Assessing the cost of soybean production in MP, and the sustainability of a continuing increase in its area of cultivation in MP and in India as a whole.

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1. Acknowledgements

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2. Executive Summary

Soybean is a major crop grown during the Kharif, or monsoon, season (July-October) in the rain-fed (dry land) areas of central and peninsular India. Madhya Pradesh (MP) is known as the "soybean state" of India, comprising 55% of the total national area of soybean cultivation. Soybean yield in MP, and India as a whole, is low compared to other major soybean-growing countries, and has remained more or less stagnant. Thus, it is important, at this time of high farm input prices and increasing area of soybean cultivation in India, to endeavor to assess how the cost, to farmers, of soybean production is changing.

Thus the project "Assessing the cost of soybean production in MP, and the sustainability of a continuing increase in its area of cultivation in MP and in India as a whole" was undertaken to understand the changes in the cost of production of soybean that have taken place over the period of time and to find out the reasons for the same.

For the purpose of the study Malwa region, Ujjain and Ratlam districts, of Madhya Pradesh in India were chosen because of it being the largest producer of soybean. Various stakeholders namely farmers, research institutes, agriculture department officials, soybean marketers and processors, NGOs, consultants fertilizer producers etc. were interviewed for the purpose of research.
Following observations were found as an outcome of the project:

- Production cost increases confirmed by farmers are not specific to soybean, but are a result of increased awareness of new technologies.
- It was noted by the majority of farmers interviewed that soybean requires less inputs than alternative Kharif crops.
- Discussions with farmers, as well as data from the public domain, indicate that soybean continues to be the preferred Kharif crop for farmers due to its high net returns.
- It can be predicted that the continuing spread of soybean in India may be stable with respect to the future market environment.

In addition, there was some evidence from the field that long-term soybean production is reducing soil health and increasing problems of pests brought about by inefficient nutrient management, continued monocropping and use of old varieties, as well as appearance of new pests and unfavourable agro climatic conditions.

3. Introduction

Soybean is a major crop grown during the Kharif, or monsoon, season (July-October) in the rain-fed (dryland) areas of central and peninsular India. Madhya Pradesh (MP) is known as the "soybean state" of India, comprising 55% of the total national area of soybean cultivation.

Soybean yield in MP, and India as a whole, is low compared to other major soybean-growing countries, and has remained more or less stagnant since soybean was introduced to India in the early 1970s. Despite this, the area of cultivation in MP, and India, continues to increase at a fast rate.

Soybean is considered to be a relatively high-input crop and over the years a few concerns have emerged regarding the future of soybean as a viable crop for Indian farmers. Over recent years, prices of farm inputs (such as fertilizers, pesticides, labour etc.), in India, have increased significantly. As input prices increase, soybean may become a less-favourable option for the Kharif season due to its high input requirement.

There is further concern that, in the areas where soybean is already established, its high-input nature, coupled with inefficient nutrient management, may be degrading the soil health. Degrading soil health would further increase the need for inputs to soybean, as well as to sequential crops.

Thus, it is important, at this time of high farm input prices and increasing area of soybean cultivation in India, to endeavour to assess how the cost, to farmers, of soybean production is changing.

The increase in area of cultivation of soybean in India year on year, despite significant increases in input prices, shows that soybean remains a profitable crop; however, global and domestic markets may not sustain the increasing domestic production of soybean in India, especially in view of an increasing cost of production.

4. Reason for Research

The project was initiated due to a perceived increase, over recent years, in the cost of soybean production in MP which can be attributed mainly to degrading soil health, poor adoption of new varieties and continued monoculture, as well as the increasing price of agricultural inputs.

Small-scale and marginal farmers constitute almost half of the farmers of MP who depend on soybean as a Kharif crop. An increase in the cost of soybean production could have significant impacts on the livelihoods of small and marginal farmers in MP, with whom ASA work.

As the area of cultivation of soybean in MP continues to increase annually, an increase in cost of soybean production will have a negative impact upon a large number of farmers, and thus needs to be properly assessed.

Though research into productivity of soybean in India is widespread; research into the cost of soybean production, and the repercussions of an increased production cost, is limited.

5. Hypothesis

There are likely to be many interdependent factors responsible for an increase in the cost of soybean production in MP. The main factors are thought to be: degrading soil health due to inefficient nutrient

management; poor adoption of new varieties and continued monoculture; and increasing agricultural input prices.

5.1 Input Price Increase

There has been a steep increase in the price of farm inputs in India, and in the rest of the world, over recent years (DAC (Department of Agriculture and Cooperation) 2008 (1)) and (FAO, 2008).
These input price increases include:

- Fertilizer – there is insufficient domestic production and global prices have increased dramatically.
- Pesticide
- Labour Cost – the National Rural Employment Guarantee scheme has hiked labour prices in India's poorest districts, and also decreased availability of labour as people migrate to exploit other opportunities that are being created.
- Energy e.g. diesel - modernization of agriculture is leading to an increase in the use of non-renewable energy sources.
- Land - changing land use, i.e. diversion of land for non-agricultural purposes such as real estate and industry, has increased the cost of land for tenant farmers.
- Seed - Increased input costs also act to increase the cost of quality seed as its cost of production increases.

The effects of an increase in the price of inputs reach across all crops. However, the effects may be more pronounced for soybean.
Soybean production in India is low in yield compared to other soybean growing countries (section 5.2), and compared to its potential yield in India, which has been defined by research (V.S. Bhafia, 2008) and (P. Singh et al., 2006). It can therefore be predicted that net returns for soybean may become insufficient as prices of agricultural inputs increase.

Commercial farmers in developed countries are able to cope better with high input prices, but in India and other developing countries, farmers often do not have sufficient access to markets (The Guardian UK, 2008).

5.2 Input Requirement Increase

5.2.1 Fertilizer

The input demand of soybean production in MP may be on the rise. Soybean has a high nutrient-demand compared to other crops, due to the high quality seeds produced. Although soybean is a legume crop, its requirement of nitrogen is much higher as compared with its own biological nitrogen fixation (BNF) (R. Chand, 2007).
There is evidence of a lack of efficient nutrient management among soybean farmers in MP, and it has been found that S, P and Zn tend to be deficient in soybean fields (ACIAR (Australian Centre for International Agricultural Research), 2008). This could be resulting in declining soil fertility/quality in soybean-growing areas, and a corresponding increase in fertilizer demand.

5.2.2 Pesticide

A repercussion of the poor nutrient management in soybean production in MP (section 5.2.1) is increased pesticide demand, as weaker less healthy plants are more susceptible to attack by pests.

Pesticide requirement for soybean production may be increasing due to two additional factors: development of resistance by pests/weeds due to low seed replacement rates for soybean in MP; and continued use of old seed varieties, (section 4.2.3).

Appearance of new pests in soybean is likely to be a factor contributing to an increased pesticide demand. During 2007-08, twenty four soybean diseases appeared in India, out of which seven were wide spread and six were zone specific (DAC, 2008 (2)). Diseases such as rust (caused by fungus *Phakopsora pachyrhizi*), *Rhizoctonia solani* rot and others, have recently become more common in India, and have spread to new areas, e.g. rust has spread to the Malwa region of MP. (Indian Soy Forum, 2001).

Continued mono cropping of soybean may also be aggravating nutrient loss from soil and pest attack.

5.2.3 Seed

The maximum area under soybean cultivation in India is covered under only two major varieties JS-335 and JS-93-05. Correspondingly, maximum breeder seed indent is being placed for these two varieties only, even though hundreds of varieties have been released for cultivation under different areas (DAC, 2008 (2)). [NB Breeder seed is produced in India as per the indent submitted by the Ministry of Agriculture based on the demand from both the public and private sectors.]
JS-335 and JS-93-05 were introduced to the central zone of India in 1994 and 2001 respectively. It is believed that there is a need to discourage the high indent for these varieties, as both are susceptible to pest and diseases (DAC, 2008 (2)).
Thus, an increase in seed replacement rate (which is currently low in MP (section 7.5.5)) may also be, further increasing production costs.

5.2.4 Irrigation

Agroclimatic conditions may also be a factor contributing to increased input requirements for soybean production in MP.
Greater amount and frequency of irrigation may be becoming necessary, as monsoon rains become more irregular. Water availability is important at critical periods of growth of soybean.

Agroclimatic conditions also can result in increased attack by pests and increased growth of weeds, and thus greater quantities of pesticides become necessary.

