SOYBEAN IN INDIA
— RETROSPECTIVE AND PERSPECTIVE —

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Abstract

Unless suitable measures are taken in time, rapid increase in population could further increase the gravity of the global problem of food and oil shortage. Soybean, often designated as miracle crop with over 40% protein and 20% oil, has now been recognized all over the world as a potential supplementary source of edible oil and nutritious food. In a society predominantly vegetarian as that of India, the importance of soybean is even more conspicuous.

Soybean is not new for India: black soybean has been cultivated for ages in hills and in some scattered pockets of Central India. However strangely enough, the crop has not so far become popular in the Indian sub-continent and other tropical countries.

The importance of soybean in India as a crop to narrow the oil and protein gap has now been generally appreciated and ambitious plans have been drawn-up. Compared to pulse crops grown in India, soybean produces about 2.5 times more yield with twice as much protein and 20% edible oil. Area under soybean has increased from 300 hectares in 1968 to 900,000 hectares in 1982.

Recognizing the potential of soybean to augment production of vegetable oil and protein-rich food, the Indian Council of Agricultural Research, launched the multi-locational inter-disciplinary All India Coordinated Research Project on Soybean. There are 19 centers involved in the project which represent different agro-climatic regions of the country. In addition, research is also undertaken elsewhere in the country. The headquarters of the project are located at G. B. Pant University of Agriculture and Technology, Pantnagar, India. Research during the period has sequentially led to the identification/development of suitable varieties for different agro-climatic zones of the country and standardization production technology for high yield of soybean. Utilization of soybean is envisaged for oil extraction and use of defatted soybean as well as whole soybean for food and feed. Out of more than 120 solvent extraction plants established in the country, several have started processing soybean for oil extraction. Extrusion products based on defatted soya flour have also come in the market. Recipes, using various percentages of soybean for dishes similar to those being conventionally used in different parts of the country have been published. More recently, "soy milk " and "tofu" are being popularized in some parts of the country.

Lack of appropriate agencies to ensure market to soybean growers and raw material to processors, want of consumers' awareness of the benefits of soy products and need for low cost product process development, have been some of the reasons for slow development. Creation of a center to undertake operational research on product, process and market development studies will go a long way in achieving the target of soybean production and utilization in India.

Introduction

Notwithstanding the fact that due to the combined efforts of agricultural scientists and the ingenuity of Indian farmers significant strides have been made in increasing the food production, the rate of population growth has, to some extent neutralized the impact of increased food productivity. The race between the food supply and population increase has in fact become the

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greatest challenge to man. The population of India has doubled to 684 million in the last 34 years. Thus, 15.53% of the total world population lives in our country. In other words every one of six people in the world is an Indian.

Although, hunger and poor nutrition are the problem of developing and under-developed countries, they are not unknown even in developed countries. A national conference on nutrition held early in 1982 at New Delhi concluded with the observation that 30 million children in India alone are suffering from hunger and malnutrition. On a global level not less than 15 million people die each year due to starvation and diseases caused by malnutrition and 75% of these deaths affect children, resulting in 41,000 deaths each day and over 1,700 each hour. During the 30 minutes of this presentation more than 856 people will have died of starvation and malnutrtion caused by diseases. An estimate of the survey conducted by the FAO and the World Bank, independently, indicates that 450 to 1,000 million people i. e. 11 - 25% of the world population in developing countries do not receive sufficient food (Shurtleff, 1976) .

On the oil front the situation is even more uncomfortable. To narrow the gap between the domestic production and the requirement of edible oil in India, import of soybean oil and soybean grain has been ranging from 3,509 tons to 350,617 tons during 1970 to 1980 (Table 1) . The requirement in India would further increase with increasing per capita consumption of edible oil from the present 11 g/day to the recommended 30 g/day which is likely to occur with the development and rise in living standards of the people, in India.

Table 1 Import of soybean and soy oil (1970-71-1979-80)

Year	Beans (ton)	Oil (ton)
1970-71	—	78,956
1971-72	—	101,506
1972-73	—	50,257
1973-74	—	60,387
1974-75	—	14,874
1975-76	—	3,509
1976-77	—	87,949
1977-78	5	345,795
1978-79	516	350,617
1979-80	—	58,179

Source : Chief Controller of export and import (Statistics Division) "Monthly Statistics of Foreign Trade in India. Vol. 1."

The severity and duration of the world food and oil problem lead only to the conclusion that massive long range, innovative efforts, unprecedented in the human history are necessary to avert the inevitable food crisis. Among the various means to increase the supply of nutritious food and oil for people, agricultural research will continue to play an important role. It has been reiterated that both conventional and unconventional sources of food and oil must be tapped to meet the challenge. Nevertheless, the plain fact that has been emerging is that the yield/unit for many conventional crops has perhaps come to a plateau. This has necessitated the search for unconventional sources of food, nutritious feed and edible oil supply. The potential of soybean in this context has now been generally recognized in India, too.

