## Keynote Address

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Director General Sekiya, Director Nakagawa, Dr. Kauffman, Distinguished Participants:

It is a privilege for me to welcome you to this international symposium on soybean. My colleagues and I at the Asian Vegetable Research and Development Center appreciate your presence here and look forward to your presentations. We are also most grateful for the support of the various donors and for these excellent facilities provided by the Tropical Agriculture Research Center.

The Green Revolution, which greatly increased cereal crop production through the use of new high-yielding cultivars appears to have averted a pending world food crisis. Increased production in Asia has created a rice surplus for the first time in memory. Paradoxically, this occurs at a time of famine in several African countries.

Twenty years ago, nearly 30% of the world's population suffered from nutritional diseases (Aykroyd and Doughty, 1980). Today, despite the apparent adequacy of staple food production in the world, protein and calorie malnutrition are widespread (FAO, 1981). Even though several developing countries are now exporting staple crops, the percentage of the world's population suffering from nutritional diseases has not decreased, and this year an estimated 40 million people will die of starvation or nutrition-related diseases. In developing countries, nearly half of all children exhibit symptoms of malnutrition. The silent crisis of protein and calorie malnutrition may be denying a billion human beings of the opportunity to realize their physiological and intellectual potential (Brown, 1974).

The need for soybean is amply demonstrated by tremendous increases in world demand. Production more than doubled between 1970 and 1979, from 46.7 million tons to 94 million tons. By the year 2000 demand is expected to reach 275 million tons (Shanmugasundaram and Selleck, 1982).

It is unlikely that greater amounts of animal protein will be available to the world's poor in the near future, mainly because of high cost. In India vegetable protein sells for about US$ 0.25/kg compared with US$ 4-5/kg for mutton, chicken, and eggs (Shanmugasundaram and Selleck, 1982). Soybean can play a major role in alleviating nutrition-related diseases. In terms of its biological value and net protein utilization, soy protein is superior to corn, wheat, or rice (Table 1). Current

**Table 1 Biological value of protein from selected commodities**

| Source | Biological value | Protein score | New protein utilization |
|---|---|---|---|
| Egg | 96 | 100 | 100 |
| Soybean | 72 | 70 | 56 |
| Corn | 54 | 45 | 55 |
| Wheat flour | 53 | 50 | 52 |
| Rice (milled) | 61 | — | 59 |

world average yields of soybean are about 1.7 ton/ha. Of this amount, approximately 38% is protein, which translates into about 0.65 ton/ha. This compares with 0.27 and 0.46 ton/ha for wheat and corn, respectively (Table 2) and translates into high protein productivity in terms of kg/ha/day.

Soybean has been an important food crop in Asia for 5000 years (Ma and Zhang, 1983). This crop has made an important contribution in supplying protein and other nutrients to human diets. Aside from its uses as animal feed and as a source of oil, soybean can be consumed as texturized protein (tofu), as a whole soybean food, and as a vegetable (seeds and sprouts).

**Table 2 Energy input and output relationship for selected crops per hectare in the USA**

| Crop | Crop yield ton/ha | Crop yield in protein ton/ha | Crop yield in food energy $10^6$K cal | Fossil energy input for production $10^6$K cal | Labor (man-hours) | K cal fossil energy input/ K cal protein output |
|---|---|---|---|---|---|---|
| Soybean | 1.9 | 0.65 | 7.6 | 5.3 | 15 | 2.1 |
| Corn | 5.1 | 0.46 | 17.9 | 6.6 | 22 | 3.6 |
| Wheat | 2.3 | 0.27 | 7.5 | 3.8 | 7 | 3.4 |

**Table 3 Protein productivity of major cereals and grain legumes**

| Crop | Estimated yield ton/ha (1) | Crop yield in food energy $10^6$K cal | Protein content % | Crop duration days | Protein productivity kg/ha/day[a] |
|---|---|---|---|---|---|
| Legumes | | | | | |
| Soybean | 1.7[c] | 6.9 | 38 | 95 | 6.8 |
| Lima bean | 3.2 | —[b] | 25 | 115 | 7.0 |
| Cowpea | 1.8 | — | 25 | 80 | 5.6 |
| Peanut | 1.6 | — | 26 | 120 | 3.5 |
| Winged bean | 1.4 | — | 31 | 112 | 3.9 |
| Chickpea | 2.5 | 2.3 | 20 | 125 | 4.0 |
| Mungbean | 0.9 | 2.9 | 24 | 75 | 2.9 |
| Cereals | | | | | |
| Rice | 5.0 | 18.1 | 7.5 | 140 | 2.7 |
| Wheat | 2.3 | 7.6 | 11.9 | 100 | 2.7 |
| Maize | 4.0 | 14.0 | 9.5 | 120 | 3.2 |
| Sorghum | 3.5 | 11.7 | 10.1 | 110 | 3.2 |

[a] $\frac{1\times 2}{3}=4$

[b] Not available

[c] World average for 1979

The establishment of international soybean research programs marks a turning point in the history of soybean in the tropics and subtropics. At AVRDC, new cultivars with improved adaptability to tropical environments have been developed and released to farmers in India, Indonesia, Malaysia, Honduras, Sri Lanka, and Taiwan (AVRDC, 1983). During the past 10 to 15 years, breeding efforts by national programs in the tropics, i.e. Thailand, Indonesia, Brazil, and Korea, have also made significant contributions to soybean production.