5.3 Agricultural Technology Extension

It is important to note that, should this project find an increase in the amount of inputs used in soybean production by farmers in MP, this is not necessarily a result of an increase in input requirement. It may simply be due to better extension of new agricultural technology, such as chemical inputs and improved seed varieties, to farmers in MP.

High input farming is a legacy of the Green Revolution in India. However, much of the Green Revolution agricultural developments did not reach the marginal cropping environments of rain-fed agricultural systems which make up much of MP. It may be that recent extension activities are leading to an increase in input use.

One would expect that an increased cost of soybean production as a result solely, or primarily, of agriculture extension, would be reflected in an increased soybean yield.

5.4 Impacts of Perceived Increase in the Cost of Soybean

Hypothesized impacts of an increased cost of soybean production are as follows:

- Reduced investment in soybean production by the farmers, whilst conserving or increasing its area under cultivation. Likely secondary impact of this is a decrease in yield;
- Diversification of crops in other seasons to generate additional income and make up for losses on soybean production;
- Intercropping between soybean rows to create additional income to make up loss;
- Adoption of alternative monsoon crops.

6. Background Information

6.1 Origin of Soybean Crop in India and MP

Soybean (*Glycine max*, family Fabaceae) is a species of legume native to East Asia, and has been a crucial crop there since before written records.Soybean was introduced into Europe in the 1700's and to the United States in 1765, where it was grown for hay. However, soybean was not an important crop outside Asia until about 1910, and was not utilized as a food crop in US until the 1920s.

The five major soybean producing countries in the world today are USA, Brazil, Argentina, China and India. India contributes about four per cent of total world soybean production and it stands at fifth position in terms of production. See figure 1.

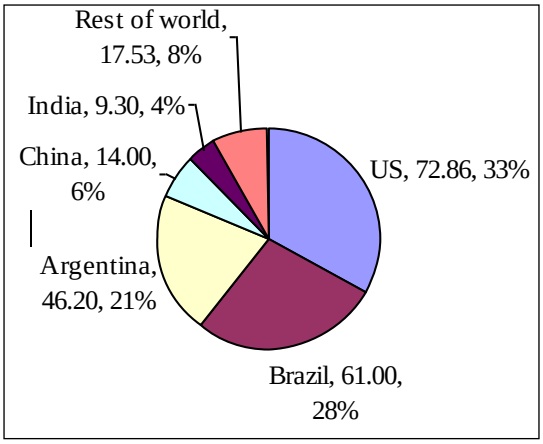

Figure 1World soybean production for 2007/08 in Million Tonnes and percentages of whole. (USDA FAS (United Stated Department of Agriculture, Foreign Agricultural Service), 2009)

Soybean became a major crop in India in the 1970s. The total area under soybean has increased dramatically from 30 thousand hectares (Ha) in 1970 to 9.6 Million Ha in 2008 (SOPA, 2008 (1)).

Based on the success of High Yielding Varieties (HYVs) of wheat and rice at the beginning of the Green Revolution in India, during the late 1960s the Government started research into HYVs for other crops. This research included experiments with high-yielding, early-maturing varieties of soybean, developed in the US, which proved very successful in Northern India.

However, soybean is not a new crop in India. Soybean was first introduced to the Indian states of Uttar Pradesh and Madhya Pradesh. The main reason for this was that in these states, cultivated land was left fallow during the Kharif season in order to preserve moisture for the Rabi season (October to March). The fast-maturing varieties of soybean introduced did not affect the sowing of a second crop in Rabi. (R. Chand, 2007) .Previously low-yielding and late maturing native varieties of soybean used to be grown in small areas in the hills of Northern India; the bean was used as a pulse for local consumption and vegetative parts used as fodder. Indeed, soybean was grown in India, in low Himalayan hills, as well as in the foothills and some scattered pockets of central India, long before it was introduced to the USA (S. Bisaliah, 1986).

In 1989-90 short duration, early maturing (90 days), high-yielding soybean varieties were developed in India (V. Deosthali et al., 2005).

As a result of this enhancement of cropping intensity, and the concurrent increase in land productivity, the profitability of land per unit area increased in soybean growing areas. This improved the socioeconomic conditions of marginal and small-scale farmers in these areas.
(V.S. Bhafia, 2008).

Today, soybean is primarily cultivated in the states of Madhya Pradesh, Maharashtra, Rajasthan, Karnataka and Andhra Pradesh. Percentage area under soybean, of total area of soybean cultivation in India, in these states in 2007-08 was 55%, 30%, 9%, 2% and 1% respectively (SOPA, 2008 (2)).

6.2 Soybean Productivity in India and MP

The production of soybean and its area of cultivation in India has increased dramatically since its introduction in the 1970's (see figure 2). During this time, however, the yield of soybean in India has remained almost stagnant, at around 1 Tonne/ha, i.e. the increasing production of soybean in India reflects an increase in area of cultivation and not an increase in yield.

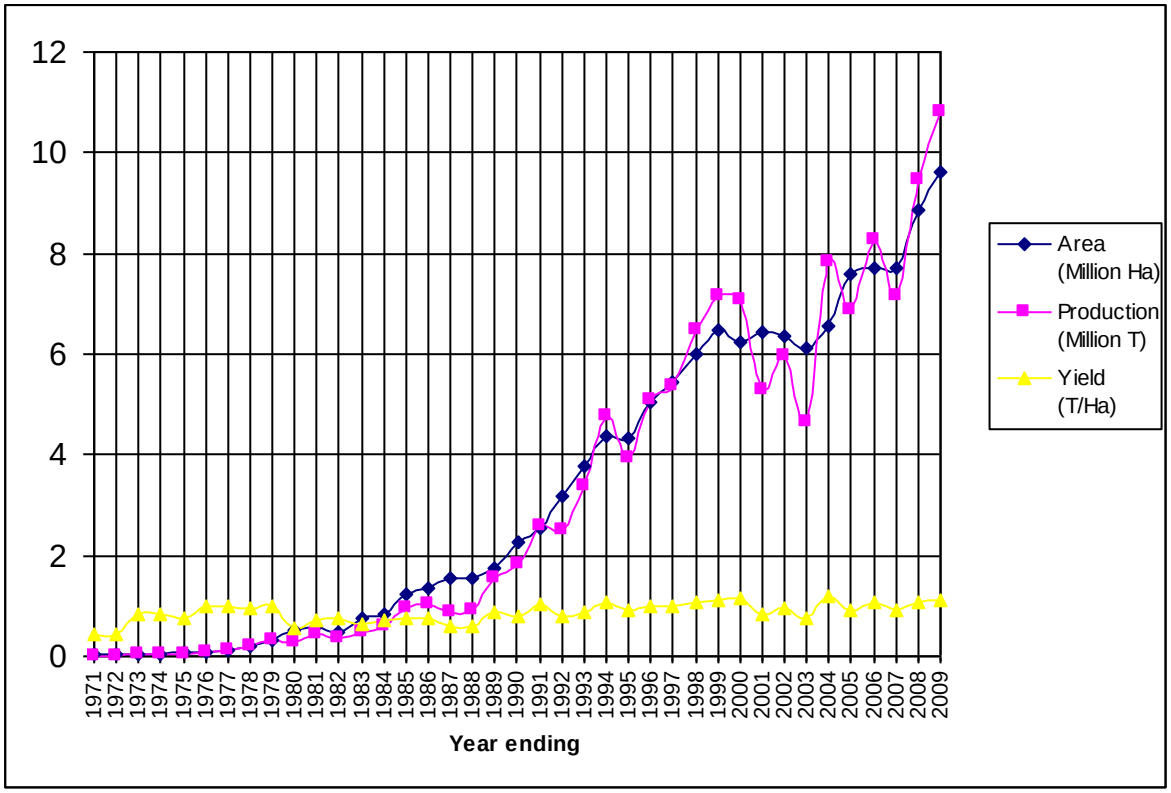

Figure 2. Area, production and yield of soybean cultivation in India from 1970/71 to 2008/09. (DAC, 2008 (3)).
Data for 2006/07, 2007/08 and 2008/09 is from www.sopa.org/1st%20Crop%20Report%202008%20Final.doc. Data for 2008/09 for soybean area is from reports of State Department of Agriculture; the data for production and yield are estimates based on soybean crop survey conducted by SOPA (Sept 16 - 24, 2008) in the four states Madhya Pradesh, Rajasthan, Maharashtra and Andhra Pradesh, and reports of Agriculture Departments of other states.

Compared to other major soybean growing countries, such as the US, Brazil, and Argentina, which have yields of almost 3 Tonnes/hectare (T/Ha) (USDA FAS, 2009 (1)), India's soybean yield is very low, hovering at around 1 T/Ha.

