AGRICULTURAL MANAGEMENT,
MARKETING AND FINANCE
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Agro-industries characterization and appraisal: Soybeans in India

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Preface

This Working Document constitutes one study in a series of agro-industry characterizations and appraisals being carried by the Agricultural Management, Marketing and Finance Service. The purpose of these studies is to improve understanding of the dynamics that have led certain industries to grow rapidly, while creating significant opportunities for participation of smaller scale farmers. Through these studies, we are seeking to:

- draw lessons on how to support positive patterns of change leading to sustainable increases in farm incomes, and
- provide guidance to governments and donors on potential risks and responses.

The main criteria for selecting the case studies in this series have been:

- Rapid uptake of new enterprise by a substantial number of farmers.
- Legitimate public interest in the specific subsector and agro-enterprise.
- Potential for replication/extension to other areas with similar circumstances.
- Basis for drawing lessons on how to support future agro-industry development.

Most studies in the series have focused on diversification into higher valued products as a response to new international market opportunities. These have included, for example, the Robusta coffee industry in Viet Nam, paprika in Zambia, and asparagus in Peru. This study on soybeans, and another on dairy (AGSF Working Document 21), covers two successful cases of agro-industry development for the domestic market.

The progress of soybean cultivation in India represents a case of success in diversification. In 1970, when new varieties were introduced for commercial purposes, the future of soybean was seen in its use as pulse (*dhal*) to meet growing demand and deficiency of proteins. Other uses of soybean were thought to be soya milk, nuggets etc. In fact, as it turned out, soybean production in India has been primarily pushed by its demand as edible oil in the domestic market and as oilcake in overseas markets. At he time, nobody had envisioned the scope of soybean as an oilseed in India. Further soybean had been introduced in the State of Uttar Pradesh, where it was initially promoted and expected to have high potential and popularity, but what resulted over time was a high geographic concentration of soybean cultivation in the States of Madhya Pradesh and Maharashtra.

There are some important lessons to be learnt from soybean diversification in India. A potential product requires intense international research and development for its adaptation to the local environment; success has been high where soybean fitted well into the cropping system without impacting to much on existing crops, rather than in areas where it involved substitution. Alternative uses (oil instead of *dhal*) which may not initially be evident, can matter more in harnessing the potential of a new crop. The case also points out that it is very difficult

to replace traditional tastes and preferences; its high protein could not become a favourite *dhal* of Indian consumers.

After establishing its suitability in the field, the most important factor for the success of soybean was to find a market for it. This was initially ensured through institutional interventions by oilseed (soybean) growers' cooperatives federation which ensured input provision and ready market for the produce. Subsequently, the private sector found potential in soybean and set up a large number of soybean processing industries in and around soybean growing areas. Henceforth strong linkages developed between producers and processors. Success and spread of soybean cultivation in India provides some pertinent lessons for enterprise development and successful diversification.

The paper is aimed at those working at ministries of agriculture and extension services, Non-Governmental Organizations (NGOs) and related projects concerned with agricultural development.

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Gratitude is owed to the Food and Agriculture Organization of United Nations (FAO), in Rome, Italy, for enabling a unique opportunity to appraise the success of soybean cultivation in India. In particular a thank you goes to Doyle Baker, Chief, Agricultural Management, Marketing and Finance Service, for his support, advice and contribution in the development of this study. Thanks also go to David Kahan, Senior Officer, for his review of the document, Martin Hilmi, for editing and for following the publication process and to Marianne Sinko, for the layout and desktop publishing.

Acronyms

AICRP	All India Coordinated Research Project
APC	Agricultural Prices Commission
APEDA	Agricultural and Processed Food Export Development Authority
APMA	Agricultural Produce Marketing Act
ASEAN	Association of Southeast Asian Nations
BNF	Biological Nitrogen Fixation
CACP	Commission on Agricultural Costs and Prices
CCI	Cotton Corporation of India
CFTRI	Central Food Technology Research Institute
CGIAR	Consultative Group on International Agricultural Research
CIAE	Central Institute of Agricultural Engineering
CIMMYT	International Maize and Wheat Improvement Centre
CSCCPC	Comprehensive Scheme for Cost of Cultivation of Principal Crops
ECA	Essential Commodity Act
FCI	Food Corporation of India
FLD	Frontline Demonstration
FMA	Forward Market Act
FOB	Free On Board
GCA	Gross Cropped Area
GDP	Gross Domestic Product
GM	Genetically Modified
GOI	Government of India
HYV	High Yielding Variety
IARI	Indian Agricultural Research Institute
ICAR	Indian Council of Agricultural Research
ICT	Information and Communication Technology
IRRI	International Rice Research Institute
JCI	Jute Corporation of India
KVK	Krishi Vigyan Kendras, (Indian states agricultural departments)
MSP	Minimum Support Prices
NACS	National Active Collection Site
NAFED	National Association For Export Development
NAFED	National Agricultural Cooperative Marketing Federation
NCAER	National Council of Applied Economic Research
NCAP	National Centre for Agricultural Economics and Policy research
NDDB	National Dairy Development Board
NGO	Non-Governmental Organization
NRCS	National Research Centre for Soybeans
OGCS	Oilseed Growers' Cooperative
OILFED	Oilseed Growers' Federation Limited

OPTP	Oilseed Production Thrust Project
R & D	Research and Development
SBSP	Soybean Breeder Seed Production
SEA	Solvent Extractors' Association
SOPA	Soybean Processors' Association
SPRA	soya Production and Research Association
SQS	Soybean processors' association Quality Seal
TMO	Technology Mission on Oilseeds
TPD	Tonnes Per Day
TRIFED	Tribal Cooperative Marketing Development Federation
USAID	United States Agency for International Development
WTO	World Trade Organization

1. Sector overview

1.1 The Indian context for Soybean

In the early 1970s, prices of edible oil on the domestic market rose sharply. Beginning in 1976/77, India had to increase the import of edible oil, and from 1977/78 to 1987/88, imports constituted about 30 percent of the total availability of edible oils in the country. Between 1981/82 and 1987/88, India imported on average 1 377 million tonnes of edible oil, which corresponded to about 44 percent of the domestic production of edible oil. At this time soybean cultivation was being launched in India.

In order to address the shortages of edible oils in the country, the Government of India (GOI) launched the Technology Mission on Oilseeds (TMO) in May 1986 and initiated the Oilseed Production Thrust Project (OPTP) in 1987. The main goal of these measures was to increase the production of oilseeds through an increase in the planted area, extension of oilseed cultivation under the irrigated area and the transfer of yield-increasing technology. Simultaneously, marketing and price support were also extended to oilseeds.

Subsequently, market intervention operations were started in the domestic market through the National Dairy Development Board (NDDB). These operations involved buying, stocking and selling oilseed and edible oil and maintaining a price band. At the same time, imports were regulated through canalization and high tariffs to protect domestic oilseeds from import competition. Strong policy support for technology diffusion combined with marketing and price support produced impressive results in a short time. Between 1980/81 and 1990/91, the total oilseed production in India increased from 9 404 million tonnes to 17 937 million tonnes, while soybean production in the same period increased from 341 million tonnes to 2 227 million tonnes. It was also observed that since the launch of the TMO in 1986-1987 up until 1996-1997, oilseed production performed much better than cereals, which were considered the best success story of the green revolution in the country (Chand, 2004). The rising trend in oilseed production faced a big setback after that, which coincided with the liberalization of edible oil imports.

Some studies have asserted that India's oilseed sector is highly protected and that there ware large gains involved in the reallocation of resources from oilseeds to other crops. Accordingly, a case was made that meeting domestic requirements through imports was considered a much cheaper option when compared with the cost of domestic production (Gulati and Sharma, 1998).

Until recently, agricultural marketing was subject to a plethora of central and state government regulations such as the Essential Commodity Act (ECA), restrictions on free movement of agricultural produce across states and the monopoly of agricultural market committees in the setting up of agricultural markets. (These regulations restricted competition and investments by

private trade in agricultural markets). During recent years the central government has initiated some measures for domestic reforms in agriculture to change the regulatory and institutional environment and to increase the participation of the private sector. These reforms included change in the provision of the ECA, removal of restrictions on interstate movement of farm produce, the model Agricultural Produce Marketing Act (APMA), encouragement of contract farming, and the Forward Market Act (FMA). Provisions to allow contract farming are expected to facilitate partnership between processor and producers of soybeans.

Liberalization of trade in 1992 accompanied by a devaluation of the exchange rate created a favourable environment for agricultural exports. From 1993-1994, agricultural exports started increasing in leaps and bounds. The significant growth in agricultural exports, witnessed further increases in the initial years of India's membership in the World Trade Organization (WTO) and reached a historical peak of US$6.8 billion in 1996-1997. However, after 1996-1997 earnings from agricultural exports started to decrease and dropped to US$5.8 billion by 1999-2000. This happened despite further liberalization in agricultural exports announced in the export-import policy 1997-2002. Agricultural exports started growing again from 2000-2001. The provisional figure for 2003-2004 shows that agricultural exports reached US$8 billion, which is about 30 percent higher than exports during 2000-2001.

The trend in imports and exports shows that the integration of Indian agriculture with the global economy has improved considerably during the last 13 years; however, the ratio of trade to GDP is very low compared with most of the developing Southeast Asian countries.

Export of oilmeal, which was the second biggest export item after marine products, increased from US$377 million in the early 1990s to close to US$1 billion by 1996-1997. However, oilmeal exports suffered a serious setback during the late 1990s because of a decline in international prices and the east Asia financial crisis. Likewise, the export of most commodities increased with liberalization and then declined during the late 1990s. The export of marine products and groups of livestock and horticultural products maintained the growth rates from the pre-WTO period. This shows that the post-WTO situation was favourable to the export of high-value and processed food products. Moreover, this growth was mainly market-driven as there was little direct government intervention in these products.

1.2. Diversification

During the period from 1960 to 1963 a total of 23 agricultural universities were established in various parts of the country to deal with the perennial food shortage. One choice at that time was to introduce the cultivation of new seeds of high-yielding varieties (HYVs) of wheat and rice, which were available at the Consultative Group on International Agricultural Research (CGIAR) institutes such as the International Maize and Wheat Improvement Centre (CIMMYT) and the International Rice Research Institute (IRRI). The GOI made a decision to import and spread the HYVs of wheat and rice that required the use of fertilizers and irrigation. This strategy produced quick results as there was a quantum leap in yield. Consequently, wheat and rice production in a short span of six years, between 1965-1966 and 1971-1972, witnessed an increase of 30 million tonnes, which was 168 percent higher than the total achievement in the preceding 15 years.

HYVs of wheat and paddy were found suitable for areas with assured irrigation, whereas more than two-thirds of the cultivated area of the country at that time was rainfed. Impressed by the initial success of the HYVs of wheat and paddy, during the late 1960s the government started looking for such varieties of other crops also. It was around this time that attention was being given to the soybean crop. Until then, soybeans were grown in small pockets in the hills of Northern India for local consumption. The native varieties were low yielding and also late maturing. In contrast, soybean varieties developed in the United States were found to be high yielding and early maturing. Experimental trials conducted in India during late 1960s showed that the varieties of soybeans developed in the United States were very successful in Northern India.

These technological breakthroughs, backed by policy support, led to large shifts in crop patterns, which are better understood by looking at the state level data presented in Table 1. The table shows crop pattern shifts/diversification between 1970-1971 and 1990-1991, with the introduction of high-yielding and improved varieties of various crops.

