd.,
     Level 41, Governor Phillip Tower,
     1 Farrer Place,
     SYDNEY NSW 2000.
     Telephone: (02) 335 3732; Fax: (02) 335 3777
     Contact person: Mr. Masaaki Uemura, General Manager.

- Austwinds International Pty. Ltd.,
  Hangar 103, Lionel Street,
  ESSENDON AIRPORT VIC. 3041
  Telephone: (03) 9379 8397; Fax: (03) 9379 8514
  Contact person: Ms. Miho Hayashi.

- Japan Food Corp (Australia) Pty. Ltd.,
  10/175 Gibbes Street,
  CHATSWOOD NSW 2067.
  Telephone: (02) 417 7566; Fax: (02) 417 5972
  Contact person: Mr. Mitsuaki Miyashiro, General Manager.

- Tokyo Mart Pty. Ltd.,
  3/171 Gibbes Street,
  CHASTSWOOD NSW 2067.
  Telephone: (02) 417 7200; Fax: (02) 417 7469
  Contact person: Mr. Masa Mura, General Manager.

3.3 Financial/Commercial Benefits:

The minimum wholesale price which Japanese has paid to China for frozen green soybean is 174 ¥/kg. which is equivalent to A$2.35/kg. If Australia could supply Japan's requirements of approximately 10,000 t of frozen green soybean during the period from January to March, Australia would earn minimum of A$23.5 million. If Tasmania could supply fresh green soybeans during the same period when Japanese markets pay a peak premium, ie. 400-600 ¥/kg. (A$5.4-A$8.1/kg. [A$ = 74 ¥]), supplies of 10,000 t would, therefore, bring a return of A$54~A$81 million.

It is envisaged that the green soybean will be grown in Australia by vegetable growers on the Central Coast, or in the Hunter Valley of New South Wales and seed grain from Southern areas of New South Wales will be supplied to these growers.

## 4. PUBLICATIONS:

4.1 Magazines/Newspaper:

- Town and Country, January, 1995. Opportunity in Soybean.
- NSW Agriculture Today, February, 1995. Green Soybean Market Chance:27.
- The Land, February, 1996. Japan Export Hopes Rise in Green Soybean Trial.
- NSW Agriculture Today, February, 1996. Green Soybean Set to Expand into Export Area:13.

4.2 TV/Radio:

- ABC Radio, Maitland, 6th January, 1995: Green Soybean.
- ABC Radio, Muswellbrook, 17th October, 1995: Green Soybean to Japan.
- NBN TV, News 24th January, 1996: Vegetable Green Soybean.

4.3 Seminar/Field day:

- "Vegetables to Japan". In "Vegetables to Asia", Seminar in Cowra on 6th February, 1996.
- "Overview of Market Green soybean". In "Vegetables to Asia" Field Day at Griffith on 23rd February, 1996.

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Kamiyama, Y., 1991. Vegetable soybean seed production technologies in Japan : 43-44.

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Masuda, R., 1991. quality requirement and improvement of vegetable soybean : 92-102.

Nakano, H.J., 1991. Vegetable soybean area, production, demand, supply, domestic and foreign trading in Japan : 8-16.

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Shanmugasundaram, S. *et al.*, 1991. Varietal improvement of vegetable soybean in Taiwan : 30-42.

Takahashi, N., 1991. Vegetable soybean varietal improvement in Japan - Past, Present and Future : 26-28.

# APPENDIX I

## APPRAISAL AND TASTE TESTING

## UNICO-OP JAPAN, TOKYO, JAPAN

## ASSESSMENT OF FROZEN GREEN SOYBEAN PRODUCED IN AUSTRALIA APRIL, 1996, TOKYO, JAPAN

Frozen green soybean (Reito edamame) samples produced in Australia in March of 1996 were assess at the Tokyo Head Office of Unico-op Japan in early April, 1996 by eight panellists. Results of the assessment were as follows:

**A. Cultivar GSB-1:**

1. External appearance:

| | | | | |
|---|---|---|---|---|
| a) Pod colour | Good (2); | Bad (6); | | |
| b) Pod hair | Good (3); | Bad (5); | | |
| c) Pod size | Good (3); | Bad (3); | | |
| d) Acceptance of two-seed pods | Yes (8); | No (0); | | |

2. Quality:

| | | | | |
|---|---|---|---|---|
| a) Taste | Excellent (0); | Good (4); | Fair (2); | Bad (2); |
| b) Texture of bean | Normal (3); | Soft (0); | Hard (5); | |
| c) Comparison with Edamame from: | | | | |
| China | Excellent (0); | Good (0); | Fair (8); | |
| Taiwan | Excellent (0); | Good (0); | Fair (8); | |

3. Other comments:
   * Pod colour is not bad but not as good as those coming from Taiwan and/or China.
   * Pod appearance is unacceptable due to bruising on skins.

**B. Cultivar GSB-4:**

1. External appearance:

| | | |
|---|---|---|
| a) Pod colour | Good (2); | Bad (6); |
| b) Pod hair | Good (6); | Bad (2); |
| c) Pod size | Good (5); | Bad (3); |
| d) Acceptance of two-seed pods | Yes (8); | No (0); |
| e) Acceptance of light bruising on skin | Yes (0); | No (8); |

2. Quality:

| | | | | |
|---|---|---|---|---|
| a) Taste | Excellent (0); | Good (2); | Fair (4); | Bad (2); |
| b) Texture of bean | Normal (4); | Soft (0); | Hard (4); | |
| c) Comparison with Edamame from: | | | | |
| China | Excellent (0); | Good (0); | Fair (8); | |
| Taiwan | Excellent (0); | Good (0); | Fair (8); | |

3. Other comments:
   * GSB-4 appears to be better than GSB-1 but is still below the Taiwanese and China's standard.
   * Bruising on skin is unacceptable.

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**Conclusion from tests and author's comments:**

i) Pod colour is not good enough due to unfavourable growing conditions;
ii) Pod hair colour : white pod hair colour is preferred;
iii) Bruising, even light bruising, on skin is unacceptable;
iv) Hard texture of bean : processing technology, including blanching and freezing, needs improvement;
v) Commercially-produced Australian Edamame is unacceptable as being of better quality than those from Taiwan and China.