It is important to note, however, that these other countries, in general, cultivate soybean varieties with growing periods of a minimum of six months. The most common varieties in India (JS-335 and JS-9305), on the other hand, have maturity durations of not more than 100 days (NRCS (National Research Council for Soybean), 2008).
Yields for other oilseeds (peanuts, rapeseed, and sunflower seed) in India also rank far below the rest of the world, typically only 50-60 percent of the world average.
(USDA ERS (United States Department of Agriculture Economic Research Service), 2003).

Water stress is a significant factor in the low yield of soybean in India compared to other countries; adequate moisture is vital at critical growth periods, but nearly all soybean production in India is under rain-fed conditions, and thus water availability is dependent on the frequency and amount of the monsoon rains. Rains in September, during pod-filling, are critical for the soybean crop, and lack of rain can lead to 50% yield loss (State Dep. of Agri., 2008). Rain is also important for other crop development periods, specifically: sowing; flowering; and pod formation.
It can be seen from the graph (figure 2) that yearly soybean production does not always directly reflect the area of cultivation, indeed the production sometimes varies widely year to year. This could be a reflection of the changing monsoon conditions year to year.

MP shows a similar pattern of soybean production, since the 1990's, to India as a whole; increasing production of soybean and area of cultivation, coupled with roughly stagnant yield, figure 3.

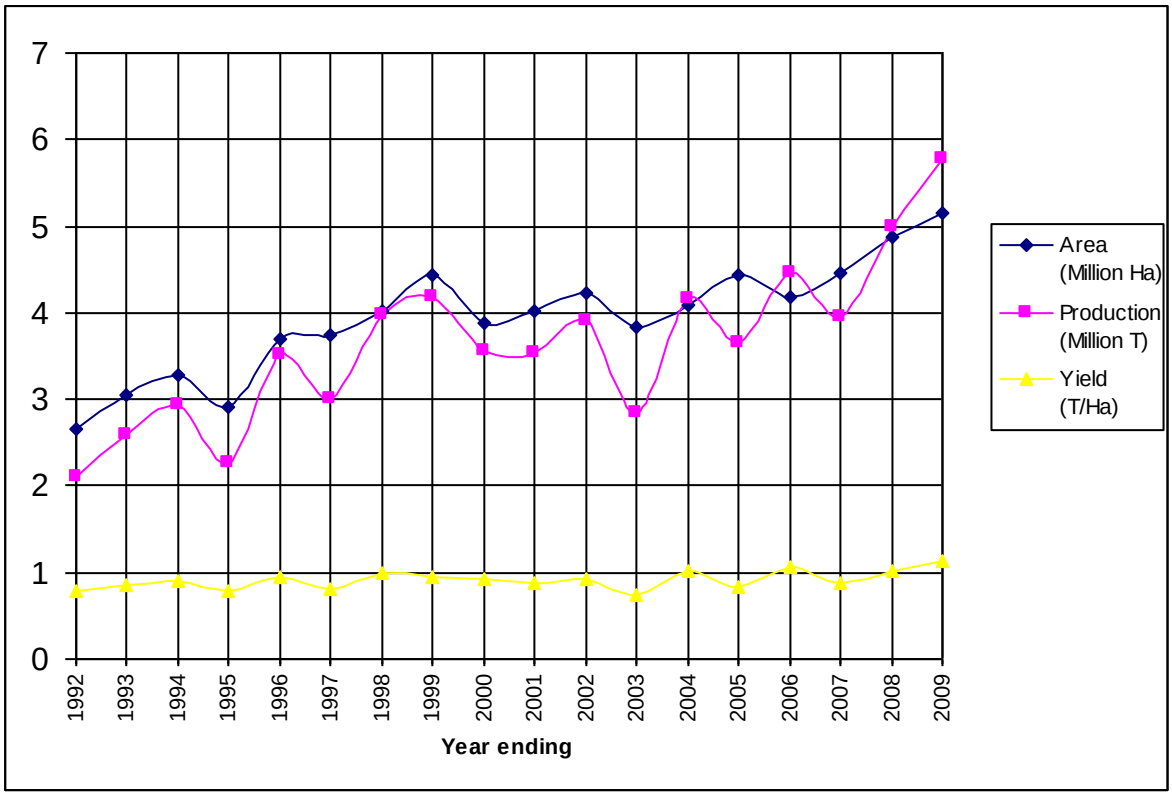

Figure 3. Area, production and yield of soybean cultivation in MP from 1991/92 to 2008/09.
Data for 1970/71 to 2006/07 is from SOPA (SOPA, 2008 (3)).
Data for 2007/08 and 2008/09 is from www.sopa.org/1st%20Crop%20Report%202008%20Final.doc. Data for 2008/09 for soybean area is from reports of State Department of Agriculture; the data for production and yield are estimates based on soybean crop survey conducted by SOPA (Sept 16 - 24, 2008) in the four states Madhya Pradesh, Rajasthan, Maharashtra and Andhra Pradesh, and reports of Agriculture Departments of other states.

The other two important soybean growing states, Maharashtra and Rajasthan, have also seen soybean production in Kharif increasing year to year over the same period of time (See figures 4 and 5).

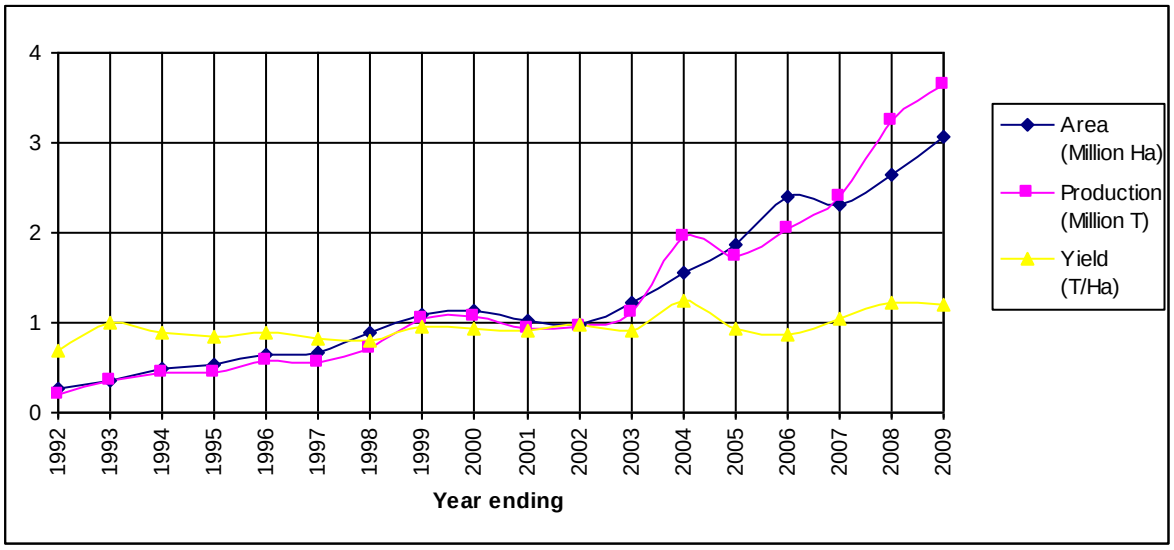

Figure 4. Area, production and yield of soybean cultivation in Maharashtra from 1991/92 to 2008/09.
Data for 1970/71 to 2006/07 is from SOPA (SOPA, 2008 (3)).
Data for 2007/08 and 2008/09 is from www.sopa.org/1st%20Crop%20Report%202008%20Final.doc. Data for 2008/09 for soybean area is from reports of State Department of Agriculture; the data for production and yield are estimates based on soybean crop survey conducted by SOPA (Sept 16 - 24, 2008) in the four states Madhya Pradesh, Rajasthan, Maharashtra and Andhra Pradesh, and reports of Agriculture Departments of other states.