Table 1. Share of crops in gross cropped area (GCA) in major states *(in percentages)*

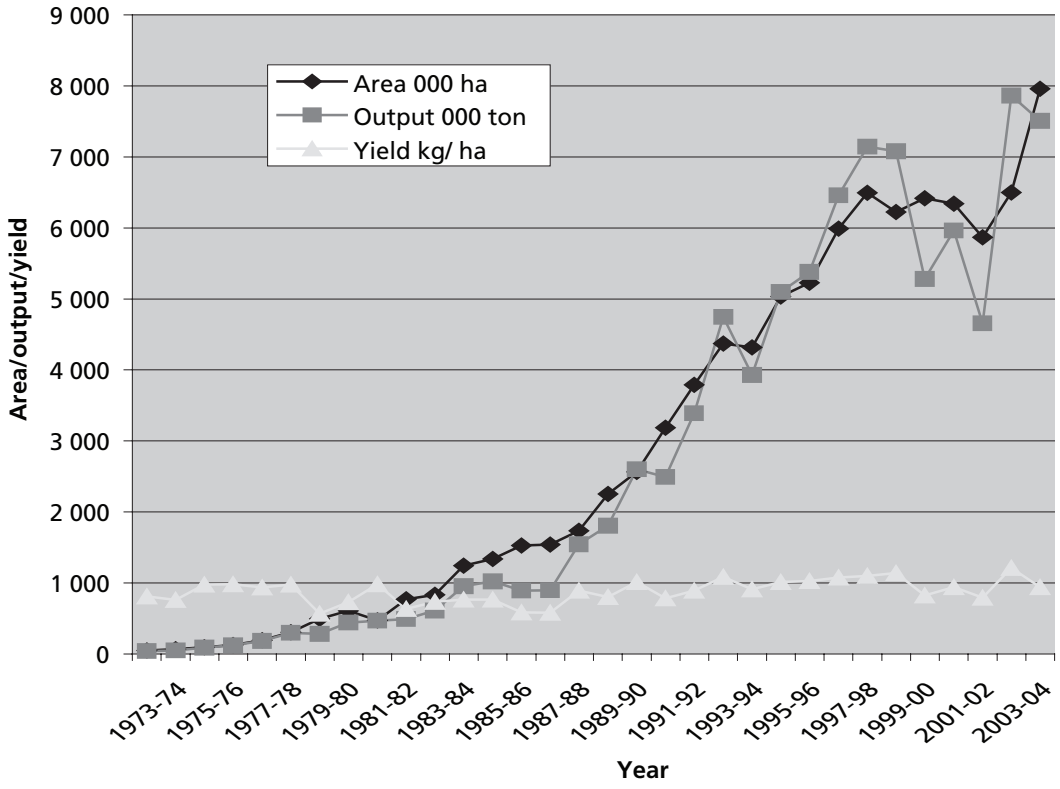
States	Rice		Wheat		Pulses		Oilseeds	
	1970/71	1990/91	1970/71	1990/91	1970/71	1990/91	1970/71	1990/91
Andhra Pradesh	26.4	30.6	0.1	0.1	10.9	12.4	16.4	24.1
Assam	70.5	65.6	0.7	2.2	3.0	3.0	5.5	8.7
Bihar	47.8	51.4	11.9	18.7	14.9	11.2	2.3	2.3
Gujarat	4.7	5.1	5.5	6.9	4.0	9.0	18.7	26.2
Haryana	5.4	11.2	22.8	31.3	23.0	12.4	2.8	8.2
Himachal Pradesh	11.5	8.6	33.1	38.2	7.7	4.3	2.4	1.8
Jammu and Kashmir	25.7	25.0	21.3	23.0	5.1	3.8	4.6	6.4
Karnataka	11.3	10.0	3.0	1.7	11.0	13.8	12.9	23.2
Kerala	29.8	18.5	0.0	0.0	1.4	0.8	25.4	29.4
Madhya Pradesh	21.3	21.4	16.6	16.1	20.6	21.0	9.3	18.7
Maharashtra	7.2	7.2	4.7	4.0	13.3	14.9	9.7	13.1
Orissa	66.7	45.9	0.2	0.4	15.1	20.4	6.1	12.2
Punjab	6.9	27.0	40.5	43.6	7.3	2.0	5.4	1.5
Rajasthan	0.7	0.6	8.8	9.4	21.6	19.0	6.2	15.9
Tamil Nadu	36.4	28.0	0.0	0.0	6.5	13.0	17.6	20.7
Uttar Pradesh	19.7	22.0	25.5	33.6	16.1	11.9	17.0	6.6
West Bengal	69.1	67.1	5.0	3.1	9.3	3.6	2.4	6.1
All India	22.7	23.0	11.0	13.0	13.6	13.3	10.7	13.8

Source: Indian Agriculture in Brief, Ministry of Agriculture, GOI, New Delhi. Various issues.

New varieties of soybeans were introduced in India during the 1960s. The crop was promoted initially with the expectation that it would meet the demand for pulses in the country. Soybeans were seen as a miracle crop and were expected to repeat the success story achieved in the United States. The crop was then found to be the most profitable among all legume crops and it was anticipated that the inclusion of soybeans in the cropping system would increase farmers' income by 88 percent (Dovring *et al.,* 1973).

The pioneering work on testing new soybean varieties in India was initiated at the Indian Agricultural Research Institute (IARI), G.B. Pant University of Agriculture and Technology, Pantnagar, Uttaranchal and Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, in Madhya Pradesh, in collaboration with the University of Illinois and the United States Agency for International Development (USAID). The Bragg soybean variety from Mississippi was found to yield three to four tonnes per hectare within a period of four months; this yield was two to three times more than the average yield of major pulse crops grown in the country. Based on this, the Indian Council of Agricultural Research (ICAR), set up the All India Coordinated Research Project (AICRP) in April 1967 with Delhi, Pantnagar and Jabalpur as the main centres and subcentres throughout the country. All main centres had at least one position for breeders, agronomists, entomologists, food scientists, plant pathologists, microbiologists and economists. Substantial funds were contributed by ICAR and USAID for the AICRP on Soybeans. AICRP played a critical research and development (R&D) role in evolving suitable varieties of soybean and product utilization as food for human and cattle feed.

Figure 1. Area, output and yield of soybeans: 1973 to 2004



Source: Agricultural Statistics at a Glance 2005, GOI.

Varietal trials at these stations showed an outstanding performance of soybeans, particularly compared with other pulses grown in the country. Based on this, the Bragg soybean variety was released for general cultivation. A sizable quantity of soybean seed was then imported and multiplied and the first commercial crop was grown during 1970.

Soybeans were initially introduced in Madhya Pradesh and Uttar Pradesh. The main reason for this was that in these areas cultivated land during *kharif* (monsoon) season was kept fallow

for preserving moisture for *rabi* (sowing) season. Such areas were also available in the State of Maharashtra. The short duration of new varieties of soybeans did not affect the sowing time of the second crop after the monsoon season. It was estimated that 15.22 million hectares of fallow land were available during the monsoon season in these three states.

Among all crops, taken individually, soybeans recorded the highest growth rate in planted area and output after 1971. Soybeans rank second even in terms of absolute increase in area; the first position is occupied by wheat. During the last 15 years, the soybean planted area in India increased fourfold while production increased more than fivefold. The growth rate in area and output at this scale is unparalleled in the history of Indian agriculture. As can be seen from Figure 1, expansion in the soybean planted area took place without large and clear increases in productivity over time. The reasons for the expansion in area despite stagnant productivity are: (a) the suitability of soybeans for cultivation in fallow land; (b) the yield and price advantage over other crops, mainly coarse cereals and pulses.

Table 2. Growth in soybean area and output since 1971-1972

Period	Area	Output	Yield	Share in gross cropped area (%)
	(000 ha)	(000 tonnes)	(kg/ha)	
1971/72	30	25	819	0.18
1975/76 to 1979/80	243	196	805	0.14
1980/81 to 1984/85	786	594	755	0.45
1985/86 to 1989/90	1 679	1 233	734	0.94
1990/91 to 1994/95	3 645	3 432	941	1.96
1995/96 to 1999/2000	5 794	6 232	1 076	3.05
2000/01 to 2004/05	6 616	6 254	945	3.54

Source: Agricultural Statistics at a Glance, Ministry of Agriculture, GOI, various issues.

1.3 Regional spread of soybeans

During 1970-1971 the regional spread of soybean cultivation covered 7 700 hectares in Madhya Pradesh, 5 900 hectares in Uttar Pradesh, and 18 000 hectares in Maharashtra. Soon the crop started spreading based on comparative advantage. In recent years, soybeans have been cultivated on more than 4 million hectares in Madhya Pradesh, 1.6 million hectares in Maharashtra and about 0.5 million hectares in Rajasthan. These three states together account for more than 96 percent of the area under cultivation, as well as the production of soybeans in the country.

The AICRP on Soybeans was given strong support to develop and adapt varieties suitable for Indian conditions and to develop appropriate processing technology. This was accompanied by dedicated extension services provided by the agriculture departments of concerned states and public sector organizations such as *Tilhan Sangh* (Madhya Pradesh State Cooperative Oil Growers Federation). The latter also provided marketing and processing facilities.

Recognizing the importance of soybean cultivation, in 1987 the ICAR established the National Research Centre for Soybean (NCRS) at Indore in the State of Madhya Pradesh to support soybean

production systems research with basic technology and breeding material. The coordinating unit of AICRP on Soybeans, the Soybean Breeder Seed Production (SBSP) and the National Active Collection Site (NACS) for soybean germplasm are also located at the NCRS.

The Central Institute of Agricultural Engineering (CIAE) at Bhopal, Madhya Pradesh (another institute of ICAR) is currently undertaking major research on soybean processing and utilization and is offering training to set up small enterprises to produce various kinds of soya foods for local consumers in different parts of the country. The CIAE has developed more than 20 soya food products to suit the preferences of Indian consumers. Out of these, full-fat soya flour, soya fortified biscuits, muffins, and soya paneer are reported to have good and growing consumer acceptance (Kulkarni, 2005). In order to promote soybean processing for various food products at the small-scale level, the CIAE has also developed 18 different apparatus for soybean processing which are commercially sold. It is presumed that because of the great variation in food preferences in the country, small-scale production would be based on local demand. According to CIAE, of the 659 persons trained by them, about 160 are running small-scale enterprises for soybean processing for food products.

The adoption of soybean cultivation was not affected by the size of the land holdings, as there was no element in soybean cultivation that favoured large-size holdings. Thus, as with the HYVs of paddy and wheat, the soybean varieties introduced in India were adopted by all categories of farmers. Soybean was a new crop in the north central plains where it was introduced and it was grown primarily to sell on the market for income. Opportunities to sell produce were available to all farmers. Thus, small-scale farmers did not face any hindrance in increasing the area under soybean cultivation; therefore they allocated larger areas to soybean cultivation. According to a study conducted in Madhya Pradesh, the cropped area allocated to soybean cultivation was found to be 60.12 percent on small-size holdings, 40.31 percent on medium-size holdings and 27.27 percent on large-size holdings for 1984-1985 (Bapna *et al.*, 1992).

1.4 Enterprise development

When the commercial production of soybeans was promoted in the initial years it was thought that, as in the United States and in east Asian countries, soybeans would be used for a variety of foods, for example, soya milk, tofu, soya protein, soya cheese, soya yoghurt, health food and as a dairy product alternative as well as a pulse (*dhal*). However, soybeans did not become as popular as *dhal* and there was a serious challenge to find a market. Thus the search for alternative uses of soybean started. The first systematic research on soya food development was started in 1971 at G.B. Pant University of Agriculture and Technology at Pantnagar, with the technical collaboration of the University of Illinois. Around 1970 some cookbooks and recipes based on soya products were published in the country.