For over 2 million years in China and 1000 years in Japan, the importance of soybean has been

realized. Soybean has been priced for its remarkable ability to produce over 33% more protein from an acre of land than any other known crop and 20 times as much usable protein as would be raised from an acre given over to grazing beef cattle for growing their fodders (Shurtleff and Aoyagi, 1981). The world production of soybean has increased seven fold from 13,169,000 tons in 1939 to 94,375, 000 tons in1979. The production during the first half of this period doubled while during the second half, it has trebled (USDA Agricultural Statistics, 1980) . This points to the fact that with growth and development of society, the importance of soybean has been increasingly recognized.

Soybean in India

Soybean is not new to India: black soybean has been cultivated for ages in the low hills of the Kumaon and Garhwal regions of UP as well as on the foothills of the Himalayas and in some scattered pockets of Central India. However, strangely enough, the crop has not so far become popular in the Indian sub-continent and other tropical countries. While the importance of soybean as number one in world oil production and as a cheap source of protein for food and feed has been recognized by developed countries, it is ironical that the tropical and sub-tropical under-developed or developing countries are still debating whether soybean is good or bad for their people. Surprisingly, this indifference towards soybean prevails in spite of the fact that in general, these tropical or sub-tropical countries depend for their dietary requirement of protein on less productive and less nutritive pulse crops. It has, however, been realized thad even with concerted efforts, productivity of pulse crops in general could not show a marked increase. Soybean yields are two to three times higher than those of the pulse crops which are the major source of dietary protein requirement in India (Singh *et al.* , 1975) . Soybean also contains twice the quantity of protein and yields 20% edible oil (Gopalan *et al.* , 1971) (Table 2') , and is much cheaper than any pulse crop in India. Besides, soya protein is known for its high lysine, methionine and cystine content.

The importance of soybean in Indian agriculture as a crop to narrow the oil and protein gap has now been generally appreciated and ambitious plans to achieve a target of around 20 lakh hectares under soybean during the Sixth Plan were drawn up.

Many nutritionists indeed expect pulse crops (edible legumes) to play an increasing role in meeting food and protein need at a time of widespread food shortage and malnutrition. The role of soybean in providing a cheap source of protein is undisputed. Fortification of wheat flour with protein-rich defatted soy meal alone would result in 10 - 15% increase in the availability of food, on the one hand and increase of protein content of wheat flour on the other. In addition, several other low-cost products can go a long way in providing protein-rich food to the weaker sections of the society.

Table 2 Average yield, oil and protein content of soybean and other pulse crops in similar conditions in India

Crops	Yield (q/ha)	Oil* g/100g	Protein** g/100g
Soybean (*Glycine max* L.)	29.60	19.5	43.2
Pigeon pea (*Cajanus cajan*)	16.60	1.7	22.3
Black gram (*Phaseolus mungo*)	10.40	1.4	24.0
Cowpea (*Vigna sinensis*)	10.40	1.0	24.1
Green gram (*Vigna radiata*)	8.80	1.2	24.5

Source : *Singh *et al.*, 1975.

**Gopalan, Ramasastri and Babsubramaniam, 1971.

A fallacy

Some sections of society apprehend that soybean in India will compete with groundnut. This however, is not correct. Soil and climatic requirements of the two crops being different, replacement of groundnut by soybean is not likely. In fact, soybean would complement groundnut to meet the national needs of edible vegetable oil. In addition, high protein food will be provided as by-product. Nevertheless, comparative potential of these crops in oil production in India can be well appreciated from the fact that, while a wide gap between the national and world average of soybean productivity for oil (132 kg/ha v/s 216 kg/ha) does exist, in groundnut the national and world average of groundnut oil production per hectare (246kg v/s 258 kg) is almost the same. This highlights the prospects of increasing the national average of soybean yield while increase in groundnut yield could not be expected in the near future.

Time and again the question has been asked whether soybean will displace any crop of importance to disturb the commodity balance in the country. In fact, soybean will not have any adverse effect on other important crops. This is mainly because several hundred thousand hectares of land lying fallow during summer could be utilized for growing soybean (Table 3, William *et al.*, 1974) . This could result in an additional production of 24,84,000 tons of soybean to provide a stable supply of oil in the country.

Table 3 Estimated area potentially available for soybean in Madhya Pradesh and Uttar Pradesh

State	10% of land in		5% of land in	Total potential	
	jowar, small millets, kharif pulses (ha)	kharif fallow (ha)	maize, bajra, cotton, upland paddy (ha)	area (ha)	production (ton)
M. P.	493,000	494,000	140,000	1,127,000	1,401,000
U. P.	157,000	538,000	201,000	896,000	1,083,000
Total	650,000	1,032,000	341,000	2,023,000	2,484,000

Source : Williams *et al.*, 1974.

Soybean development

The increase in area of soybean from 300 hectares in 1968 to about 900,000 hectares during 1981-82 in India speaks for itself and shows that in spite of numerous detractions, the importance of soybean in India has been ultimately recognized. The pace has however been slow (Table 4) .

To promote the soybean development in the country the government of India has launched a centrally sponsored scheme in many States. In addition, Rs. 15,55,55,000.00 have been allocated for soybean development during the VI Plan period in the State of Madhya Pradesh.