The introduction of photoperiod- and temperature-insensitive, narrow-leaflet types with increased photosynthetic efficiency and improved resistance to diseases and insects further enhances production potential of soybean in the tropics (Shanmugasundaram and Selleck, 1982). Soybean yields of 2 ton/ha are attainable on farmers fields through the use of improved varieties and management practices presently available. In the future, yields of 4 ton/ha may be attainable (Shanmugasundaram *et al*., 1980).

Unlike in the temperate countries, soybean can be grown the year around in the tropics and subtropics. Furthermore, the crop can be introduced without jeopardizing the production of other staple crops. Soybean fits well into multiple cropping systems and can be intercropped with staple or plantation crops (Shanmugasundaram, 1976).

Vegetable soybean seeds and sprouts can be grown successfully even during hot, humid conditions when other vegetables are in short supply. Unlike grain soybean, vegetable soybean can be harvested during wet weather with little or no adverse effect on yield or quality.

The ability of soybean to fix atmospheric nitrogen through its symbiotic relationship with *Rhizobium* is a major advantage (Hardy *et al*., 1980). Nearly 90% of the crop's N requirement is provided through biological nitrogen fixation. In developing countries alone, nitrogen fixation resulted in savings of US$ 1.5 billion in producing the 1979 soybean crop which was valued at US$ 4.66 billion (Shanmugasundaram and Selleck, 1982).

This symposium is unique in that the discussion of production in tropical and subtropical environments will focus on cropping systems. To be successful, soybean production must be considered as a component in integrated cropping systems, modified appropriately for changing environments. INTSOY, IRRI, IITA, and AVRDC, along with various national institutions have done considerable work in this area. It is now time to review this research. What are the areas of achievement? What problems have developed? Which strategies can resolve, circumvent, or minimize these problems? Do present researcher philosophies coincide with farmers' requirements? To progress, national programs and international Centers must identify priorities for research, generate improved high-yielding varieties and appropriate economical management technologies, improve consumer products that are nutritious and acceptable in local diets, and most important, efficiently transfer new technology to farmers. If your efforts can increase average yields by only 0. 1 ton/ha, total annual production in Asia will increase by one million tons.

I therefore hope that this symposium will identify soybean production and utilization problems in the tropics and help to integrate the research generated in the more than 25 countries represented here today. I expect that special efforts will be made to identify where and how research and extension can increase soybean production, development, and utilization. I trust that in future national programs will commit resources to the transfer of technology without jeopardizing the welfare of the farmer in the process.

Obviously, the potential for soybean in the tropics is great, the challenges are many, and the responsibilities are awesome. The well-being of a billion people may well depend upon the success of your plans and programs for the future. I wish you every success in your deliberations.

## References


1) The Asian Vegetable Research and Development Center, 1983. AVRDC, The first decade. (AVRDC publication 83-192). Shanhua, Taiwan, ROC. (In press).
2) Aykroyd, W. R. and J. P. Doughty, Jr., 1980. Legumes in human nutrition. FAO Nutritional

Studies, No. 19. UN Food and Agriculture Organization, Rome.
3 ) Brown, L. R., 1974. Man, food and inter-relationships. Basic Life Sciences 7 : 3-12. Symp. on Agri. and Econ. Dev. in the Tropics, Guatemala City, Dec. 2-6.
4 ) FAO, 1981. Food Outlook No. 3. Rome, Italy, March/81.
5 ) Hardy, R. W. F., U. D. Havelka and P. G. Heytler, 1980. Nitrogen input with emphasis on $N_2$ fixation in soybeans. In : F. T. Corbin ed. World Soybean Conference II Proceedings, pp. 57-72. Westview Press, Colorado, USA.
6 ) Kaldy, M. S., 1972. Protein yield of various crops as related to protein value. Econ. Bot. 26 : 142-144.
7 ) Ma, Rhu-hwa and Zhang Kan, 1983. Historical development of soybean production in China. Proceedings of the first China/USA Soybean Symposium and Working Group Meeting, pp.16-18. Urbana, Illinois, USA.
8 ) Pimentel, D., W. Dritshilo, J. Krummel and J. Kutzman, 1975. Energy and land constraints in food protein production. Science 190 : 754-761.
9 ) Shanmugasundaram, S., 1976. Soybean cropping systems in the tropics. In : R. M. Goodman, ed. Expanding the use of soybeans in Asia and Oceania. INTSOY series 10. INTSOY, Illinois, USA.
10) Shanmugasundaram, S., G. C. Kuo and A. Na Lampang, 1980. Adaptation and utilization of soybeans in different environments and cropping systems. In : Advances in legume sciences. Royal Botanic Garden, Kew, England.
11) Shanmugasundaram, S. and G. W. Selleck, 1982. Soybean, an energy saving protein and oil source. Proceedings of the Tamil Nadu Agricultural University Platinum Jubilee Celebration. (In press).