The soya food research facility established at G.B. Pant University of Agriculture & Technology, Pantnagar, in 1971 developed a variety of soya products such as soya milk, soya candy, soya nuts, soya paneer and low cost high protein soya products, for example, nutri-nuggets, protein ahar, poshtic ahar and nutri ahar. These products were already developed at the University of Illinois and research was done at the G.B. Pant University to adapt these foods to the Indian diet. The University of Illinois, USAID and the foundation of an American missionary, Robert

W. Nave, played a key role in the commercial development of soya products and in setting up initial processing facilities. Mr Nave founded the soya Production and Research Association (SPRA) as a joint venture of the Nave Technical Institute, already established by him in Bareilly and Pantnagar University. SPRA played a key role in pioneering soya food and production in India during the initial years. SPRA, which was set up in 1972 as a profit-making organization, was the first to produce a reasonable amount of soya products. The products were marketed at a low price for the lower income level consumers, but this did not help to popularize soya products. SPRA then adopted a new approach of marketing the product to the rich and ultimately reaching the poor. The company chose attractive packaging and the name nutri-nuggets, and introduced it to elite consumers. After much hard work the product caught on.

In 1974 SPRA introduced a soybean extension programme in Rohilkhand, a region of Uttar Pradesh, to popularize soybean cultivation among farmers by providing certified seed and chemical and technical support (Trikha and Nave, 1979). Producers were even assured a price guarantee. By this time it had become clear that soybeans grew best in the north and north central regions during the monsoon season. One of the important characteristics of the land use system in this part of the country was the availability of cropland left fallow during the monsoon season. This was especially striking in Madhya Pradesh where more than 40 percent of croplands remained idle during the monsoon season.

By the late 1970s, soya milk emerged as an important product of soybean and it was supplied to metropolitan areas. However, after a few years the use of soybean as soya milk started phasing out because of low consumer preference and the improved availability of livestock milk in the country.

It is ironical that soybeans, which were initially perceived as a pulse food to meet the protein demand and deficiency in India, did not gain much popularity as a protein food. Only one product, nutri-nuggets, was established on a sustained basis; the demand for other soya products remained quite low.

Food shortage in India during the 1960s was not confined to cereals alone. There was a rising deficiency of pulses and edible oil/cooking oil. The deficiency of edible oil was perceived as more severe than that of pulses and was met through imports. During 1970-1971, India imported 79 000 tonnes of soybean oil to meet the deficiency in domestic supply. Because of the sluggish production of oilseeds after 1964-1965, solvent extraction plants in the country, which numbered more than 85 in 1970, were not getting adequate raw material and were running well below their planned capacity. The availability of soybeans on the market provided an opportunity for these plants to improve their performance.

Soybean scientists at Pantnagar played a crucial role in convincing owners of oil plants about the scope and benefits of extracting oil from soybeans. With small additional investments in necessary equipment for roasting and flaking soybeans for oil extraction, mill owners could receive rich dividends. This encouraged the private sector to set up oil extraction plants for soybeans to produce oil and defatted cake. These cakes were very rich in protein (more than 50 percent protein) and were in demand for export. The already established market for soybeans produced in India and the increase in soybean production and solvent extraction plants complemented each other.

With the increase in the domestic demand for edible oil as well as in the export demand for oilcake and oilmeal, soybeans became a very important commodity for agro-industry. Thus, soybean cultivation and the number of extraction units expanded together and a strong linkage developed between farm production and the processing industry. Cooperatives and the private sector set up processing industries in the soybean growing areas close to available raw material.

During the early 1980s, India turned out to be the largest net importer of vegetable oil. Soybean oil was found to be more lucrative in India than using soya for other kinds of food. The use of soybeans for oil witnessed rapid growth on the domestic market. Oilcake and oilmeal, derived from extracting oil from soybeans, found attractive markets in East and Southeast Asian countries and in Europe as feed for livestock. Almost all of the refined soya oil produced in India is consumed in the country; nonetheless, India has a very high edible oil deficit. De-oiled cake is largely exported; however, domestic demand for it is also increasing. At present one-fourth of de-oiled cake is consumed in the country and three-fourths is exported. It is estimated that approximately 90 percent of soybeans produced in India is used for oil extraction (Table 3).

Table 3. Estimated use of soybeans for soya oil (000 tonnes)

Year	Total production		Estimated use for oil extraction*	Soybean output used for oil extraction (%)
	Soybeans	soya oil		
1995/96	5 096	814	4 522	88.74
1996/97	5 380	861	4 783	88.91
1997/98	6 460	1 034	5 744	88.92
1998/99	7 143	1 143	6 350	88.90
1999/00	7 081	1 133	6 294	88.89
2000/01	5 280	845	4 694	88.91
2001/02	5 963	954	5 300	88.88
2002/03	4 655	745	4 139	88.91
2003/04	7 863	1 258	6 989	88.88
2004/05	7 510	1 202	6 678	88.92

*Assume 18 percent recovery.
Source for output of soybean and oil: Agricultural Statistics at a Glance, 2005, GOI, New Delhi.

Madhya Pradesh Cooperative Oilseed Growers' Federation Limited (OILFED) was established in October 1979 to integrate the production, procurement, processing and marketing of oilseeds (mainly soybeans) on cooperative lines. The activities of OILFED can be broadly divided as follows:

1. Organize cooperatives at the village level to supply quality seeds and modern inputs to member-farmers through the cooperatives and undertake research, development and extension activities to enhance the production and productivity of oilseeds.

2. Enable village cooperatives to undertake procurement of oilseeds on its behalf and provide adequate storage facilities.

3. Create processing facilities.

4. Develop market networks for the sale of oil and by-products (Desai *et al.,* 1991).

The grassroots level of OILFED is the Oilseed Growers' Cooperative (OGCS) consisting of farmers growing primarily oilseeds. Each of the independent units covers six to eight villages with an area of 500 to 750 hectares under oilseeds.

OILFED set up two solvent extraction plants, each with a capacity of 200 tonnes per day (TPD), one in Seoni in 1984 and the other in Sehore in 1986. Subsequently, two more soybean complexes were set up, one in Ujjain in 1987 and the other in Chindwara in 1991. OILFED is credited with pioneering the production and processing of soybeans in the State of Madhya Pradesh. It has also developed and is engaged in the marketing of various soya value-added consumer products.

In 2002-2003 OILFED started an organic soybean project with farmers on a contract basis. The programme is certified by Skal International of the Netherlands, which is accredited to the Agriculture and Processed Food Export Development Authority (APEDA), Ministry of Commerce, India.

In the private sector, the State of Madhya Pradesh has 31 solvent extractor units with a combined capacity of 16 325 TPD for processing oilseed. The Solvent Extractors' Association of India (SEA) is a primary vegetable oil association for private trade. The Soybean Processors Association (SOPA) is another private sector association involved in the processing and promotion of soybeans. SOPA has also created the independent unit called SOPA Quality Seal (SQS) to provide a fully independent, transparent and efficient working system backed by dedicated professional management. SQS certifies those soybean products covered by SOPA standards and assures that they have been produced to comply with requirements of that standard under a well defined system of evaluation, testing and quality standardization devised and supervised by the SQS monitoring team. This offers credible assurance on the quality of the product.

1.5 Risks and trade

Soybean cultivation in India like many other crops grown in the country faces several risks related to production and prices, which result in fluctuations in the income of soybean producers. Production risks can be seen from the deviations in area, yield and output of soybeans, while price risks are seen in the year-to-year instability of soybean prices in the annual average price and the minimum and maximum monthly prices over a year.

During the period from 1975-1976 to 1990-1991, the cultivated area, output and yield of soybeans deviated from the trend by more than 20 percent. The highest instability was seen in yield, which showed a deviation from the trend to the extent of 26 percent. During the next 15 years, instability in area declined very sharply, whereas fluctuations in output showed a minor increase. Instability in yield declined from 26 percent to 21 percent between the two periods (Table 4).

Table 4. Instability in area, output and yield of soybeans in India (in percentages)

	Instability in		
Period	**Area**	**Output**	**Yield**
All India			
1975/76 to 1990/91	20.8	21.9	26.4
1991/92 to 2004/05	9.4	23.8	21.0
States: 1991/92 to 2004/05			
Madhya Pradesh	12.4	27.9	25.8
Maharashtra	13.4	36.9	25.2
Rajasthan	23.6	73.1	61.0

Source: Computed by author using data from Agricultural Statistics at a Glance, GOI, New Delhi, various issues.

Risk to farmers' income owed to price fluctuations can be seen in Table 5, which contains information on prices for the Indore market in the State of Madhya Pradesh. The table presents the annual average of monthly prices, the highest monthly price, and the lowest monthly price. The range of maximum and minimum prices indicates seasonal variation in prices. Minimum prices in general represent the farm harvest price. The table shows that price spread has been on an increase over time, particularly in recent years. It can also be seen from the table that the annual price and the peak monthly price fluctuate much less over time when compared with fluctuations in the minimum price. This implies that price risk is much higher at farmer level than at wholesale level. The instability index for minimum price was 18.7 percent compared with 13.2 percent for wholesale (trade) price.

Table 5. Soybean prices in Indore mandi (produce market) (Rs/qtl)

	Annual	Range in monthly prices in a year	
Year	average price	Maximum	Minimum
1998/99	946	1 080	825
1999/00	830	920	700
2000/01	983	1 060	800
2001/02	988	1 100	900
2002/03	1 282	1 360	1 130
2003/04	1 347	1 580	940
2004/05	1 448	1 770	1 180
Instability index (%)	13.5	13.2	18.7

Source: Basic data from website of Madhya Pradesh Mandi Board (http://www.mp.nic.in/MandiBoard) taken on 14 March 2006.

There is no crop insurance in India except for a few instances in selected areas where farmers take institutional credit for crop production. The only insurance for farmer income is price guarantee through the system of minimum support price, which is, again, effectively available for a few crops in some surplus states. In the case of soybeans, efforts were made to ensure price guarantees for soybeans at a pre-announced minimum support price through procurement by the National Association For Export Development (NAFED). However, the scale of operations of NAFED has remained very low and occasional.

1.6 Export and import

Trade in soybeans and soybean products is quite high and therefore soybean prices in India are affected by the international trade situation and prices. As mentioned before, more than 90 percent of soybeans produced in India is used for oil extraction and for manufacturing oilcake and oilmeal, which in turn are exported in great quantities. As India has a large deficit in edible oil, this deficiency is met through imports, which mainly consist of palm oil and soya oil.

Exports constituted more than 50 percent of soybean production in the country during the early 1990s to the mid-1990s. Since 1997-1998, however, the proportion of production for export has sharply declined. In recent years India has exported only 30 percent of its soybean production.

The demand for edible oils in India has been increasing at a fast rate. Despite efforts to raise edible oilseed production in the country, the growth in production could not keep pace with the growth in domestic demand. Thus India meets the demand deficit through imports. Palm oil is the biggest agricultural import item. Soybean oil is now the second largest edible oil imported by India. Soya imports were less than 100 000 tonnes until 1997-1998. With the liberalization of imports and a sharp decline in the international prices of soybean oil, imports of soybean oil started rising rapidly. During the period from 2001 to 2005 India imported on average more than one million tonnes of soybean oil annually.

Table 6. Import of soybean oil to India

Year	Import (000 tonnes)
1990/91	22
1991/92	22
1992/93	62
1993/94	29
1994/95	39
1995/96	101
1996/97	21
1997/98	46
1998/99	440
1999/2000	610
2000/01	583
2001/02	1 358
2002/03	1 197
2003/04	993
2004/05	1 048

Source: Monthly Statistics of Foreign Trade in India, Volume I, Annual Number, Directorate General of Commercial Intelligence & Statistics, Kolkata, Ministry of Commerce & Industry, GOI.