Research in India

There is a general consensus in the world that the rate of technological advancement in agriculture must increase to keep pace with our growing requirement of food, timber and fibre. As in the case of other crops, in soybean too, research and educational programs are the key to exploiting its full potential as a cheap source of protein and high quality edible oil.

Recognizing the potential of soybean in meeting the present and future needs of the country for vegetable oil and protein-rich food, the Indian Council of Agricultural Research—an apex national

Table 4 Targetted and actual cultivation (ha) as well as production (ton) in India under the centrally sponsored scheme for soybean development

State	1978—79		1979—80		1980—81		1981—82	
	Acreage	Production	Acreage	Production	Acreage	Production	Acreage	Production
Madhya Pradesh	232,562 (200,000)	232,000 (211,400)	414,341 (40,000)	N. R. (51,400)	447,606* (480,000)	350,000 (375,000)	647,711 (600,000)	500,000
Uttar Pradesh	68,689 (130,000)	60,326 (76,400)	75,866 (137,500)	36,121** (70,400)	131,745 (175,000)	84,002 (106,400)	141,196 (213,000)	100,000
Karnataka	1,181 (3,000)	588 (2,400)	1,296 (3,000)	NGR. (2,400)	— —	— —	— —	—
Bihar	665 (3,000)	500 (2,400)	N. R. (3,000)	N. R. (2,400)	157 (5,000)	77 (4,000)	111 (6,000)	N. R.
Himachal Pradesh	4,000 (3,000)	N. R. (2,400)	244 (3,000)	N. R. (2,400)	4,000 (6,000)	6,000 (4,800)	N. R. (8,000)	N. R.
Rajasthan	—	—	—	—	12,500 (2,000)	6,250	13,000 (10,000)	11,975
Total	307,087 (339,000)	293,414 (395,000)	491,747 (556,500)	36,121 (139,000)	596,008 (668,000)	446,329 (490,200)	802,018 (837,000)	611,975

Figures in parenthesis indicate targetted acreage and production.
* However, the State has taken-up a coverage of 6,000 hectares during 1980—81.
** Due to drought the yield and total production have decreased.
The production figures are communicated by the Director of Agriculture and the concerned States.
N. R. = Not received.
Source : Directorate of Oilseeds Development, Ministry of Agriculture, Government of India.

body for agricultural research—launched the multi-locational inter-disciplinary All India Coordinated Research Project on Soybean in 1967 (Fig. 1) . There are 19 centers involved in the project which represent different agro-climatic regions of the country. In addition, research on specific aspects is being independently undertaken at some other institutes/universities in the country. The headquarters of the project are located at G. B. Pant University of Agriculture and Technology Pantnagar, India (Fig. 2). The total outlay of the project is Rs. 86,26,997.00 (US$ 8, 62,699.7) (Bhatnagar, 1981c) . Eighty one scientists are engaged in soya research. Under an international cooperation program with the USA, a project on Post-Harvest Technology of Soybean has also been approved. Moreover it has been decided to set up a National Soybean Research Center in India.

Some of the main objectives of the All India Coordinated Research Project on Soybean have consisted of the identification and development of varieties suited to the various Indian conditions; standardization of production technology for high yield of quality soybean as pure or companion crop; isolation and standardization of techniques for commercial production of the most efficient strains of *Rhizobium* for soybean plant; surveillance of diseases and their control with economic threshold; post-harvest technology; product development, marketing and economics.

The research efforts devoted so far in India sequentially led to an understanding of the genotype environment interaction, identification/development of suitable varieties and standardization of production technology for remunerative yield.

Screening of 4,000 germplasm collected from all over the world has resulted in the identification of resistance of yellow mosaic (UPSM-534, *G. formosana*) , rust (Ankur) , bacterial pustule (Bragg) and *Macrophomina*. These sources of resistance are being used for evolving disease-resistant varieties of soybean (Singh *et al.* , 1974) .

Varietal improvement program attaining high priority has resulted in the identification/ development of suitable exotic and indigenous varieties for different agro-climatic zones (Table 5). Some varieties in pipeline incorporating, resistance to yellow mosaic and other diseases, have widened the scope of soybean cultivation in India (Bhatnagar, 1982) .