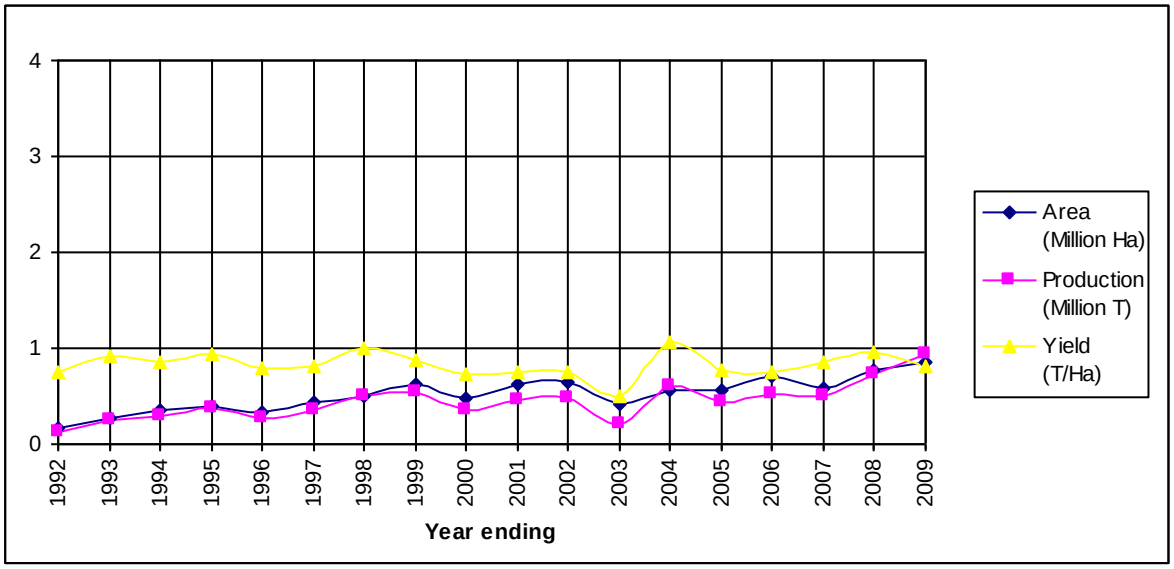

Figure 5. Area, production and yield of soybean cultivation in Rajasthan from 1991/92 to 2008/09.
Data for 1970/71 to 2006/07 is from SOPA (SOPA, 2008 (3)).
Data for 2007/08 and 2008/09 is from www.sopa.org/1st%20Crop%20Report%202008%20Final.doc. Data for 2008/09 for soybean area is from reports of State Department of Agriculture; the data for production and yield are estimates based on

soybean crop survey conducted by SOPA (Sept 16 - 24, 2008) in the four states Madhya Pradesh, Rajasthan, Maharashtra and Andhra Pradesh, and reports of Agriculture Departments of other states.

It is important to consider the reasons for a continued increase in area cultivated with soybean despite its stagnant and low productivity, and in spite of the increasing cost of production. The following possible factors contribute to the increased area under soybean cultivation:

a) Suitability of soybeans for cultivation on fallow land;
b) Yield and price advantage over other Kharif crops;
c) Stable price and well organised markets;
d) Soybean net returns are higher than other Kharif crops;
e) Alternative Kharif crops, e.g. cotton, sugarcane, sorghum, maize, can be completely destroyed by excess moisture. Soybean is more tolerant. Soybean sustains drought and excess rains. Except in critical periods such as germination, flowering and pod formation, soybean is generally considered to be tolerant to shortages of moisture. Also, soybean, compared with other legumes, is relatively tolerant to temporary water logging and in the absence of disease it recovers quickly after water logging ceases; (V. Deosthali et al., 2005).
f) Risk taking ability of farmers, i.e. low risk soybean vs high risk crops in other seasons;
g) The efficiency of Government schemes, e.g. the Technology Missions for Oilseeds, discussed briefly below, for the development of soybean production and processing in India.

6.3 Factors Involved in the Low Productivity of Soybean in India

Research into the productivity of soybean in India is widespread. A summary of the major constraints limiting yield, based on findings from such studies, is given below.

6.3.1 Agroclimate

- Undependable weather in terms of onset of rainy season and amount of rainfall and its distribution during the soybean growing period.
- Low photo synthetically active radiation levels during overcast days of the monsoon.
- Early end to monsoon resulting in water stress during pod-filling.
- Poor exploitation of soil profile for water due to much of the root system having been destroyed in the deeper soil profile by anoxic conditions during water logging.

6.3.2 Cultivation techniques

- Inefficient use of natural resources, particularly rainfall, and inappropriate soil and water management practices.
- Inefficient nutrient management/imbalanced use of chemical fertilizers and biofertilizers. Lack of use of micronutrients. Integrated Nutrient Management (INM) not adopted. (ACIAR, 2008).

- 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. Integrated Pest Management (IPM) is still not adopted. (DAC DPP, 2001).

- Lack of plant protection measures: The soybean crop is often affected by diseases, for example, rust, and yellow mosaic virus. Farmers rarely use any plant protection measures.

- Low seed replacement rate and low adoption of improved varieties.

- Waterlogging in low-lying fields leading to stunted growth and nitrogen deficiency. Much of the land suitable for cultivation in MP is left uncultivated during the Kharif season because of waterlogging. Even though some waterlogged fields are sown with soybean, the yields are very low due to poor establishment. Use of Broad Bed and Furrow (BBF) system would overcome problems of waterlogging and also may alleviate water stress on early end of monsoon.

- Inadequate tillage. Soybean sowing is often done hurriedly with the onset of monsoon without the desired level of cultivation. Inadequate tillage exacerbates the weed problem.

- Incorrect sowing. The sowing is still done by primitive methods as farmers are unaware of latest practises. Soybean exhibits epigeal mode of germination and may be planted too deep in order to avoid damage by birds.

- Untimely sowing. Pre-monsoon sowing must be avoided as soil moisture is insufficient and thus germination is reduced. It is not possible to manipulate the time of sowing in rainfed systems as it depends on the onset of monsoon. It has been found by the NRC for soybean that the average soybean yield decreases linearly by 181.77 Kg/Ha for every five days delay in sowing from the normal date (25th June) in the central zone of India, and the delayed sowing also reduces the oil and protein content of soybean. Delayed sowing may result in yield reduction to the magnitude of 17-39%. (NRCS).

- Untimely harvesting. Premature or delayed (after seed drop). Machine harvesting is also not possible due to water logging.

- Inadequate use of improved farm equipment for various field operations such as sowing and harvesting. An example is that threshing is often done using a wheat thresher which breaks much (20-25%) of the soybean seed

- Inappropriate post-harvesting management, e.g. storage before sale may be on top of fields after cutting, and if it rains the whole crop could be destroyed.

6.3.3 Government Policies

- Lack of efficient agricultural technology knowledge dissemination, e.g. IPM and INM (Integrated Nutrient Management) package of practices.

- Inaccessibility of inputs such as seed, fertilizer, pesticides.

- Meager credit facilities are extended by the government to the small farmers for appropriate investments in their farm equipments.

6.3.4 Research

- Lack of region-specific, high-yielding varieties due to inadequate research facilities.

- Low quality of seed. 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). Farmers often are not aware of, and do not compensate for, the low viability when planting seeds.

(P. Singh et al., 2006); (R. Chand, 2007); (DAC DPP (Department of Agriculture and Cooperation Directorate of Plant Protection, 2001) and (ACIAR (Australian Centre for International Agricultural Research), 2008).

7. Objective

Investigate how the cost of soybean production in MP has changed over recent years, and consider the sustainability of the continuing increase in area of soybean cultivation in MP, and in India as a whole

8. Methodology

Interviews were done with various stakeholders and questionnaires were used to collect data from soybean farmers on the field.

8.1 Consultations with Stakeholders

Following stakeholders were interviewed during the course of the project:

a) Farmers
b) State Agriculture Department and affiliates
c) Research institutes
d) Fertilizer and pesticide producers and dealers
e) Soybean marketers and processors
f) Soybean Processors Association (SOPA)
g) Farmers' Producers' Companies
h) NGOs and cooperatives
i) Independent researchers/consultants

The timescale followed for data collection from various stakeholders is given below:

- Farmers in MP *(3rd-19th December)*
- SOPA, Indore *(Mr GS Kalpa, Executive Director, 24th November 2008)*
- NRC Soya, Indore *(Dr GS Chauhan, Director, 24th November 2008)*
- Independent consultant *Ashok Kumar.*
- MP State Cooperative Marketing Federation, Bhopal *(Mr JP Sharma, Vice Chairman, 7th November 2008).*

- MP Department of Farmer Welfare and Agriculture Development, Bhopal. *(Mr A S Parmer, Deputy Director of Agriculture, 12th November 2008).*
- State Seed Corporation (MP Rajya Beef Evam Farm Vikas Nigam), Bhopal. *(Mr Ranjam Sharma 12th November 2008).*

8.2 Fieldwork

8.2.1 Location

Questionnaire-based discussions with farmers were carried out in two districts of MP: Ratlam and Ujjain.