2. Marketing and commercial viability

In the field of agricultural marketing and internal trade, several public sector institutions and cooperative marketing organizations have been set up to improve market structure, conduct and performance and to help growers in marketing as well as in the realization of better returns for their produce. These institutions are:

Public sector institutions

- Food Corporation of India (FCI)
- Cotton Corporation of India (CCI)
- Jute Corporation of India (JCI)
- National Dairy Development Board (NDDB)
- Commodity boards for various plantation crops
- Special marketing/processing corporations
- Commission on Agricultural Costs and Prices (CACP)

Cooperative marketing institutions

- National Agricultural Cooperative Marketing Federation (NAFED)
- State level - Agricultural Cooperative Marketing Federation
- State level - agricultural marketing boards
- Primary, central and state level marketing societies/unions
- Special marketing/processing societies
- Tribal Cooperative Marketing Development Federation (TRIFED)

The FCI and the APC, later on renamed as Commission on Agricultural Cost and Prices (CACP), were established in January 1965 by an act of parliament. These two agencies have dominated food management in India since their establishment. The main role of APC/CACP has been to suggest and recommend to the government minimum support prices (MSP) for various agricultural commodities in each harvest season/year. Soybeans were brought under MSP in 1977-1978 and the purchase of some quantities of soybeans by public agencies under the price support scheme were started in the same year.

Institutions involved in the procurement, processing and marketing of oilseeds, including soybeans, include the NDDB, state-level cooperative marketing and processing federations, and NAFED. The main task of NDDB was to promote the dairy industry; however from the mid-1980s NDDB was also involved in the procurement and processing of oilseeds and in the marketing and supply of edible oil to domestic consumers. NDDB undertook these operations in some cases, and in other cases, it involved state-level cooperative organizations such as OILFED in Madhya Pradesh.

The main role of cooperative marketing institutions is to take up agricultural surplus from farmers and to sell it at the best price possible. Cooperative marketing organizations compete with private trade to ensure better prices for agricultural produce. NAFED is the top organization of marketing cooperatives in India. State-level marketing federations are its constituent members. Over time, NAFED has expanded its functions to the procurement, processing, storage and distribution of selected agricultural commodities. NAFED also undertakes price support operations for pulses and oilseeds on a selective basis.

Procurement of soybeans by NAFED under the price support scheme in different years is shown in Table 7. As can be seen from the table, procurement by NAFED is only symbolic and occasional. The largest quantity of soybeans ever procured by NAFED was 495 000 tonnes in 1999-2000, which constituted about 7 percent of the total production in the country. Recent procurement figures are less than 1 percent of soybean production. Soybeans have also been procured by OILFED in Madhya Pradesh under MSP operations.

Table 7. Procurement of soybeans by cooperative parastatal NAFED

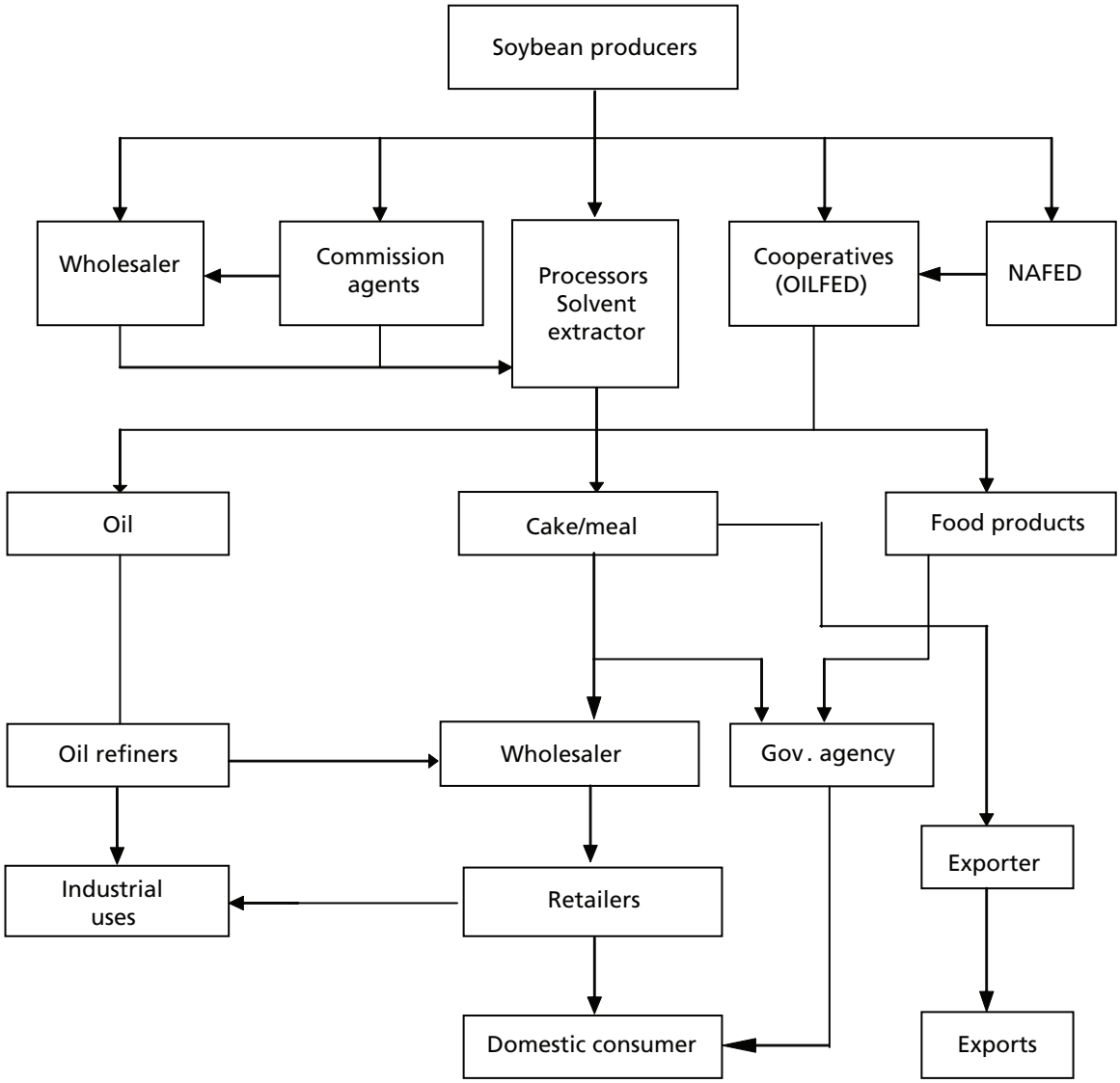
Year	Quantity procured (tonnes)
1984/85	3 700
1985/86	62 700
1998/99	4 000
1999/00	495 000
2000/01	54 700
2001/02	3 270
2002/03	0
2003/04	0

Source: Agricultural Statistics at a Glance, 2001 and 2005, Ministry of Agriculture, GOI, New Delhi.

2.1. Soybean marketing

The general structure of the soybean marketing system is provided in Figure 2. A small part of the output is retained for self-use or sold to local consumers in the village. The greater part is sold outside the village in neighbouring markets and is generally purchased by five types of agencies. These are wholesaler commission agents, traders, processors, cooperatives and NAFED. Wholesalers and traders, in turn, sell the produce to processors, except for a small fraction, which passes through trade channels for sale in the form of seed. Processors and cooperatives use most of the produce to extract oil, which is also used to produce oilcake and oilmeal for sale as feed. Crude soya oil is further processed in processing mills and is then marketed for direct consumption and industrial use. Most of the oilmeal is exported.

Figure 2. Soybean marketing system in India



According to a recent study (Banfar *et al.,* 2003) the most common marketing channels are as follows:

- Channel I: Producer – village merchant – wholesaler – processor – refiner – oil wholesaler – oil retailer – consumer

- Channel II: Producer – cooperative society – processor – refiner – oil wholesaler – oil retailer – consumer

- Channel III: Producer – wholesaler in the regulated market – processor – refiner – oil wholesaler – oil retailer – consumer

According to the study, the producer's share in the consumer price of oil/cake was above 50 percent in all the channels. Marketing costs and the margin at various levels are shown in Table 8.

In the three marketing channels mentioned above from the State of Madhya Pradesh, marketing charges paid by producers were Rs 5.75 – 5.17 per quintal. The highest marketing charges were paid by the wholesaler. Processing charges accounted for a major cost item in the price spread. Total marketing charges including processing cost varied between Rs 160.00 and Rs 202.00. The middleman margin is quite high in all the marketing channels. This includes a net margin of market intermediaries in trade and oilcake trade at wholesale and retail level, corresponding to Rs 20.00/kg paid by consumer for oilcake, producers received Rs 11.23 to 11.44 (Table 8).

Table 8. Marketing charges and margins for soybeans and oil in different marketing channels (Rupees/100 kg)

Particular	Channel		
	I	II	III
Total marketing charges paid by the producer	5.75	16.50	5.17
Marketing charges paid by village merchant	22.50	-	-
Marketing charges paid by cooperative societies	-	10.00	-
Marketing charges paid by wholesaler	40.37	-	40.37
Marketing charges paid by processor	13.00	13.00	13.00
Processing charges	107.00	107.00	107.00
Marketing charges paid by wholesale dealer of oil	6.50	6.50	6.50
Charges paid by retailer of oilcake	7.00	7.00	7.00
Total marketing charges	202.52	160.54	191.27
Middleman margin	753.23	701.10	685.73
Net margin of village merchant	70.25	-	-
Net margin of cooperative societies	-	35.00	-
Net margin wholesaler	16.88	-	19.63
Net margin of processor	69.60	69.60	69.60
Net margin of wholesaler of oilcake	223.50	223.50	223.50
Net margin of retailer of oilcake	373.00	373.00	373.00
Net amount received by producer	1 044.25	1 138.50	1 123.00
Price paid by the consumer	20.00	20.00	20.00
Producer share in consumer price (%)	52.21	56.92	56.15

Source: Adapted from Banfar *et al.*, 2003

2.2. Consumer demand and desired product quality

The domestic demand for soybeans is mainly for soya oil. Soya oil is used for cooking and also for making vanaspati (hydrogenated fat), which is also used in cooking. During the last 10 years the demand for vegetable oil in India has increased annually by close to 5 percent. Per capita demand for edible oil in the country is more than 10 kg (GOI, 2006) and is expected to further increase at a fast rate. Both the income elasticity of demand for vegetable oil and price elasticity of demand for oilseeds are high. The accepted estimate puts price elasticity at -0.567 and -0.522 and income elasticity at 0.389 and 0.234 for rural and urban populations, respectively (Kumar, 1998). The increase in per capita income during the 1990s and the decline in real prices of edible oil during the late 1990s are the prime factors in increasing the demand for edible oils in India.

The second most important demand for soybeans is oilcake and oilmeal for export. Concern is expressed in India about not using soybeans for different types of protein food and animal feed. In fact, the livestock sector in India has been growing at more than 4 percent per year in the last two decades and there is considerable commercialization of the poultry and dairy industry. However, this has not created a very large demand for soybean products as feed, mainly because of the price factor in the national and international markets. Livestock growers find other sources of feed such as cereals cheaper than oilcake and oilmeal. The international price is invariably higher than the domestic price, which makes the export of oilcake more lucrative than selling it on the domestic market.

This ongoing trend in retaining oil for domestic consumption and exporting protein rich products is counterproductive to national health.

One of the advantages of soybeans produced in India is that the varieties cultivated in India are not genetically modified (GM) whereas the major soybean exporting countries are now growing GM varieties of soybeans. This gives India an advantage in those markets that have a preference for non-GM products. According to some experts, India has a strong advantage in exporting soya food in various forms to Japan and other East Asian countries; however, so far this has not been explored to its full potential.