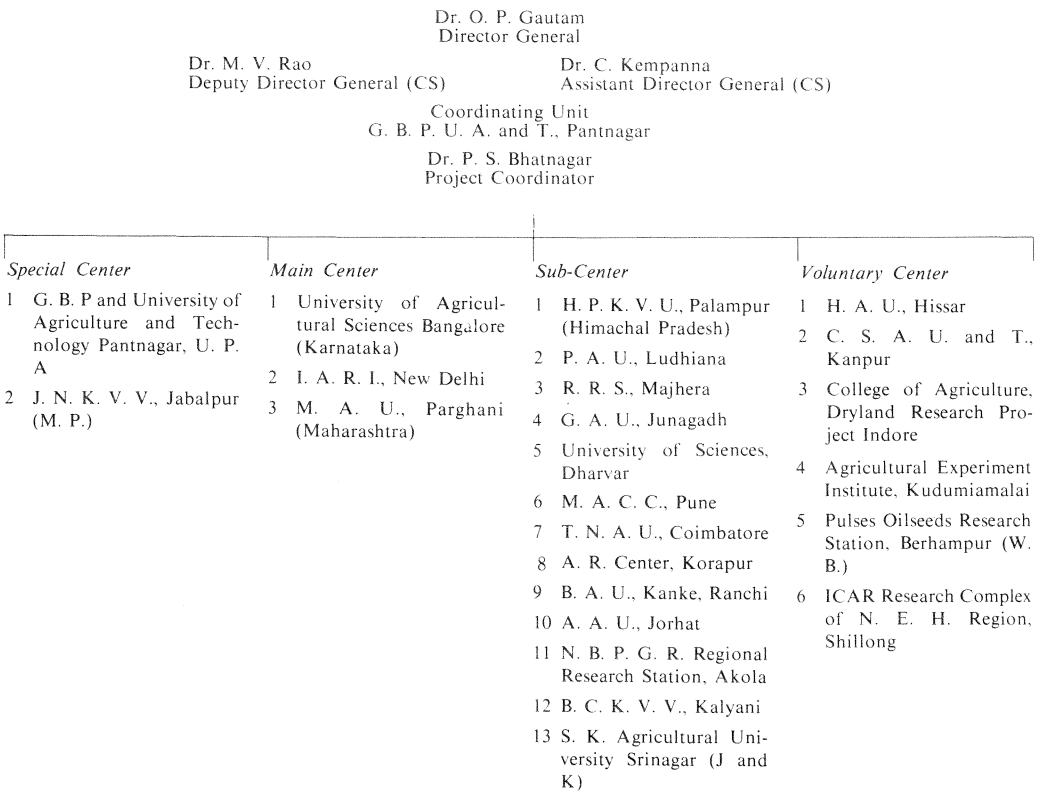

Fig. 1 Organizational pattern of All India Coordinated Research Project on Soybean, Indian Council of Agricultural Research, New Delhi.

Studies on fundamental aspects relating to ideal plant type, path coefficient analysis, mutation research and inter-relationship of various morphological, anatomical and quality characters are in progress to accrue useful information for adaptive research.

Seed production

Suitable areas with mild temperature and low humidity have been identified and cultural practices for production of seed of high quality have been standardized. Locations in foothills of UP (Kumaon and Garhwal) and Himchal Pradesh provide bright prospects for high quality seed production of soybean. Harvesting of the crop when all the leaves are shed and the moisture content in the seed comes down to 14% or less, has given the best results. Post-harvest weathering and seed handling are also of prime importance in tropical countries like India. To avoid any possible seed damage during threshing, low cylinder speed (500 rpm) at a moisture content of 13 - 14% is recommended. Soybean seed being hygroscopic must be stored in moisture-proof bags/godowns.

Production technology

Research conducted on various aspects of crop management and input demand has led to the standardization of production technology for remunerative yield of soybean. It has been indicated

ALL INDIA COORDINATED RESEARCH PROJECT
ON SOYBEAN
(Indian Council of Agricultural Research)