Ratlam and Ujjain districts are in the Malwa area of MP, which is where soybean was first introduced and is thus well established.
The districts of the Malwa region are among those with the greatest area under soybean cultivation in MP, and together they made up over 50% of total soybean area in MP in 2008.
In the Malwa region soybean is grown in 99% of Kharif cultivated area, cf. 60% for whole of MP. (State Dep. of Agri., 2008).

The Malwa districts are also among those with the highest soybean yield. A major factor leading to this high productivity is the growth over time of farmers' knowledge and experience of soybean production. In addition, there are strong reliable markets in the area, processors are well established and seed availability is good.

Therefore, the Malwa area of MP represents well-developed soybean production and market structure, and so is ideal for getting an idea of the optimum state of soybean in MP, and also the future stability of an increase in the area of cultivation throughout the state.

8.2.2 Sample Specifications

The survey sample in each district comprised soybean farmers from small-, medium- and large-scale farms, so as to ensure a representative sample and also to investigate variations in the method and cost of soybean production according to farm size.
More than half of farmers in MP are small or marginal, and take up less than 25% of the land, Table I.

	Number of holdings	Total area of farm coverage
Marginal	35%	7.0%
Small	25%	15.7%
Other	40%	78.0%

Table I. Types of farmers and their respective area of land use, for MP. (M. Yasin et al., 2006).

Survey sample sizes in Ujjain and Ratlam were small, twelve and thirteen respectively, but the consistency of results obtained indicated that such a sample size was sufficient.

9. Fieldwork Results

A spreadsheet of the data collated from discussions with farmers in Ratlam and Ujjain districts can be found in appendix II. Due to the consistency of results obtained, a summary of the main findings is an appropriate presentation of the results. Such a summary follows.

9.1 Summary of Data from Fieldwork in Ratlam (3-5th December 2008):

Interviews were held with soybean farmers, twelve in total, from small-, medium- and large-scale farms in Ratlam. Soybean adoption, yield, agricultural inputs, and net returns, were discussed with each farmer. For farmer questionnaire please see appendix I.

General information: Soybean was adopted 15-20 years ago. Usually all cultivable land in soybean is Kharif. Sowing time is generally 5th to 15th June, which is dependent upon rains. Water logging problems in some areas but not affecting yield

Reasons for adopting: Less labour requirement, less disease, less irrigation, greater profit than other Kharif crops are the reasons for adoption of Soybean as a major crop. NB Two small farmers, both cultivating on light soil, stopped soybean cultivation due to reduced soil fertility.

Other Kharif Crops: Cotton, chilli, sunflower, maize are the other prominent crops grown.

Yield : Is around 20-30 Qtl (quintals)/Ha today (this is much higher than expected and it is suspected that there may have been some unit conversion error during translation). Yield has increased, since the cultivation began (10 to 20 qtl/Ha).The reason given for this was the availability of new information regarding pests/nutrients and adoption of new varieties. One farmer noted decreasing yield due to increasing problem of disease, one farmer noted stagnant yield despite new variety, due to nutrient loss from soil.

Fertiliser: Urea, DAP, Potash, Super Phosphate are commonly used today. Earlier hardly any fertiliser was used. The reasons given for this were an observed nutrient loss from the soil by farmers, and also more information available on fertiliser use. Fertiliser price has roughly doubled, from around 50 to 200 Rs/50 Kg bag at the beginning to around 200 to 500 Rs/50 Kg bag today. Three farmers use culture seed treatment.

Pesticides: Avaunt, Triazophos, Endosulfan are being used as fertilizers today. Either none or much less was used 15-25 (also5) years ago. This is mainly due to increased disease, also due to more information available on pesticides, which was mentioned as the reason for increase in yield. Also, agroclimatic conditions were mentioned as a reason for increased disease. Three farmers were found using use fungicide treatment (NB these were not the same farmers as used culture treatment).

Seed: Seed varieties (JS 9305, NRC7 and 37) are being used today. 15-25 (also 5) yrs ago JS 335, JS7105, Punjab1 were used. Seed replacement is still low; farmers tend to use saved seed from previous year's crop. Seed purchase depends on money available each year.

Irrigation: Irrigation need has increased due to infrequency of rains, but it seems irrigation was available 15-25 (and 5) yrs ago as well. Today electric pumps are as a major source for lifting water.

Labour: The amount of manual labour has decreased due to use of herbicides, and also because labour has become expensive (10-20 Rs/day – 100-150 Rs/day) and scarce. The price of manual labour has increased fivefold.

Market price of soybean: Increased two to four fold from around 500-1000Rs/Qtl to around 1500-2000 Rs/Qtl.

Impact of cost increase: Soybean is preferred Kharif crop as it requires less labour, less fertiliser, less pesticide, less irrigation, i.e. in general less inputs that other Kharif crops. It also has fewer problems with disease. The market price for soybean is high compared to other Kharif crops.

9.2 Evident Status of Soybean in Ratlam, from Fieldwork

The majority of farmers have experienced increase in yield due to the availability of new information regarding pests/nutrients, and adoption of new varieties. The amount of fertilizer/pesticide use has increased. Decreased soil nutrients and an increase in diseases were often cited as the reason for this. Prices of fertilizer, pesticide and seed have increased. Price of labour has also increased dramatically.

Cost of soybean production has increased significantly, due to both increase in amounts of inputs (fertiliser, pesticides, irrigation), and increases in the price of inputs (fertiliser, pesticides, seed labour). However, soybean is still the preferred crop in Kharif because it requires less agricultural inputs than other crops, especially labour, and has fewer problems with disease, and has a high market price.

9.3 Summary of Data from Fieldwork in Ujjain (17-19th December):

Interviews were held with soybean farmers, thirteen in total, from small-, medium- and large-scale farms in Ujjain. Soybean adoption, yield, agricultural inputs, and net returns, were discussed with each farmer. For farmer questionnaire please see appendix I.

General Information: . Soybean was adopted 10 to 32 yrs ago. Usually all cultivable land in Kharif is under soybean cultivation Kharif. Main additional Kharif crop is maize. Soybean is often intercropped with maize. Crop rotation is not adopted.

Reasons for adopting: High yielding, short duration, low input, high market price.

Other Kharif crops: Maize, Groundnut, Urad, Mung

Previous Kharif crops: Jowar, Urad, Groundnut, Maize, Mung, Cotton, Chili

Yield: Is Around 15 to 20 qt/Ha today. Yield has increased from 5 years ago when it was 10 qt/Ha to 15 qt/Ha. The reason for this was the use of new agricultural technology, such as chemical use and adoption of new varieties, which has replaced traditional techniques. The small farmers are currently experiencing lower yields than larger farmers.

Cost of production: Five years ago the cost of production was around 200 -2000 Rs/Acre, today it is 2000-5000 Rs/Acre. The small farmers have lower production costs than larger farmers. The increased costs of production is attributed to greater amounts of inputs being used so as to increase yield (one farmer mentioned increased cost of labour).

Fertiliser: DAP, Super Phosphate, Urea are being used today. Earlier either none or only biofertiliser, or small amount DAP and Urea, used 5 yrs ago. The reasons given for this was the desire to increase yield. A couple of farmers mentioned decreased soil quality as a reason, and one farmer cited exhaustive pesticide use. Two explanations were given for reduced use of biofertiliser by the farmers: slow action and reduced availability. Total cost of fertilizer increased from nothing or up to 1000 Rs/Acre 5 years ago to around 1000 to 3000 Rs/Acre today. Fertiliser is generally easily available (from nearest market, societies, cooperatives) but some farmers noted non-availability due to high demand. No farmer used culture seed treatment, or INM.

Pesticides: Indoxocarb, Endosulphan, Monochlorophosphate, Pursuit, Cypermethrin, Triazophos are being used today. Either none or small amount Endosulphan was used 5 years ago. This is mainly due to farmers wanting increased yield, and experiencing increased pest problem (two farmers cited pollution and pesticide use as reasons for increased pest problem). Total cost of pesticides has increased in the last 5 years from nothing to up to 900 Rs/Acre to around 500 to 2200 Rs/Acre today. Pesticides are easily accessible (from nearest market). No farmers used seed treatment, or IPM (one farmer used tradition IPM).

Seed: JS-335, JS-7105, JS-9305, NRC7, NRC37, 7355, 7322 being used today. 5 yrs ago Punjab1, Kali, D4, PK, Ankur etc. were used. Seed rate of 75-140 Kg/Ha is being followed (DPP of DAC IPM considers optimum seed rate to be 75 to 100Kg/ha (DAC DPP, 2001)). Almost all farmers replace seed 5% to 20% every year, in some cases it is more. Price of seed has increased from 400-1300Rs/Qtl 5 yrs ago to 1500-3500 Rs/Qtl today. Seed is easily accessible (from nearest market, society).