2.3. Profitability and efficiency

The efficiency of any product can be assessed based on different indicators. In the first years of the expansion of soybean cultivation in India, the efficiency of soybean cultivation was seen from the protein efficiency criteria. The protein efficiency ratio of soybeans was found to be 2.4 as compared with 1.7 for groundnut and from 1.5 to 1.7 for pulses (Dovring *et al.,* 1973).

The profitability and efficiency of soybean cultivation can be seen from Table 9. According to a study by Bapna *et al.,* soybean cultivation provided a net return of Rs 779 per hectare during 1984-1985 in the State of Madhya Pradesh. The recent estimate of net returns and the efficiency of soybean cultivation were computed from data on the cost of cultivation. The data was collected by the Directorate of Economics and Statistics, Ministry of Agriculture, GOI, under the project Comprehensive Scheme for Cost of Cultivation of Principal Crops (CSCCPC) for the purpose of preparing cost estimates to be considered in announcing the minimum support price. The net return from soybean cultivation during 2001/02 was highest in the State of Maharashtra, followed by the State of Madhya Pradesh. However, among the three states, the output-input ratio is found to be the highest in Madhya Pradesh and the lowest in Maharashtra. The net return in the three major soybean producing states varies between Rs 5 207 and 9 335. There has been considerable improvement in the efficiency of soybean cultivation over time. The output-input ratio was 1.60 during 1984/85; it has now risen to more than 2.4 in all three states.

Table 9. Profitability and efficiency in soybean cultivation

Particular	2001/02			1984/85
	Madhya Pradesh	Maharashtra	Rajasthan	Madhya Pradesh
Gross return Rs/ha	11 240	15 816	8 603	2 084
Operational cost Rs/ha	4 160	6 481	3 396	1 305
Net return Rs/ha	7 080	9 335	5 207	779
Output/Input ratio	2.70	2.44	2.53	1.60

Source of basic data: Bapna *et al.*, 1991 (for 1984/85); reports of the Commission on Agricultural Costs and Prices for the crops sown during the 2004/05 season, Ministry of Agriculture, GOI, New Delhi, 2005.

2.4. Input supply services and provisions

Soybean producers generally use home-produced seeds and small quantities of inorganic fertilizers and pesticides. The major suppliers of fertilizers are public sector/cooperative organizations. They have a well-established network of distribution centres and also sell fertilizer through private dealers. Fertilizer distribution centres are generally located in small towns and serve the requirements of a few surrounding villages. Fertilizer is also distributed through the village-level primary agricultural cooperative societies. OILFED has also played an important role in arranging for the supply of improved seeds and pesticides to oilseed growers' cooperatives.

The number of fertilizer depots has increased greatly between 1981 and 2001, along with progress in new technology and diversification in the country. There were only 2 361 fertilizer sales points in Madhya Pradesh in 1981. In the succeeding 20 years their number increased to more than 15 000 (see Table 10). Farmers now travel a much shorter distance to purchase fertilizer. The average number of villages served by a fertilizer depot declined from 30 to 5 in Madhya Pradesh, from 5 to 1 in Maharashtra, and from 6 to 4 in Rajasthan after 1981.

The number and density of markets for output is quite low in Rajasthan where one rural market handles the produce of as many as 68 villages. In contrast, there is one rural market on average for every 12 villages in Maharashtra and one for every 24 villages in Madhya Pradesh.

Table10. Infrastructure for input supply in major soybean growing states

Particular	Madhya Pradesh	Maharashtra	Rajasthan
Fertilizer sale points			
- 1981	2 361	7 571	5 904
- 2001	15 787	29 234	10 051
Average number of villages covered per depot			
- 1981	30	5	6
- 2001	5	1	4
Number of output markets	3 633	4 357	968
Average number of villages served by rural market	24	12	68

Source: Thorat and Sirohi, 2004.

The mechanization requirements for soybeans are moderate. Most of the crop production operations are performed by human labour and bullock labour, and machinery is used for only a few operations.

Farmers meet their requirements for production credit and investment credit from three sources, namely (i) personal savings, (ii) loans from private sources such as moneylenders, traders, and relatives and friends (iii) institutional sources such as commercial banks, land development banks and cooperatives.

In the three soybean producing states, between 48 and 53 percent of farmers take loans and the rest of them manage their farm business and households with their own resources (Table 11). Out of those who take loans, approximately 57 percent in Madhya Pradesh, 84 percent in Maharashtra, and 34 percent in Rajasthan depend on institutional sources, and the rest depend on private sources. Dependence on private sources in Maharashtra is very low because of the strong network of cooperatives in this state. Public sector banks are quite active in the States of Maharashtra and Madhya Pradesh, but their coverage of farmers is low in the State of Rajasthan. Another disadvantage to Rajasthan farmers in meeting their credit needs is that the cooperative credit institutions are also very weak. Only about 6 percent of farmers have access to credit from cooperative societies, as compared with 17 percent in Madhya Pradesh and 48.5 percent in Maharashtra.

Table 11. Assessment of loan sources for farmers (in percentages)

State	Gov't.	Cooperative society	Bank	Money-lender	Trader	Relatives/ friends	Others	Farmers taking loans
Madhya Pradesh	1.9	16.9	38.1	22.6	9.0	10.1	1.3	48.3
Maharashtra	1.2	48.5	34.1	6.8	0.8	5.9	2.7	51.5
Rajasthan	1.3	5.9	27.0	36.5	19.2	6.9	3.2	52.5

Source: Indebtedness of Farmer Household, Situation Assessment Survey of Farmers, Report No. 498(59/33/1), NSS 59th Round, January-December 2003, National Sample Survey Organisation, GOI, New Delhi, 2005.

2.5. Institutional support

Extension service for soybean production is provided by the state agriculture departments, *Krishi Vigyan Kendras* (KVK) and, to some extent, by the extension departments of state agricultural universities and ICAR institutes. Non-Governmental organizations (NGOs) such as SPRA and SOPA played a significant role in promoting cultivation in the initial stages. SOPA is again playing an active role in promoting soybean production in various ways.

The state agricultural departments and KVKs also provide training to producers in using the improved package of practices. Input manufacturers, particularly fertilizer manufacturers, also offer some training and extension service to growers.

Public sector extension agencies undertake mainly two activities: (a) farmer training; (b) field demonstrations for groups of farmers. The magnitude of these extension activities can be seen in Table 12. More than 17 000 farmers in Madhya Pradesh, around 41 000 farmers in

Maharashtra, and 46 300 farmers in Rajasthan were given training during 2001/02. The number of farmers who received training is quite low compared with the population of farmers. The training, which covered less than 1 percent of the farmers, was 0.18 percent in Madhya Pradesh, 0.38 percent in Maharashtra, and 0.86 percent in Rajasthan.

Field demonstrations are held where teams of experts interact with groups of farmers in a selected village/locality and demonstrate the improved technology. The number of field demonstrations organized by public extension agencies during 2001/02 was 1 536 in Madhya Pradesh, 2 256 in Maharashtra, and 2 283 in Rajasthan.

Table 12. Activities of public sector extension agencies in major soybean growing states

	Madhya Pradesh	Maharashtra	Rajasthan
Number of farmers trained 2001/02	17 221 (0.18%)	40 921 (0.38)	46 372 (0.86)
Field demonstrations 2001/02	1 536	2 256	2 283

Note: Figures in parentheses are percentages of total operational holdings existing in the state based on the 1995/96 agricultural census.
Source: Thorat and Sirohi, 2004

In spite of the system created for agriculture extension, access to and adoption of modern technology in the country continues to be quite low. This can be seen from the information furnished in Table 13 on the percentage of farmers accessing modern technology and the different sources of information. The information is based on a recent nationwide survey conducted by the GOI on access to modern technology for farming. The survey does not provide crop specific information on sources and frequency of accessing modern technology, but it does cover all aspects of farming.

Table 13. Percentage of farmers accessing modern technology through various sources (in percentages)

Source	Maharashtra	Madhya Pradesh	Rajasthan	India
Extension worker	7.6	9.0	1.4	5.7
TV	20.9	6.6	2.1	9.3
Radio	12.6	8.4	2.8	13.0
Newspaper	14.6	3.4	2.1	7.0
Input dealer	17.1	10.2	5.6	13.1
Other progressive farmers	17.0	19.1	5.3	16.7
Any source	46.2	41.4	14.7	40.4

Source: Access to Modern Technology for Farming, Situation Assessment Survey of Farmers, Report No. 499(59/33/2), NSS 59th Round, January-December 2003, National Sample Survey Organisation, GOI, New Delhi, June 2005.

At country level about 40 percent of farmers reported that they had accessed information about modern technology during the last year. Among the major soybean-growing states, the proportion of farmers accessing modern technology was relatively better in Maharashtra (46

percent) but it was exceedingly low in Rajasthan where less than 15 percent of the farmers reported that they had obtained some information about modern technology.

The percentage of farmers accessing information from input dealers and other progressive farmers in the area was higher compared with accessing information from extension workers. In Madhya Pradesh, only 9 percent of the farmers got information about modern technology from extension workers. In Maharashtra, the extension workers were the sources of information for 7.6 percent of the farmers. In Rajasthan, more than 98 percent of the farmers did not have any interaction with extension workers during the reference year. These results show that the public system of extension in India is very weak in terms of reaching farmers.

There is a widespread feeling that the public extension system in the country is not as dedicated and committed as it was during the early years of the green revolution. Also, the requirements for information on different dimensions of agricultural technology had increased enormously and become much more complex. The public extension system is not able to cope with this demand. There is a growing concern to evolve new mechanisms such as public/private partnership dissemination of information through new tools of information and communications technology (ICT) to meet the requirements of modern farming.

Among the private initiatives, SOPA plays an important role in the promotion of soybeans in India. It is the only national-level body representing the processors, farmers, exporters and brokers in India working towards strengthening soybeans as a viable crop. SOPA was established in 1979 with headquarters at Indore in the State of Madhya Pradesh. The main objectives of SOPA are as follows:

- to protect and promote the interest of soybean farmers, processors, exporters and consumers;
- to encourage adoption of the modern package of practices in cultivation of soybeans;
- to promote and organize scientific research programmes for improvement in the cultivation, processing technology and development of soy-based products;
- to promote export of soybean extraction, meal and soy-based products.

SOPA has been pursuing soybean development programmes with a sense of urgency in collaboration with the departments of agriculture, agricultural universities and other research institutes. This is evident from the fact that SOPA organized 50 frontline demonstrations during the monsoon season in 2002, under the close supervision of scientists. Other activities taken up by SOPA to promote soybean production are the multiplication of foundation seed and organizing farmers' meetings, field days and training programmes in collaboration with various NGOs.

3. Impact on farm households

Initially farmers in India took up soybean cultivation to make productive use of fallow lands during the monsoon season. Soybeans fitted best in the crop rotation and thus increased crop intensity. By cultivating fallow lands farmers were able to make productive use of family labour, bullock labour, and other resources. As soybean cultivation spread to larger areas it had to compete with other crops, for example, sorghum, maize, groundnuts, and even rice on marginal land. In such situations the motivation of farmers was to benefit from the higher returns offered by soybeans compared with other competing crops. Initially there was the problem of a market for soybeans; however, as processing facilities expanded, a strong linkage emerged between soybean production and processing.

The importance of soybeans in relation to other opportunities for increasing farm income has been studied by comparing net returns from soybeans with alternative crops in the same area. The profitability of soybeans *vis-à-vis* competing crops in the States of Madhya Pradesh, Maharashtra and Rajasthan is presented in Table 14 for 2001-2002, which was a normal agricultural year. The table also presents detailed information about input use, output and returns from soybean and other selected crops.