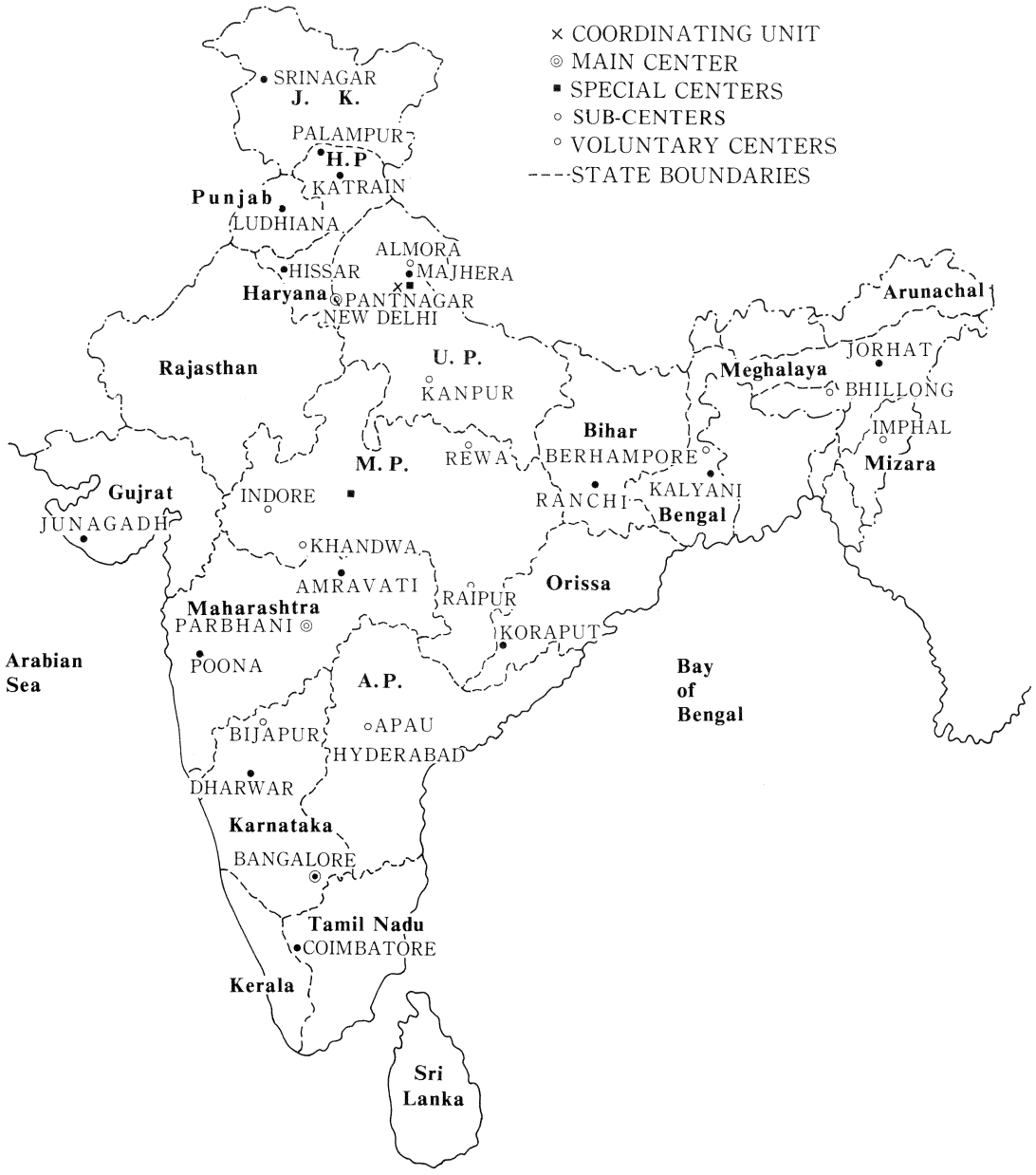

Fig. 2 **Centers of research under All-India Coordinated Soybean Research Project.**

Table 5 Improved varieties of soybean for different agro-climatic zones*

Agro-climatic zones	Variety recommended	Days to mature	Yield (q/ha)
Northern Hill Zone	Bragg	120	25—30
	Lee	110	20—25
	Pb—1	110	20—25
	Shilajeet	105	20—25
	DS—74—24—2	110	20—30
Northern Plain Zone	Bragg	120	20—30
	Ankur	125	20—30
	Alankar	120	25—35
	Shilajeet	105	20—30
	Pk—327	110	25—35
	PK—271	115	25—35
	DS—74—24—2	120	25—35
	DS—73—16	120	25—35
Central Zone	Bragg	115	20—30
	Ankur	120	20—30
	JS—2	105	20—25
	MACS—13	110	20—30
	JS—72—44	110	25—35
Southern Zone	Improved Pelicon	110—120	15—20
	Hardee	110—120	15—20
	KHSb—2	110—120	20—25
	DS—74—40	110—120	20—25
	PK—74—292	110—120	20—25

* Summary Tables of experiments under All India Coordinated Research Project on Soybean 1982—83.

that a good crop of soybean can be raised with comparatively low fertilizer doses (NPK 20:60:40 kg/ha) . The application of nitrogen can be often avoided if the soil is richly inoculated with *Rhizobium japonicum* strain by cultivating soybean during previous years. However, the starting dose of nitrogen (15 kg/ha) has been found to be useful for good yield (Singh and Saxena, 1972) .

Row spacing of 45 -70 cm to maintain a plant population of 0.4 million per hectare has been found to be ideal for high yield. The depth of planting is reported to be an important factor for maintaining optimum plant stand. Optimum depth of planting has been found to be 3 cm. Required moisture in the field should be ensured by giving one pre-sowing irrigation, if necessary. Subsequent irrigation may not be necessary for rainy season crop, however, in case of early withdrawal of monsoon, one or two irrigations during the pod filling stage have given good response (Saxena, 1977) . The field should be maintained free of weeds during the early stages by hand weeding or by using chemical herbicides like Lasso and Basalin. Cropping systems studies have indicated that cultivation of soybean with crops like maize, cotton, millets has as potential to increase the returns per unit area.

Microbiology

Identification of efficient strains of *Rhizobium japonicum* for maximum nodulation and nitrogen fixation in soybean has been continuing. Indigenous commercial production of bacterial inoculum has resulted in the decrease in foreign dependence on *Rhizobium* culture. The studies have indicated that to achieve the best results there should be a small gap between the seed treatment (@ 1 kg soil medium or 1/2 kg in peat medium with bacterial culture, fungicide) and planting.

Plant protection

Surveillance studies have indicated the possibility of economic damage by some diseases like soybean mosaic, yellow mosaic virus, bacterial pustule, anthracnose (pod blight) and *Rhizoctonia* aerial blight (Fig. 3) .

Insect pests of significance to soybean cultivation in India, have been reported to be pea stem fly, white fly, thrips, Bihar hairy caterpillar and girdle beetle. Overall survey of the pest occurrence and damage is presented in Fig. 4 (Gangrade, 1974) .