Irrigation: Often, no irrigation is used, or is used once if necessary. The reason given for this is that Irrigation from rain is sufficient. All farmers asked; had problem with waterlogging and drought.

Labour: The total cost of manual labour has increased from 150-1000 Rs/Acre 5 years ago to 500-3000Rs/Acre today. The amount of labour used is the same but price of labour has increased.

Mechanical labour: Five years ago either no mechanical labour was used or cost of mechanical labour was low around 400 Rs/Acre. Today mechanical labour is used by all farmers at around 300-1800 Rs/Acre. The reason given for this is to shorten time of cultivation processes.

Market price: Increased from around 500-1000 Rs/Qtl 5 years ago to around 1500-2000 Rs/Qtl today. Net return increased from around 3000-6000 Rs/Acre 5 years ago to around 6000-12000 Rs/Acre today. The produce is sold at nearest Mandi.

Impact of cost increase: Soybean is preferred Kharif crop as it requires less inputs and gives high yield and has high market price. One farmer said trying new crops would be too risk.

9.4 Evident Status of Soybean in Ujjain, from Fieldwork

Farmers have experienced increase in yield over the last 5 yrs, only one farmer had experienced stagnant yield.
Similar increases in fertilizer/pesticide use are seen by farmers in Ratlam, but reasons given were slightly different, i.e. wanting to increase yield rather than an observed need for increased

fertilizer/pesticides. Only a couple of farmers mentioned reduced soil quality or increased pest problem as the reason for increased pesticide yield.
Seed replacement seems to be quite high in Ujjain compared to Ratlam, though slightly older varieties are used than in Ratlam.
There has not been an increase in irrigation. Usually rains are enough, but one irrigation is used if necessary.
Prices of fertilizer, pesticide and seed have increased. Price of labour has increased by same proportion as in Ratlam, though in Ujjain the amount of labour used has remained the same, whereas in Ratlam farmers have reacted to increased labour price by decreasing manual labour use. Increased use of mechanical labour has added to the cost of production in Ujjain.

Cost of soybean production has increased significantly in the last five years from around 200 -2000 Rs/Acre to 2000-5000 Rs/Acre. However, soybean is still the preferred crop in Kharif because it has: high yield; short duration; low input; and high market price.
Whilst costs of production have increased dramatically (more than doubled or tripled), increases in yield, as well as doubled or tripled market prices, in the last 5 yrs has meant that net returns from soybean have actually increased.(two or three times or more).

It is important to note that while calculating total cost of seed inputs per acre, based on seed rates and seed replacement rates, it was noticed that they were low compared to other inputs. Costs per acre ranged from under 100 up to 544 Rs. This is discussed further below.

NB: though data from Ratlam was looking at changes over a greater period of time than 5 years, similar results were found. This may be because agricultural extension has been most active in the last 5 years

9.5 Conclusions from Fieldwork in Ratlam and Ujjain

9.5.1 Cost of Production

The cost of soybean production has increased over recent years. Cost increases, however, are not specific to soybean and span across all crops. In the Ratlam area there is some evidence that increased fertilizer and pesticide use is occurring as a result of, declining soil fertility/quality and increased problems with pests.
However, in general it seems that increased use of fertilizer and pesticides, and indeed seed, has been occurring primarily as a result of increased awareness of new technologies. Increased ability to invest has also played a part in increasing input use.

It was noted by the majority of farmers interviewed suggested that soybean actually requires less inputs than other Kharif crops, this is often the reason for converting to soybean coupled with soybean being a short duration crop and having less problem of disease and having high yield.

9.5.2 Net returns

Though the cost of soybean production has increased over recent years it has been accompanied by an increase in yield and an increase in market price, both of which have acted to actually increase the net returns from soybean.

These two main findings – increased net return and lower input requirement compared to other Kharif crops – explain the continued increase in area of soybean cultivation in MP despite increasing costs of production.

9.5.3 Yield

Yield increase, as noted by the majority of farmers, was not an expected finding; due to information in the public domain stating stagnation or low yield in MP. It may be that lower yields from other areas in MP, where soybean is more recently becoming established, i.e. regions not in Malwa area, are contributing to the stagnant yield for soybean in MP as a whole.
Were it the case that my field data indicated stagnant yield, coupled with the increasing inputs for soybean production in the areas studied, this would have been a worrying finding and would indicate that increased inputs were simply staving off decreases in yield.

9.5.4 Cultivation Techniques

It is important to note, that soybean production in the areas visited remains far from optimum: Farmers' knowledge and use of IPM/INM (including seed treatment) is absent; micronutrients are not utilized and crop rotation is not adopted; widespread use of just two relatively old varieties, JS-335 and JS-9305 is prevalent; seed replacement is low or absent. These findings are a little concerning due to the fact that soybean is a well established crop in the Malwa region, and hence cultivation techniques should have been well developed.

The finding that there is much room for improvement in cultivation techniques, means that though the cost of production may be lower than other Kharif crops, and the yield high, and thus net returns high, there is scope for reduction in cost and further increase in yield.

This project focuses on input costs, however, there are many cultivation techniques unrelated to inputs, such as: inadequate tillage; incorrect or untimely sowing; untimely harvesting; and inappropriate post-harvest management. These factors, as well as lowering the yield of soybean, could be leading to higher than necessary cost of inputs.
Unfavourable agroclimatic conditions may also have a part in both a higher than necessary cost of production and a lower than optimum yield.
In addition, farmers tend to grow soybean as a sole Kharif crop, thus making them vulnerable to sudden price decreases or entire crop failure.

It was a surprising finding that soybean was viewed amongst farmers as a low input crop compared with other Kharif crops, as soybean is generally considered to be a high input crop. This finding may be indicative of a lack of knowledge about input requirements, particularly nutrients, amongst farmers, and is likely a further reason for lower than optimum yield.

9.5.5 Seed Input

It is worth looking at the situation of seed input in some further detail. Quality seed tends to give the highest returns, relative to cost of input, of all agricultural inputs, and other inputs are dependent on quality seed.
Data collected in the field indicates low investment in seed, see appendix II.

This finding is backed by the data from public domain which suggests that the seed replacement rate in MP for soybean was around six percent until 2002-2003, (R. Chand, 2007), and today is only around 16 to 17% (State Dep. of Agri., 2008).

Data from the State Seed Certification Agency indicates that in MP during the Kharif season the production of certified seed is maximum in soybean as compared to other crops. See Table II.

Year Ending	Certified seed produced for Kharif crops in MP (Lakh Qtls)			Total
	SOYBEAN	PADDY	OTHER	
1994	1.56	0.78	0.05	2.39
1995	1.64	0.8	0.02	2.46
1996	1.64	0.55	0.07	2.26
1997	1.72	0.77	0.07	2.56
1998	2.01	0.57	0.02	2.6
1999	3.2	0.72	0.04	3.96
2000	3.94	0.89	0.05	4.88
2001	4.43	0.25	0.08	4.76
2002	5.9	0.33	0.15	6.38
2003	9.75	0.27	0.14	10.16
2004	12.29	0.27	0.1	12.66
2005	8.58	0.24	0.04	8.86
2006	14.43	0.36	0.04	14.83

Table II. Quantity of certified seed produced (in Lakh qtls) for Kharif crops in MP from 1993-1994 to 2005-2006. NB. Total quantity (Kharif and Rabi) of certified seed produced in MP in 2005-06 was 19.93 Lakh Qtls. (MP SSCA (State Seed Certification Agency)). NB Around 1 to 1.5 Lakh Qtl/yr of this production is by the State Seed Corporation.

Quick calculations, taking into account the area under soybean in MP and assuming a seed rate of 100 Kg/ha, see table III, give an indication of soybean seed demand.

Year Ending	Area soybean in MP (Million Ha)	Seed required for seed rate of 100 Kg/Ha (Kg)	Seed production in MP necessary to sustain 25% SRR (Kg)	Seed production in MP necessary to sustain 25% SRR (Lakh Qtls)
2003	3.83	383,000,000	95,750,000	9.58
2004	4.10	410,000,000	102,300,000	10.23
2005	4.44	444,000,000	111,000,000	11.10
2006	4.19	419,000,000	104,750,000	10.48

Table III. Estimating soybean seed demand in MP, taking into account area of soybean cultivation and assuming a seed rate of 25% and a Seed Replacement Rate (SRR) of 25%.