In the State of Madhya Pradesh the gross return from soybeans per hectare of area during 2001-2002 was Rs 11 240, which was the highest among the major monsoon crops. Use of chemical fertilizer in soybean cultivation was moderate – 40 kg Nitrogen, Phosphorus, Potassium (NPK) /hectare. Employment of labour in soybean cultivation was found to be lower than other monsoon crops, but the use of machine labour was higher in soybean cultivation.

Most of the resources used in crop production in India are supplied by the farm household, which complicates the estimation of cost and income. In the comparison of crop income in Table 14, crop income is calculated by the value of the product and by-products less the costs for human labour, bullock labour, machine labour, seed, fertilizer, manure, insecticide and irrigation costs. Based on these costs, the net return from soybeans in Madhya Pradesh was estimated to be Rs 7 080 per hectare, which is 75 percent higher than income from paddy and almost double the income from maize cultivation. In Maharashtra, soybeans compete very closely with groundnuts. The net return from soybean cultivation over operational costs was Rs 9 335 per hectare in Maharashtra, Rs 7 080 in Madhya Pradesh and Rs 5 207 in Rajasthan. These variations in net returns explain why soybean cultivation expanded so much in Madhya Pradesh even though its profitability in Madhya Pradesh is lower than that of Maharashtra. It is because of the higher relative profitability of soybeans compared with competing crops. The area under soybean cultivation in Maharashtra remains small because of the lower relative profitability of soybeans compared with groundnuts.

Table 14. Costs and returns from soybean cultivation and competing crops per hectare in major producing states, 2001/02

	Madhya Pradesh				Maharashtra		Rajasthan
Particular	Paddy	Cotton	Maize	Soybean	Soybean	Groundnut	Soybean
Output							
Yield (quintals)	13.96	3.81	8.22	11.27	15.98	14.19	8.11
Value main product (Rs)	7 311	855	3 982	10 470	15 109	19 120	7 712
Value by-product (Rs)	1 098	615	1 157	770	708	1 514	891
Implicit price (Rs/quintal)	524	2 244	484	929	945	1 347	951
Gross return (Rs)	8 410	1 470	5 139	11 240	15 816	20 634	8 603
Material and labour inputs/ha							
Seeds (kgs)	98.40	5.07	21.95	95.68	75.99	92.18	90.02
Fertilizer (kg of nutrients)	50.71	93.69	22.57	40.36	90.88	38.17	10.62
Manure (quintals)	16.96	0.93	6.85	4.24	2.72	30.14	1.81
Human labour (man hours)	701.35	424.57	421.18	357.54	510.90	1 171.55	350.71
Animal labour (Pair hours)	145.50	46.31	68.93	46.91	82.59	104.82	32.76
Operational cost (Rs)							
Human labour hired	1 743	490	659	1 102	1 847	3 869	855
Bullock labour hired	144	46	24	142	561	1 021	85
Machine labour	342	358	173	770	1 134	625	1 024
Seed	640	671	198	1 146	1 378	2 776	1 093
Fertilizer	683	1 306	279	565	1 281	568	144
Manure	676	40	237	213	111	1 217	51
Insecticide	2	372	-	111	49	-	29
Irrigation charges	153	103	0	111	122	695	115
Miscellaneous	0	-	-	0	-	-	-
Total	4 382	3 386	1 570	4 160	6 481	10 770	3 396
Return over operational cost (Rs/ha)	4 028	1 915	3 569	7 080	9 335	9 864	5 207

Source: Reports of the Commission for Agricultural Costs and Prices for relevant years, Ministry of Agriculture, GOI, New Delhi.

The area share of soybeans increased from less than 0.5 percent in the early 1980s to more than 3.5 percent during the period from 2001 to 2005 because of the economic superiority of soybeans. Similarly, the share of soybeans in total oilseed production increased from around 5 percent in the early 1980s to 30 percent in recent years. Furthermore, this superiority is not confined to a special situation prevailing in a single year. Earlier studies referring to the early 1970s (Dovring *et al.,* 1973) and mid-1980s (Bapna *et al.*, 1992) have also reported the economic superiority of soybeans over competing crops. The results of a study on costs and returns from soybeans and competing crops are presented in Table 15 for 1984-1985. These estimates indicate that the net return from yellow soybeans, an improved variety, was higher than the net return from black soybeans, which is a traditional variety. The net return from yellow soybeans at sample farms in Madhya Pradesh was Rs 779 as compared with the net return of Rs 643 from groundnuts, Rs 510 from sorghum and Rs 325 from maize. The study also reports that the net return from soybean cultivation as the sole crop was higher than the return from mixed crops.

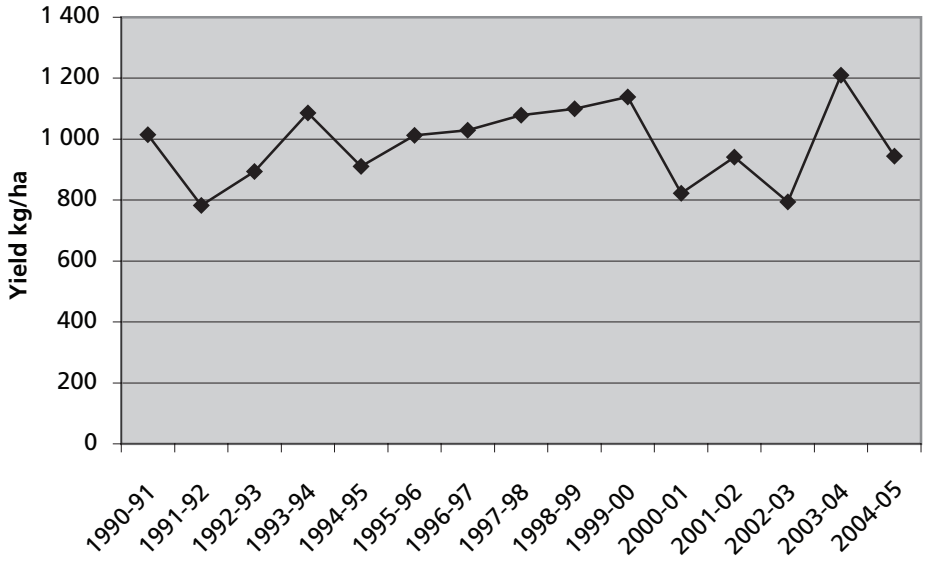
Table 15. Net return from soybeans and competing crops in Madhya Pradesh, 1984/85 (Rs/ha)

Crops	Gross output	Operational cost	Net return
Black soybeans	1 674	1 178	496
Yellow soybeans	2 084	1 305	779
Groundnuts	2 608	1 965	643
Maize	1 050	725	325
Jowar	1 471	961	510
Black soybeans + Jowar	1 504	985	519
Yellow soybeans + Jowar	1 611	1 099	512
Yellow soybeans + Maize	1 401	898	503

Source: Bapna *et al.*, 1992, p. 59.

Further expansion of soybean cultivation in India is constrained by several factors. Foremost is the low and almost stagnant, but highly fluctuating productivity. The recent productivity level of soybeans in India, Figure 3, is about one-half of the average yield in China and one-third of the yield in major producing countries such as the United States, Brazil and Argentina. One important reason for this is that the use of improved seed is very low in India – the seed replacement rate in the State of Madhya Pradesh was around 6 percent until 2002-2003.

Figure 3. Soybean productivity in India



Source: Agricultural Statistics at a Glance 2005, GOI.

Another important constraint in soybean cultivation is the soil moisture requirement during sowing and the growth period. About 98 percent of the area under soybean cultivation is rainfed and only about 2 percent is under irrigation. The crop is becoming more and more at risk as climatic changes take place and the amount and distribution of

rainfall are becoming erratic. According to soybean scientists, white fly and yellow mosaic rust are important constraints in yield. Some of the constraints, such as moisture stress and rainfed cultivation, are equally applicable to other oilseeds and pulses grown in soybean growing states. Most of these crops show either stagnation or a decline in yield and area after 1995-1996.

4. Sustaining and improving commercial viability and farmers' income

In India, both the commercial viability of soybeans and the soybean farmers' income are affected by several factors that are related to trade, technology, infrastructure, market and policy. Around 88 percent of the soybean production is used for oil and oilcakes, both of which are strongly linked to trade. In recent years, India imported more than 1 million tonnes of soya oil whereas the domestic production of soya oil is 1.2 million tonnes and the production of all edible oils is 6.5 million tonnes. Similarly, India exports three-quarters of its total production of oil meal (www.sopa.org/st12.htm). The prices of soybeans and soybean products are closely linked to international prices because of the high level of trade in such products. Consequently, fluctuations in international prices of soya oil, oilcakes and soybeans affect domestic prices, price stability, farmers' income, and the profits of processors. It is easy to control the volatility in international prices passing to the domestic market through imports by applying the appropriate tariffs. However, the adverse impact of volatility in international prices cannot be checked on exports. As India is a small supplier in the international market, exporters have to sell their produce in the international market at the prevalent price transmitted to domestic markets. In this way, the volatility in international prices affects the commercial viability of soybeans and farmers' income.

GM soybean varieties are being cultivated on large areas in the major soybean producing countries. There are no GM varieties of soybeans being cultivated in India to date. This gives a small advantage to India in terms of the export of oilcakes, particularly to European countries. However, the GM varieties being cultivated in the major producing countries have a considerable advantage over Indian soybeans in terms of higher productivity and lower production costs.

Soybean yield in India is stagnant at around 1 000 kg/ha, but input requirements are rising because of the increasing susceptibility to insects and pests and the nutritional imbalances in soil, resulting in a small squeeze on farm income.

Agricultural scientists in India have developed technologies that show a high potential to raise soybean yield and farmers' income. This can be seen from the information provided in Table 16 for the real farm situation in 2005. In the three major soybean-growing states, Madhya Pradesh, Maharashtra and Rajasthan, improved practices give from 26 percent to 35 percent higher yields and entail additional costs of Rs 1 335 to Rs 3 954. The additional return associated with improved technology varied between Rs 3 659 and Rs 6 368 in the three states. The net gain from adopting improved practice is Rs 2 033 in Madhya Pradesh, Rs 2 324 in Rajasthan and Rs 3 129 in Maharashtra. Returns on investment in improved technology over farmer's practice give a benefit/cost ratio in the range of 1.55 to 2.72.

Table 16. Impact of improved technologies on the productivity potential of soybeans in a real farm situation, monsoon season, 2005

Particular	Madhya Pradesh Indore	Rajasthan Kota	Maharashta Pune	Karnataka (Dharwad)	Uttaranchal (Pantnagar)	Andhra Pradesh CRIDA*
No. of trials	15	13	15	18	29	71
Mean yield						
Improved technology	2 055	1 592	2 050	1 987	1 284	905
Farmer's practice	1 557	1 259	1 519	1 554	1 016	642
Increase (%)	34.85	26.84	34.95	27.86	24.7	43.3
Cultivation costs (Rs/ha)						
Improved technology	8 990	8 022	12 751	8 000	7 250	7 621
Farmer's practice	5 036	6 687	9 512	6 200	5 650	6 674
Additional cost over farmer's practice	3 954	1 335	3 239	1 800	1 600	947
Gross returns (Rs/ha)						
Improved technology	24 665	17 512	24 599	21 857	14 769	14 083
Farmer's practice	18 678	13 853	18 231	17 094	11 688	9 403
Additional return over farmer's practice	5 987	3 659	6 368	4 764	3 081	4 480
Net gain from improved practice	2 033	2 324	3 129	2 964	1 481	3 533
Benefit/cost ratio	1.55	2.72	1.97	2.64	1.92	4.73

*Central Research Institute for Dryland Agriculture

Source: All India Coordinated Research Project on Soybean, Director's Report and Summary Table on Experiments 2005/06, National Research Centre for Soybean, ICAR, Indore, 2006.