Efforts to incorporate genetic resistance to diseases as best control measure, are being attempted with encouraging results. Nevertheless, effective spray schedule of fungicides and insecticides, has been standardized for efficient control of diseases and pests.

Spraying of 0.1% Thiodon and 0.1% Metasistox in combination, starting from 20th - 25th day

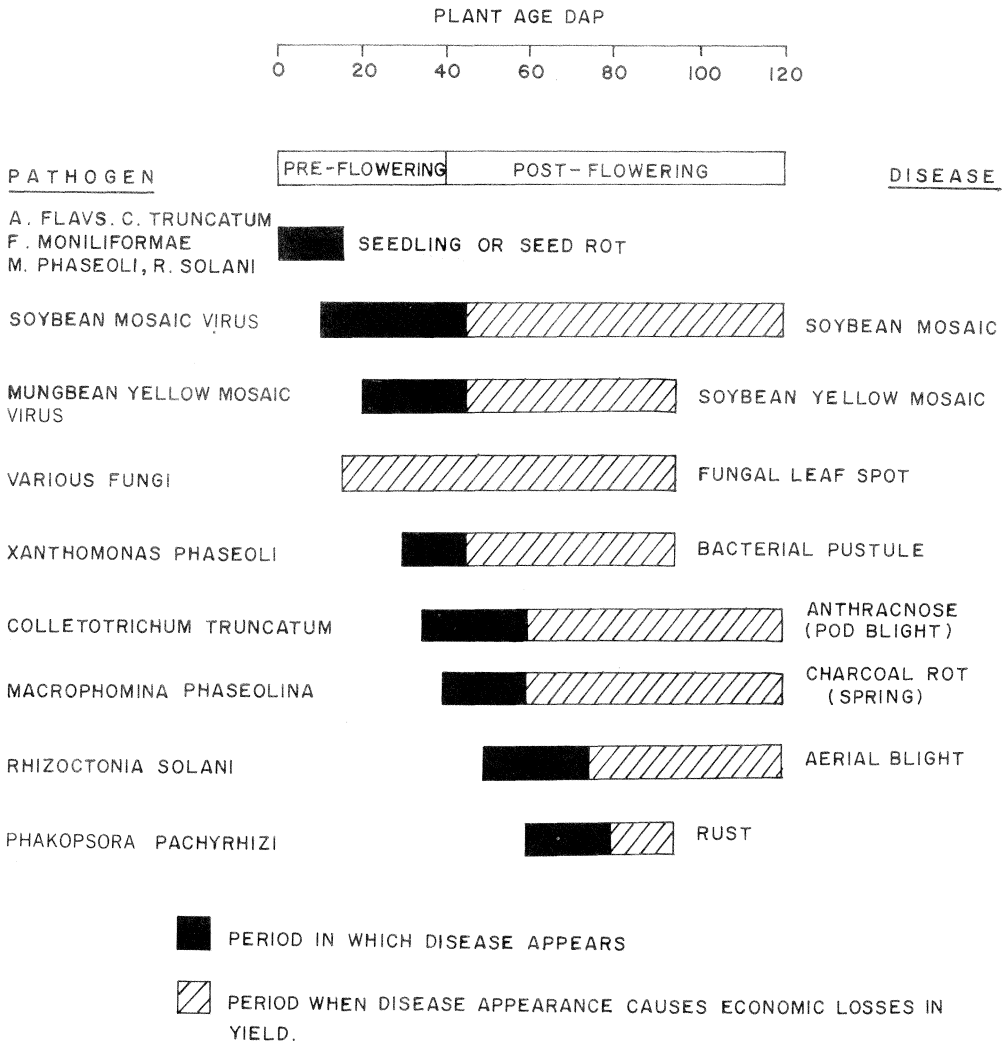

Fig. 3 Soybean disease complex.