Comparison with the data in table II, for the quantity of certified soybean seed produced in MP, suggests that over recent years there has been almost sufficient production of soybean seed in MP to meet demand.

This is the case without taking into account the production of quality soybean seed in the State.

However, the certified seed produced does not necessarily represent the seed availability to farmers. Both inaccurate assessment of demand by the State Department of Agriculture, e.g. there may be a shortfall in popular varieties, and defective distribution of seed produced, can result in insufficient availability of seed. This applies to both certified and quality seed.

Another reason for the low seed replacement rate in MP is the cost. Soybean seed is the most expensive seed of all Kharif crops, therefore it is likely that farmers tend not to invest in soybean seed, whereas they may be more inclined to do so for other crops.

10. Net-returns for Soybean Compared to Other Kharif Crops

The data collected in field visits to soybean farmers in Ujjain and Ratlam, indicates that soybean continues to be a preferred Kharif crop for farmers in MP due to its high net returns. This finding will now be compared with cost of production and market price data from the public domain.

10.1 MSP and Mandi Price

Minimum support prices (MSP) for major agricultural products are fixed by the government each year, after taking into account the recommendations of the Commission for Agricultural Costs and Prices (CACP). MSP are determined taking into account the cost of production, changes in input prices, market prices etc. (CACP, date unknown).
MSPs for soybean over recent years are shown in Table IV. It has steadily increased over recent years.

Soybean		97/98	98/99	99/00	00/01	01/02	02/03	03/04	04/05	05/06	06/07	07/08
Black	Recom.	670	705	750	775	795	795	840	900	900	900	910
	Fixed	670	705	755	775	795	795	840	900	900	900	910
Yellow	Recom.	750	795	840	865	885	885	930	1000	1010	1020	1050
	Fixed	750	795	845	865	885	885	930	1000	1010	1020	1050

Table IV. Minimum Support/Procurement Prices (in Rs/Qtl), recommended by CACP and fixed by Government for Kharif yellow and black soybean from 1997/98 to 2006/07. (CACP, 2008).

Figure 6 compares MSP for some other important Kharif crops, which have commonly been replaced by soybean. NB This is only a selection of Kharif crops and this comparison is merely to give an idea of relative market prices for Kharif crops.

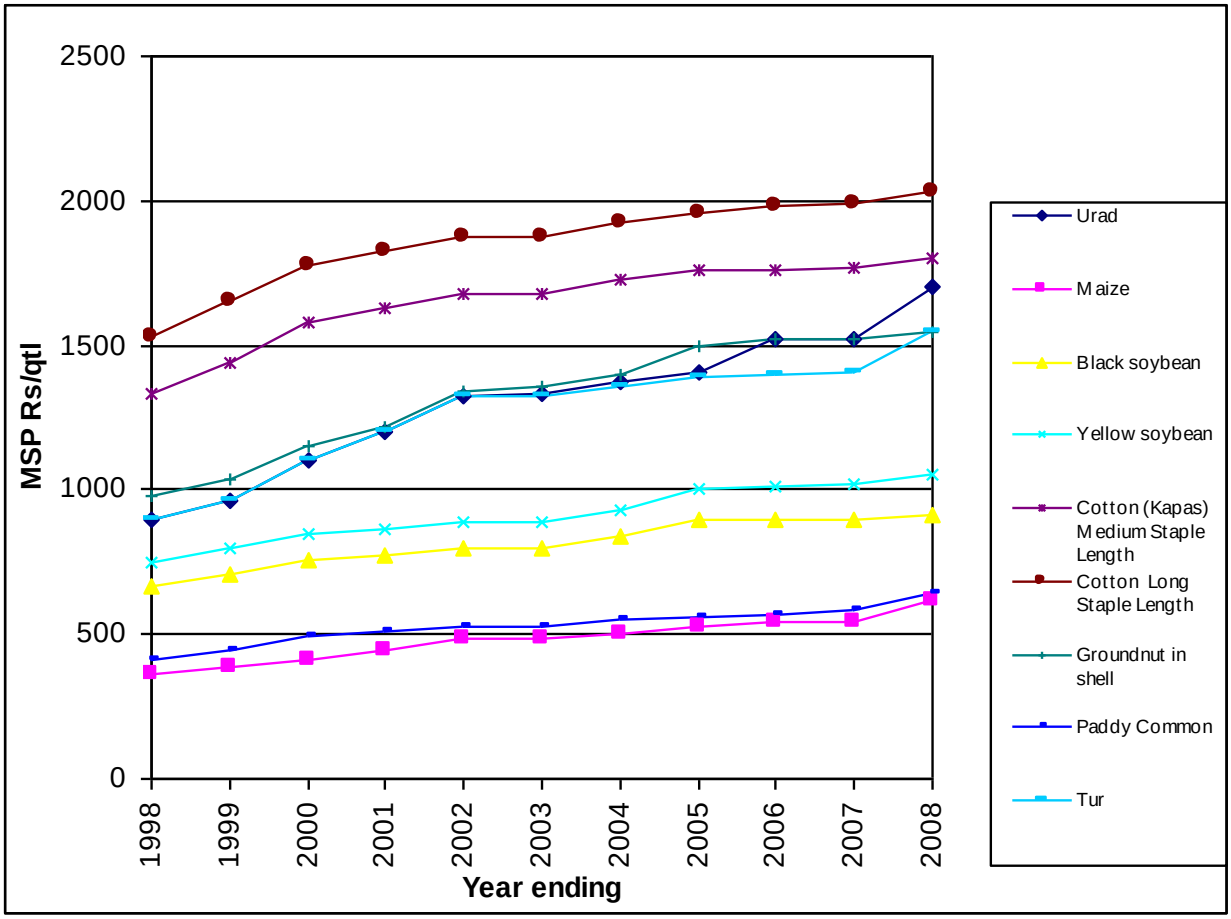

Figure 6. Minimum Support/Procurement Prices (in Rs/Qtl) fixed by the Government for some Kharif crops, from 1997/98 to 2007/08. (CACP, 2008).

This data demonstrates that the MSP for soybean is one of the lowest and has increased by similar amounts year to year as the comparison Kharif crops.

However, Mandi rates for soybean tend to be above MSPs, and Mandi rates for soybean have been in a similar range to those of Kharif crops with the higher MSPs, see figure 7. However, comparison has not been made here between Mandi and MSPs for the comparison crops.

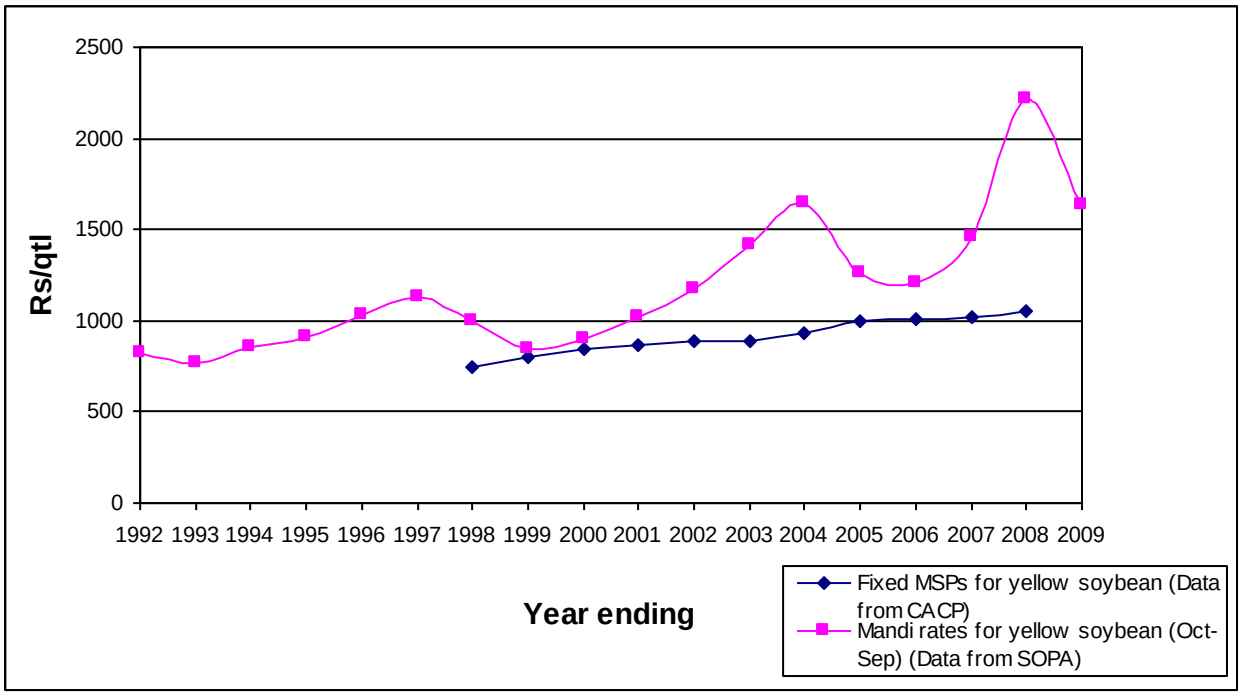

Figure 7. MSPs for Kharif yellow soybean (in Rs/Qtl) and yearly average Mandi rates (Rs/Qtl) for yellow soybean from 1992 to 2009 (CACP, 2008) and (SOPA, 2009 (1)). (Data for fixed MSPs is only provided by CACP from 1998 to 2008).