The main reasons for the difference in frontline demonstration (FLD) yield and yield at farmer's field are listed below:

1. **Use of quality seed**: The seed replacement ratio for soybeans is very low. Farmers often use their own seeds from the previous season. Soybean seeds are highly sensitive to several storage factors such as temperature, humidity, aeration, pests and pathogens, and also to physical handling. Therefore, the seeds tend to lose viability in a short time (even the seed certifying agencies approve the seeds if they exhibit 75 percent germination, unlike other crops where the minimum germination is more than 90 to 95 percent). The poor quality seeds result in below normal plant population, which leads to a reduction in yield.

2. **Correct quantity of seed**: As farmers consider the seeds to be 100 percent viable, they often use just the recommended rate of 70 to 80 kg/ha and sometimes even slightly less, without compensating for lower viability. This results in suboptimal plant population, leading to a lower yield.

3. **Proper sowing methods**: As soybeans exhibit an epigeal mode of germination, the deep placement of seeds in order to prevent bird damage results in uneven and patchy plant stands.

4. **Adequate tillage**: Because of the soil moisture requirement, sowing is often done hurriedly with the onset of monsoon without the desired level of cultivation, which accelerates the weed problem. FLDs ensure adequate tillage.

5. **Lack of weed control measures**: The soybean crop is often highly infested with weeds, which at times reduce the yield by 50 to 60 percent. FLDs ensure weed control.

6. **Nutrient management**: Although soybean is a legume crop, its requirement of nitrogen is much higher as compared with its own biological nitrogen fixation (BNF). The yield is reduced by not using *rhizobium* inoculation, a lower dose of nitrogen and other nutrients such as phosphorus and potassium and a lack of sulphur and micronutrients.

7. **Plant protection measures**: The soybean crop is often affected by diseases, for example, rust, and yellow mosaic virus. Farmers very rarely use any plant protection measures.

There is an urgent need to spread improved technologies at the farmer's field in order to sustain soybean cultivation and to improve the income of producers.

There is a strong seasonality in farmers' income derived from production. The soybean crop matures during the months of September and October and arrives at market on a large-scale basis starting in October. Farmers sell most of their marketable surplus during the period from October through December. Market arrivals start declining in January. Table 17 shows the pattern of market arrivals in major markets in Madhya Pradesh. The total sum of market arrivals in the seven major markets in Madhya Pradesh shows that farmers sell 57 percent of marketable surplus in the first three months after harvest. Market arrivals in the non-harvest period in major markets, such as Ujjain, and for a total of seven markets, did not show much variation. This pattern in market arrivals indicates that farmers are strongly affected by the seasonality in market prices. The concentration of market arrivals during a short period, which invariably fetches low prices, can be effectively reduced in two ways:

- by providing credit to farmers against the produce to meet their pressing needs;
- by creating appropriate storage facilities for farmers in which to keep their produce.

The inefficiency of the processing, transport and marketing systems for oilseeds in India results in a large price spread. Impressed by the growth of soybean production in the country during the 1980s, the processing industry expanded its capacity at a very fast rate. According to SOPA, raw material availability is around 5 million tonnes whereas the installed capacity of the processing industry is 15 million tonnes. This affects the production efficiency of the processing plants. Furthermore, the private sector generally transports produce by lorry roads, which is quite costly and does not take advantage of economies of scale.

Soybean cultivation was started in a number of places in India but was then abandoned because of inadequate market demand. Production could be sustained only in those places where the processing industry was developed on a large scale. Soybean cultivation is expanding into new areas, for example, Karnataka, Andhra Pradesh and Gujarat, where at present the cultivated area is very small, but potential is high. As markets develop in these areas, soybean cultivation is expected to grow. Soybeans are much more remunerative than other crops cultivated in rainfed

areas. With the growing strain on water resources, it seems likely that the area under soybean cultivation will expand.

Table 17. Market quantities in all major markets of Madhya Pradesh, 2005-2006 (000 tonnes)

Month/Division	Bhopal	Gwalior	Indore	Jabalpur	Rewa	Sagar	Ujjain	Total
October - December	531.5	174.5	278.6	49.2	28.6	123.0	583.4	1 768.7
	59.0	*72.0*	*56.2*	*39.1*	*55.5*	*53.4*	*55.8*	*57.2*
January – March	164.7	28.3	60.7	20.1	7.9	32.4	124.6	391.4
	18.3	*11.7*	*12.2*	*16.0*	*15.3*	*14.1*	*11.9*	*12.7*
April – June	110.1	13.4	73.1	29.0	10.9	43.4	109.9	389.8
	12.2	*5.5*	*14.7*	*23.1*	*21.1*	*18.8*	*10.5*	*12.6*
July – September	94.4	19.4	54.8	18.2	2.2	18.7	130.1	358.7
	10.5	*8.0*	*11.1*	*14.5*	*4.4*	*8.1*	*12.4*	*11.6*
Whole year	900.7	242.5	495.9	125.7	51.5	230.4	1 045.0	3 091.7
	100.0	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*

Note: Figures in italics are the percentages of marketable surplus sold.
Source: Basic data from website of Madhya Pradesh Mandi Board (http://www.mp.nic.in/MandiBoard), 14 March 2006.

The cultivation of soybeans for several consecutive years results in the extraction and imbalance of soil nutrients, which is one of the reasons for the stagnation in yield in the major soybean-growing areas. Such deficiencies must be addressed through a balanced application of fertilizer. Farmers are reluctant to shift to new, better performing varieties because they are concerned about the acceptance of new varieties on the market.

Soybean cultivation has some disadvantages with regard to fertilizer subsidies in India. Soybean is a leguminous crop and its requirement for nitrogen is very low. The main plant nutrients recommended for soybeans, phosphorus and sulphur, are not subsidized by the government, whereas there is a large subsidy for nitrogenous fertilizer.

Soybean researchers and some experts feel that India is not making the best use of its soybean output. The oil, which is considered nutritionally poor, is sold on the domestic market and protein rich products are largely exported at a low cost. Experts suggest that soybeans be used mainly as a protein food. They also point out the need for consumer awareness and low-cost processing technology. Despite a number of recipe books written by Indian authors on the use of soya for various food products and the efforts of the Central Food Technology Research Institute (CFTRI) in Mysore to popularize soya foods, not much success has been achieved. Soybeans are not used as regular food like other pulses, cereals or dairy products. They are used in small amounts as a fortified food, in baby foods and by bakeries for cookies, nutri-nuggets, nutella-like products, flakes, etc. Some consumers mix small quantities of soybeans with other cereals to use as flour for making chapattis.

Soybeans have not become part of the regular Indian diet, except as oil, despite their nutritional superiority and a very high protein deficiency in the population. As a new crop, soybeans were not accepted among the masses because of their slightly different taste and

cooking characteristics. De-oiled cake fetches better prices on the export market than it does on the domestic market and therefore only a small proportion is consumed in the country. Consequently, soybeans continue to be used primarily as a source of oil in India. However, there is great motivation to raise soybean production for this purpose as India meets more than 40 percent of its domestic demand for edible oil through imports. Also, the demand and supply of livestock products in India is growing rapidly and as a result, the demand for livestock feed is growing at a very fast rate. According to industrial sources, the share of domestic demand in the total output of de-oiled cake has increased from less than 10 percent in the 1970s to more than 25 percent in recent years. Oilmeal, used in compound feed for cattle and poultry, makes up about 25 percent of the feed. Business is also growing in full fat soya flour and feed grade, which is used for poultry, pig and ruminant feed as well as for aqua feed.

The private sector, optimistic about the demand for soy products in the country, is presently engaged in manufacturing a range of products on a small-scale to be used in food, pharmaceutical and industrial products.

Experts feel that the future use of soybeans in India would be predominantly for oil and secondly as an ingredient in livestock feed. A small part would continue to be used for various types of protein food. Based on this, industrial observers feel that several multinational companies are interested in entering into the edible oil business in India. The view in academic circles is that companies in the United States see India as a very big market for soya oil imported from the United States. At present, India imports more than 4.5 million tonnes of vegetable oil, of which more than three-quarters is palm oil. With the increase in consumers' income, preference is shifting from palm oil to soybean oil, which competes very closely with palm oil. There is also a strong possibility of a shift in demand in favour of soybean oil as it is considered superior in terms of its effect on human health.

The GOI is giving high priority to the development of soybeans in the country for several reasons. The main reason is the rising dependence on imports for meeting the domestic edible oil demand. At present India meets about 45 percent of its consumption of edible vegetable oil through imports. This level of dependence on imports is considered very high and the government is determined to reduce imports by expanding the domestic production of oilseeds. Oilcakes are an important source of foreign exchange earnings. There has been a decline in export earnings from oilcake in recent years and the government would like to reverse this trend. During the last decade, agriculture growth has declined sharply and there is widespread distress in the rural communities caused by the stagnation and decline in farm income and the price risks involved in high value crops. There are also frequent reports of suicides by farmers particularly in the cotton growing regions in the central, southern and western parts of the country. The soybean crop could be a relatively stable source of income in such areas.

At the state level, a strong voice is raised to ensure that market prices do not fall below the level of the minimum support price, which is worked out by the CACP. However, this mechanism is generally missing in soybean growing areas. Experts and farmers at the state level feel that any mechanism to ensure that market prices do not fall below the threshold level would provide a strong incentive for increasing the area under cultivation and productivity of soybeans.

The soybean processing industry claims that it has the capacity to extract a much higher output than what is currently produced in the country. The industry feels its profitability and efficiency is affected by government regulations and the poor and untimely availability of racks to take exportable cake to the ports. Big private companies have started to show interest in the production and marketing of soybeans and other agricultural commodities. The GOI has recently brought about changes in legislation to facilitate the increased participation of the private sector in agriculture production and trade. These companies are particularly keen in contract farming and the direct procurement of produce from farmers. In the case of soybeans, the private company ITC is well known for making arrangements with farmers for the production of soybeans for seeds. The company provides extension through modern means like E-choupal. Forging appropriate linkages between farmers and private companies would help farmers receive better prices for their produce and also guard to some extent against price risks.

5. Lessons learnt

New varieties of soybeans were introduced in India with the expectation that the soybean crop would meet the demand for pulses, as there was a serious protein deficiency in the diet of the population. However, the crop could not become as popular as *dhal* (pulse). Thus the search started for alternative uses of soybeans in industrial processing and as alternative foods. This coincided with massive shortages of edible oil in India caused by stagnation in the domestic production of oilseeds and a rising demand. On the one hand, India was importing soybean oil to meet demand; on the other hand, solvent extraction plants were not getting adequate raw material and were running well below their planned capacity. The availability of soybeans in the market provided an opportunity for these extraction plants to improve their performance. Soybean scientists at Pantnagar played a crucial role in convincing owners of oil plants about the scope and benefits of using soybeans for oil. With small additional investments in necessary equipment for roasting and flaking soybean for oil extraction, mill owners could receive rich dividends. The established market for soybeans produced by farmers in India and the growth of soybean production and solvent extraction plants complemented each other.

The technological options were supported by several policy measures. The GOI launched the TMO in May 1986 and initiated the OPTP in 1987-1988. Simultaneously, marketing and price support were also extended to oilseeds. The soybean crop benefited most from these policies. Subsequently, market intervention operations were started in the domestic market through the NDDP. These operations involved buying, stocking and selling oilseeds and edible oil and the maintenance of a price band. At the same time imports were regulated through canalization and high tariffs to protect domestic oilseeds from import competition. Strong policy support for technology diffusion combined with marketing and price support produced impressive results in a short time.