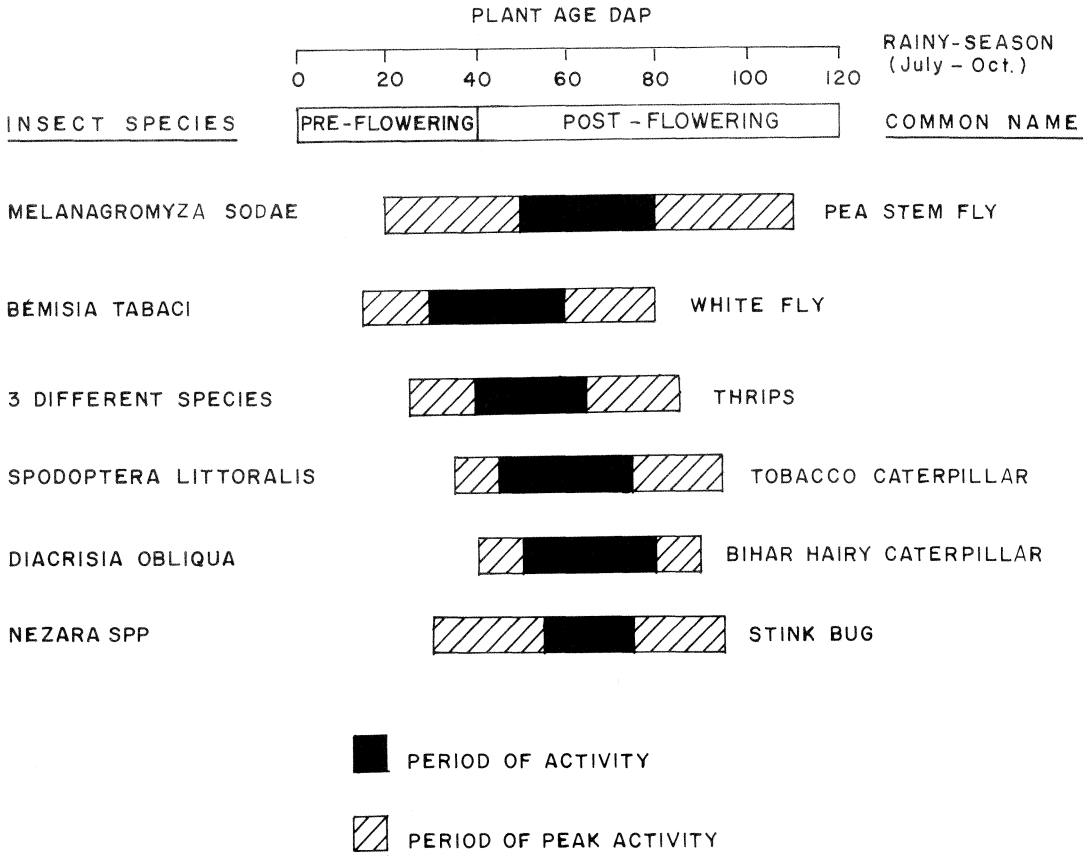

Fig. 4 Soybean insect pest complex.

of planting with an interval of 10 days till pod filling controls white fly (*Bemisia tabaci*), preventing the occurrence of yellow mosaic disease and most of the leaf-eating insects (Nene, 1972). Stem borer can be effectively controlled by Thimet-10 granules @ 10 kg/ha. To ensure effective plant stand, seed treatment with Thiram @ 3 - 4.5 g/kg, has been found to be very effective.

Product development, utilization and production economics

In India, both the American and Japanese pattern of utilization of soybean has bright scope. Out of 112 solvent extraction plants established in the country, several have started processing soybean for oil extraction. Recently, some commercial plants for extrusion products have also come into production and texturized soy food is available in the market.

Studies on product development aspects undertaken at Pantnagar, Jabalpur, Bangalore and elsewhere, have led to the standardization of recipes, using various percentages of soybean for dishes similar to conventional dishes in different parts of the country and publication of soy cookbooks (Singh, 1970; Kanthamani, 1970a, 1970b, Lingaiah *et al.*, 1975; Krishnamurthy and Shivshankar, 1975 and Mohta, 1975). More recently, production of tofu, is gaining popularity in some parts of the country.

Studies have indicated that the defatted soy flour can be used for fortification of wheat or other

cereal flour up to 15% without any detectable difference from the viewpoint of the taste or appearance but considerably increased nutritional quality. Use of soy flour for production of low cost products like soya sattu has also been demonstrated.

Development of processes for soy milk, curd, soy ice cream, nuts and weaving food has resulted in the commercial production of soy milk, soy curd and weaving food in some cities.

Although whole soybean is still fed to livestock, defatted soy flour has not yet become popular as feed due to comparative economic factors.

Investigations on production economics, based on farm survey results, conducted at Pantnagar, have revealed that the cost of soybean production was Rs.199.00/g (US$ 19.9/g) with an input/output ratio of 1: 1. 32 (Arora and Gupta, 1981) .

Constraints to rapid expansion of soybean

Although by and large the importance of soybean has been recognized in India as well, and efforts at national, state and institutional levels are being made to expand the cultivation of soybean, however, the pace of progress has been rather slow. Some of the reasons for the slow growth have been- 1) lack of appropriate agencies establishing linkage between growers and processors; 2) lack of appropriate marketing facilities; 3) convention-bound detraction and want of efforts for creating consumer's awareness of the benefit of soya products, and 4) need for low cost product and process development having consumer preferences.

Perhaps, setting up of a center for product, processing and market development would go a long way in overcoming many constraints. The center would *inter-alia* undertake in depth studies and action research with respect to consumer preferences, comparative price structure and nutritional value of competing products; the scope for product diversification based on soybean processing and problems of storage, packaging as well as marketing to provide much needed information for wider development of soybean in India.

References

1) All India Coordinated Research Project on Soybean (ICAR) , 1983. Project Coordinator's Report and Summary Tables of Experiments 1982-83. G. B. Pant University of Agriculture and Technology, Pantnagar (India) .
2) Arora, V. P. S. and S. P. Gupta, 1981. Why should farmers grow soybean? Farm Managenent: Facts and opinions. No. 11 (1980-81) October-January.
3) Bhatnagar, P. S. , 1981a. Country reports presented in INTSOY International Conference on Soybean Quality and Stand Establishment held at Colombo (Sri Lanka), January 25-31, 1981.
4) ———————— , 1981b. Oilseed production in India-Problems and prospects. Paper presented in National Seminar on Oilseeds organised by Bharat Krishak Samaj, in cooperation with Government of India, ICAR, Government of Andhra Pradesh and APAU, at Hyderabad, September 5 - 96, 1981.
5) ———————— , 1981c. An overview of soybean in India. Status paper presented in the meeting of Institute Directors, Project Directors, Project Coordinators of ICAR at New Delhi, September 21-23, 1981.
6) ———————— , 1982. The miracle crop of soybean. Commerce. 906-911.
7) Chief Controller of exports and imports (Stat. Div.) , 1982, Monthly Stat. of Foreign Trade in India. Vol. 1.
8) Gangrade, G. A. , 1974. Insects of soybean. J. N. K. V. V. , Jabalpur. Tech. Bull. 24, 88 pp.
9) Gopalan, C. , B. V. Ramasastri, and S. C. Balasubramaniam, 1971. Nutritive value of Indian food. NIN, Hyderabad.
10) Kanthamani, S. , 1970. Tasty recipes from soybean. J. N. K. V. V. , Jabalpur.
11) Krishnamurthy, K. and G. Shivshankar, 1975. Soybean production in Karnataka. The

University of Agricultural Sciences, Bangalore. Tech. Series No. 12, 50 pp.
12) Lingaiah, S. M. , M. Begum, G. Shivshankar and S. R. Vishwanatha, 1975. Green soybean variety Hardee is nutritious palatable vegetable. Curr. Res. 4: 41-42.
13) Mohta, N. K. , 1975. Report of the agronomic trials, field demonstration and home utilization programme on soybean carried out at IARI, New Delhi during 1974.
14) Nene, Y. L. , 1972. A survey of viral diseases of pulse crops in Uttar Pradesh. G. B. Pant University of Agriculture and Technology Res. Bull. No. 4, 191 pp.
15) Saxena, M. C. , 1977. Soybean in India. Country report presented in 11 INTSOY Regional Soy. Conf. at Chiang Mai (Thailand) . Feb. 23-27, 1977.
16) Shurtleff, W. , and A. Aoyagi, 1976. The Book of Miso-Food for Mankind. Balantine Books, New York.
17) Singh, B. B. , B. D. Singh and S. C. Gupta, 1974. "P. I. 171443" and *G. formosana* resistant sources of yellow mosaic. Soybean genetics News Letter. 1: 17-8.
18) ———— and M. C. Saxena, 1975. Soybean varieties for different agro-climatic zones in India. Seed Tech. News. 5 (4) : 5-7.
19) Singh, M. P. and M. C. Saxena, 1972. Field studies on nitrogen fertilization of soybean. India J. agric. Sci. 42 (11) : 1028-31.
20) Singh, R. (Ed) , 1970. Soyahar, Indian Recipes of Soybean, U. P. Agriculture University Pantnagar Edn. 1, 215 pp.
21) United States Department of Agriculture. Agricultural Statistics, several issues, and Foreign Agriculture Circular, Foreign Agri. Service, U. S. D. A. , several issues.
22) Williams, S. W. , W. E. Hendrix and M. L. Vonoppen, 1974. Potential production of soybean in north central India. INTSOY Series No. 5.

Discussion

Summerfield R. J. (United Kingdom) : In the regional evaluation of germplasm do you: 1. Rely on nodulation with indigenous strains of *Rhizobia*? or 2. Distribute a standard inoculum with the seeds? or 3. Use imported or locally-produced inoculum subject to standard quality control? or a combination of 1. and 3. ?
control? or a combination of 1. and 3. ?
Answer : 1. In the new areas we inoculate and get a response from inoculation.
However, if soybean is cultivated in the same field for a long period of time, there is no response to inoculation. 2. With seed the *Rhizobium* inoculum locally produced is distributed by the seed-producing agency. 3. Presently we are not importing the inoculum. The indigenously-produced inoculum is to observe the standards identified by the India Standard Institute.
Trikha, R. N. (India) : Comment: Nodulation in soybeans is still a problem in the new areas with low organic carbon content and sandy soils. However if soybean is continuously grown for 2-3 years nodulation takes place.
Okabe, S. (ESCAP) : It appears from your presentation that in India large amounts of soybean inported from other countries are presently used for oil production. I would like to know what is the market for the residual soybean cakes in India?
Answer : It is indeed true that the expansion of the area planted to soybean is mostly related to the large demand for edible oil. Approximately 90% of defatted soybean cakes are exported, which represents a drain of protein in India. There is a need for promoting the development of low cost products of soybean as a a source of protein for the people.
Yang, C. Y. (AVRDC): What is the current area planted to soybean in India, as well as total production and average yield/ha?
Answer : Current planted area: 802,018 hectares (1981-1982) , 900,000 hectares (1983-1984) . Total production: 802,000 tons (1981-1982) and little over 900,000 tons (1983) . National average yield: 1 ton/ha.