Soybeans were initially introduced in Madhya Pradesh and Uttar Pradesh. The main reason for this was that in these areas cultivated land during the monsoon season was kept fallow to preserve moisture for the sowing season. The short duration of new varieties of soybeans did not affect the sowing time of the second crop after the monsoon season. During the last five years the area under soybean cultivation is more than 6.5 million hectares. The reasons for such growth in the cultivated area and output of soybeans are (a) the suitability of soybeans for cultivation in fallow land; (b) the yield and price advantage over other crops, mainly coarse cereals and pulses.

The regional spread of soybeans is concentrated in and around the State of Madhya Pradesh, which occupies 60 percent of the soybean area of the country and 10 percent of the total cropped area in India. The soybean crop occupies more than 23 percent of the gross cropped area in the State of Madhya Pradesh. In the States of Maharashtra and Rajasthan soybeans are cultivated on 4.9 and 3.1 percent, respectively, of the total cropped area.

Besides demand factors and policy support, research and extension played a crucial role in the adoption of soybeans in India as it was a new crop for farmers, consumers and processors. The AICRP on Soybeans was given strong support to develop and adapt varieties suitable for India and to develop appropriate processing technology. This was accompanied by dedicated extension services provided by the agriculture departments of concerned states and public sector organizations such as *Tilhan Sangh* (Madhya Pradesh State Cooperative Oil Growers Federation). The latter also provided marketing and processing facilities. Several other institutions have also contributed to the success and spread of soybeans in India. On the marketing side, cooperative institutions have played an important role in ensuring remunerative prices to soybean growers. Extension services for soybeans are provided by state agriculture departments, KVK, and to some extent by extension departments of state agricultural universities and ICAR institutes. NGOs such as SPRA and SOPA played a significant role in promoting cultivation in the initial stages. SOPA is again playing an active role in promoting soybean production in various ways.

The adoption of soybean cultivation was not affected by the size of holdings, as there was no element in soybean cultivation that favoured large-size holdings. Thus, similar to the HYVs of paddy and wheat, the soybean varieties introduced in India were adopted by all categories of farmers.
With the increase in domestic demand for edible oil as well as the export demand for oilcake and oilmeal, soybeans became a very important commodity for agro-industry. Thus, soybean cultivation and the number of extraction units expanded together and a very strong linkage developed between farm production and the processing industry. Cooperatives and the private sector set up processing industries in the soybean growing areas near available raw material.

The use of soybeans for oil witnessed rapid growth in the domestic market. Oilcake and oilmeal, obtained after extracting oil from soybeans, found attractive markets in East and Southeast Asian countries and in Europe as feed for livestock. Almost all of the refined soya oil produced in India is consumed in the country; nevertheless India still has a very high edible oil deficit. De-oiled cake is largely exported; however, the domestic demand for it is also increasing. At present one-fourth of de-oiled cake is consumed within the country and three-fourths is exported. It is estimated that approximately 90 percent of soybean produced in India is used for oil extraction. It is ironical that soybeans, which were initially perceived as a pulse food to meet the protein demand and deficiency in India, did not gain much popularity as a protein food. Only one product, nutri-nuggets, was established on a sustained basis; the demand for other soya products remained quite low.

The prices of soybeans and soybean products are closely linked to international prices because of the high level of trade in such products. In most years, oilcake and oilmeal account for more than 95 percent of the total export of all soybean products. Soybeans are one of the most important agricultural exports. After 1998/99 export earnings from oilmeal and oilcakes fell sharply, mainly because of the East Asian crisis, as East Asian countries are the major importers of oilmeal and oilcake from India. The proportion for export of total production has fallen from more than 50 percent during the early 1990s to the mid-1990s to 30 percent in recent years.

The demand for edible oils in India has been increasing at a very fast rate. Despite the TMO and other efforts to raise edible oilseed production, the growth in production could not keep

pace with the growth in domestic demand. Thus, India meets the demand deficit through imports. Palm oil is the biggest agricultural import item. Soybean oil is now the second largest edible oil imported by India. Soya imports were less than 100 000 tonnes until 1997-1998. With the liberalization of imports and a sharp decline in the international prices of soybean oil, imports of soybean oil started rising rapidly. During the period from 2001 to 2005, India imported on average more than one million tonnes of soybean oil.

The prices of soybeans and soybean products are closely linked to international prices because of a high level of trade in soybean products. Consequently, fluctuations in international prices of soya oil, oilcakes and soybeans affect domestic prices, price stability, farmers' income and the profits of processors. It is easy to check the volatility in international prices passing to the domestic market by applying appropriate tariffs to imports. However, the adverse impact of volatility in international prices cannot be checked on exports. In this way the volatility in international prices affects the commercial viability and farmers' income.

Indian soybeans lose their competitive edge because of poor productivity. The recent productivity level of soybeans in India is about one-half of the average yield in China and one-third of that in the United States, Argentina and Brazil. Moreover, soybean yield in India is stagnant around 1 000 kg/ha, but input requirements are rising because of the increasing susceptibility to insects and pests and the nutritional imbalances in soil, resulting in a small squeeze on farm income.

Soybean cultivation was started in a number of places in India, but was then abandoned because of inadequate market demand. Production could be sustained only in those places where the processing industry developed on a large scale. Soybean cultivation is expanding into new areas, for example, Karnataka, Andhra Pradesh and Gujarat, where at present the cultivated area is very small, but potential is high. As markets develop in these areas, soybean cultivation is expected to grow.

Further expansion of soybean cultivation in India is constrained by several factors. Foremost is the low and almost stagnant but highly fluctuating productivity. One important reason for this is that the use of improved seed is very low in India. There is a large gap between the actual and attainable yield of soybeans because of the inappropriate use of inputs and low quality seed. Farmers must be trained with regard to the use of the right quality and quantity of seed and other packages of practice to enhance yield. The present arrangement for the supply of soybean seed is highly inadequate. There is a need to develop a seed distribution network to supply certified and quality seed to farmers. In order to break the present yield barrier high-yielding, location-specific varieties should be developed that are disease and pest resistant and drought tolerant. India also needs to explore the prospects of GM soybean cultivation in the country.

Soybeans are much more remunerative than other crops cultivated in rainfed areas. With the growing strain on water resources, it seems likely that the area under soybean cultivation will expand. The private sector, optimistic about the demand for soya products in the country, is presently engaged in manufacturing a range of products on a small scale to be used in food, pharmaceutical and industrial products. Experts feel that the future use of soybeans in India

would be predominantly for oil and secondly as an ingredient in livestock feed. A small part would continue to be used for various types of protein food. At present, India imports more than 4.5 million tonnes of vegetable oil, of which more than three-fourths consists of palm oil. With the increase in consumers' income, preference is shifting from palm oil to soybean oil, which competes very closely with palm oil. There is also a strong possibility of a shift in demand in favour of soybean oil as it is considered superior in terms of its effect on human health

The GOI is giving high priority to the development of soybeans in the country for several reasons. The main reason is the rising dependence on imports for meeting the domestic edible oil demand. Oilcakes are an important source of foreign exchange earnings. During the last decade agriculture growth has declined sharply and there is widespread distress in the rural communities caused by the stagnation and decline in farm income and the price risks involved in high-value crops. The soybean crop could be a relatively stable source of income in such areas. The GOI has recently brought changes in legislation to facilitate increased participation of the private sector in agriculture production and trade. Big private companies have started to show interest in the production and marketing of soybeans and other agricultural commodities. These companies are particularly keen on contract farming and direct procurement of produce from farmers. Forging appropriate linkage between farmers and private companies would help farmers receive better prices for their produce and also guard against price risk to some extent.

The future of soybean cultivation in India depends upon several factors of demand and supply. In India, soybeans are used mainly for soya oil, oilcake and oilmeal. Soya oil is sold on the domestic market. Oilcake and oilmeal are partly exported and partly sold on the domestic market; however, the share of the domestic market is increasing. The price of soya oil on the domestic market is strongly influenced by palm oil and soybean oil imports and their international prices. In most other parts of the world, GM varieties of soybeans are replacing non-GM varieties and providing cost advantages, at least in the immediate term. India has not yet allowed the cultivation of GM varieties of soybeans. If India does not keep pace with the rest of the world in adopting new technologies, it will lose the domestic as well as the export market to other major soybean producing countries such as Brazil, Argentina and the United States. It seems that the niche India enjoys in the export of non-GM soya products to the European Union is small compared with the loss of the domestic and international markets to soya products from GM varieties being grown in other countries. The domestic market demand for edible oil is increasing at a very high rate. Based on available estimates, the per capita demand for edible oil (including the quantity used as *vanaspati ghee*) increased from 6.4 kg during 1991-1992 to 10.2 kg during 2001-2002. With a population growth of 1.8 percent per year, the total demand for edible oil is growing at a very high rate. Thus, there is quite a demand for soybean oil and for expanding its production. However, this would depend on the price factor to a large extent as the demand for edible oil has high price elasticity, estimated to be around 0.54 (Kumar, 1998).

At present soybean oil and other edible oils produced in the country face competition from imported palm oil, which is available at a relatively low price from countries such as Malaysia and Indonesia. Palm oil imports face a very high tariff rate at the present time. India is negotiating a free trade agreement with ASEAN, under which there is a proposal to decrease

the tariff on palm oil by one-half after a gap of five years in the subsequent ten years, i.e. by 2022. This gives India enough time to prepare its oilseed sector to face competition from palm oil under any fair trade agreement with Southeast Asian countries. India would need to improve its soybean production and processing systems to compete with this situation. Much depends upon the future use of palm oil as there is a strong interest to divert the sizable output of palm oil for bio fuel. If the price of palm oil rises, the threat to oilseeds would be mitigated.

In order to promote soybean production and to improve its economic viability and production efficiency, the following is suggested:

- There is a large gap between the actual and attainable yield of soybeans because of the inappropriate use of inputs and low quality seed. Farmers must be trained with regard to the use of the right quality and quantity of seed and other packages of practices to enhance yield. The present arrangement for the supply of soybean seed is highly inadequate. There is a need to develop a seed distribution network to supply certified and quality seed to farmers.

- During the last decade, soybean productivity has stagnated at around 1 000 kg/ha. In order to break the present yield barrier, high-yielding, location-specific varieties should be developed that are disease and pest resistant and drought tolerant. India also needs to examine the prospects of GM soybean cultivation in the country.

- In order to improve consumer acceptability, new varieties that have a long shelf-life, no beany flavour and a low amount of linolenic acid should be developed.

- Potential pockets should be identified in different states for promoting the production and productivity of soybeans.

- Efficient rhizobial cultures should be produced on a large scale and supplied to farmers.

- Recently the infestation of pests and diseases has become a menace and is causing considerable damage to crops. This requires pest and disease resistant varieties and the adoption of integrated pest management techniques.

- With the division of holdings in the country, the proportion of crop area under marginal holdings and smallholdings is increasing. Such farms are usually skipped over by extension agencies and their resource constraints are also quite severe. Contract farming should be promoted to raise productivity at these farms.

- A systematic study should be made on the consumer preference for soybean products in different regions of the country and should be followed up by promotional methods to popularize soy products.

- Because of their high nutritional value, some soya products should be included in programmes for addressing under nutrition and malnutrition, for example, mid-day meal programmes.

- Often farmers are not in a position to buy improved seed and fertilizer because of a lack of credit. Institutional credit flow should be increased through various means to improve the purchasing capacity of farmers for inputs.

- There are considerable inefficiencies in the transport, marketing and processing systems of oilseeds in India (World Bank, 1997). These systems need to be improved in order to raise the efficiency and competitiveness of domestic production.

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