10.2 Cost of Production

A comparison of estimated costs of production for soybean and other Kharif crops, for 2006/07, see table V, indicates that cost of soybean production is low compared to cotton and pulses, but slightly higher than coarse cereals and paddy.

Crop		MSP Rs/qtl	Projected A2+FL cost of production Rs/qtl	Projected C2 cost of production Rs/qtl	Predicted net returns (MSP minus A2+FL)
Paddy		570	509	673	61
Coarse cereals	- Jowar	540	578	745	-38
	- Maize	540	445	579	95
Pulses	- Tur (Arhar)	1410	930	1379	480
	- Urad	1520	1664	2149	-144
Oilseeds	- Soybean Yellow	1020	678	979	342
	- Soybean Black	900	678	979	222
Cotton	- Medium Staple Length	1770	1893	2921	-123
	- Long Staple Length	1990	1893	2921	97

Table V. Projected costs of production in MP and MSP for soybean and other Kharif crops. Data is for Kharif 2006/07. (CACP, 2007). A2 + FL = costs actually paid plus imputed value of family labour; C2 = all costs including imputed costs of family labour, owned capital and rental on land. NB The data presented is for Kharif crops where data was available and is

not a full comparison of all Kharif crops. NB Costs of production of soybean shown here are similar to those given by farmers in this project, in response to the questionnaire (Appendix II).

Comparison of the projected A2+FL costs for each crop with the MSP for the same year (columns 2 and 3), suggests that in MP, for 2006/07, predicted net returns (column 5) were highest for soybean compared to all other crops considered here, apart from Tur, which indicates a higher net return.
Thus, it can be anticipated that even without a much increased Mandi price relative to MSP, soybean is one of the most profitable Kharif crop in MP. This supports the findings from my field data.

11. Sustainability of Soybean Market in India

The preference for soybean as a Kharif crop due to its high net returns compared to other Kharif crops, as indicated from field data and data from CACP (sections 8.1 and 8.2), explain the continuing increase in the area of soybean cultivation in MP.
Areas of soybean cultivation in the other two main soybean growing states (Maharashtra and Rajasthan) are also increasing year to year (section 5.2; figures 4 and 5).
It is thus important to consider the future prospects for continued high returns for soybean by a brief look at the market environment.

The market data in Table VI is taken from the USDA's Foreign Agricultural Service (FAS) monthly reports "Oilseeds: World Markets and Trade".

Year ending (Oct-Sep)	Soybean oilseed			Soymeal			Soyoil			
	Produ-ction	Crush-ing	Export	Produ-ction	Export	Domestic consump-tion	Produ-ction	Export	Import	Domestic consump-tion
2001	5.250	4.525	-	3.614	2.350	-	0.815	-	1.400	2.020
2002	5.400	4.629	-	3.700	2.450	-	0.855	-	1.550	2.387
2003	4.000	3.420	-	2.730	1.225	-	0.632	-	1.255	1.946
2004	6.800	5.534	-	4.422	3.310	-	1.022	-	0.759	1.782
2005	5.850	5.030	-	4.015	1.794	1.426	0.900	-	2.026	2.627
2006	7.000	5.990	-	4.782	3.679	1.525	1.070	-	1.727	2.627
2007	7.690	6.615	0.070	5.280	3.461	1.852	1.180	0.010	1.403	2.598
2008	9.300	7.998	0.050	6.385	4.790	1.920	1.426	0.010	0.733	2.269
2009	9.700	8.340	0.050	6.658	4.800	1.843	1.490	0.010	0.750	2.230

Table VI. Soybean oilseed, meal and oil production, consumption and export for all India from 2000/01 to 2008/09. Units for all values are Million Tonnes. Data for year ending 2009 is for December 2008 only. (USDA FAS, 2009 (2)). A dash in a cell indicates that India was grouped with the values for "other countries", possibly due to its value being not significant enough to mention separately.

This data indicates that minimal oilseed is exported from India, most is crushed domestically. The majority of soymeal produced is exported, but some is consumed domestically. Soyoil is almost entirely consumed domestically, with additional soyoil being imported to meet domestic demand. Data for the import of soybean oilseed and oilmeal was not provided in the reports; India was grouped with the values for "other countries", possibly due to insignificant import amounts for oilseed and oilmeal in India.

From this market data we can anticipate that global soymeal price and domestic soyoil price are important factors in determining the price received by farmers in India for soybean. The respective future market environments for each of these products are thus important for the sustainability of soybean production in India. The market environments for these two soybean products are discussed below. The possible future market for crude soybean is also discussed.

11.1 Soybean Oil

When new varieties of soybean were introduced to India in the 1970s, the initial idea was to meet the growing demand for, and deficiency of, proteins. In actual fact, soybean production in India has been primarily to meet the demand for edible oil in the domestic market, and de-oiled meal in the global market. (V.S. Bhafia, 2008)

During the late 1970s and 1980s, India was importing much edible oil from overseas.
In 1986 the Government launched the Technology Mission on Oilseeds (TMO) with the aim of increasing the domestic production of oilseeds in the country, reducing the import of oilseeds and achieving self-sufficiency in edible oils. (R. Chand, 2007). The TMO attempted to increase domestic production by increasing the MSP for oilseeds relative to grains.
(USDA ERS, 2003).

The price of, and production of, oilseeds increased dramatically in the late 1980s and early 1990s, but from the late 1990s oilseed prices declined both due to increased domestic supply, and due to the liberalisation of edible oil imports initiated in 1994. Prior to 1994, imports of edible oil were controlled directly by India's State Trading Corporation (STC). In 1994, India was obliged, under WTO rules, to place imports under a privatized Open General License (OGL) system, and also to eliminate import quotas and place upper "bound" (maximum) limits on tariffs. In 1995-98, the edible oil tariff was progressively lowered to 16.5% for all oils, and imports increased.

This decline in price of oilseeds from the late 1990s appeared not to significantly affect the price of soybean (section 8.1; figure 7), possibly due to oilmeal exports keeping the price of soybean high.

In 1998 the Government began making frequent tariff increases to protect domestic oilseed producers and processors, but a 45% bound limit tariff on soybean oil has led to significant incentives to import soybean oil over other oils. (USDA ERS, 2003).

Today around 40% of India's edible oil is still being imported. (R. Chand, 2007).
At present all soybean oil produced domestically is consumed domestically (table VI), with the additional domestic demand being met by imports. This indicates that there is room for expansion of the domestic oilseed market, provided import tariffs do not favour import over domestic procurement.

Population and income growth continue to spur domestic demand for edible oil in India. Efficiency gains by oilseed processors, together with infrastructure improvements, could strengthen returns to oilseed growers and boost production.
(USDA ERS, 2003).

11.2 Soymeal

Soybeans have not become a part of the Indian diet, except as oil, despite the high protein deficiency in the population's diet, particularly amongst pregnant women, lactating mothers and children in villages.

At the global level, however, use of soybean in food is increasing owing to nutrition, health and economic benefits. Soybean oil is sold in the domestic markets but protein-rich products are mainly exported. (R. Chand, 2007).
Soymeal constitutes around 90% of total oilmeals exported from India. De-oiled cake fetches better prices on the export market than the domestic market. (SOPA, 2008 (4)).

Figure 8 indicates yearly amounts of soymeal exported and the average FOB rates for each year from 1984/85 to 2008/09. The export values in Million Rs, follow a similar pattern to the FOB rates. On comparison with data for domestic production of soybean (section 5.2; figure 2), we can see that the export values also follows the pattern of the domestic production of soybean.

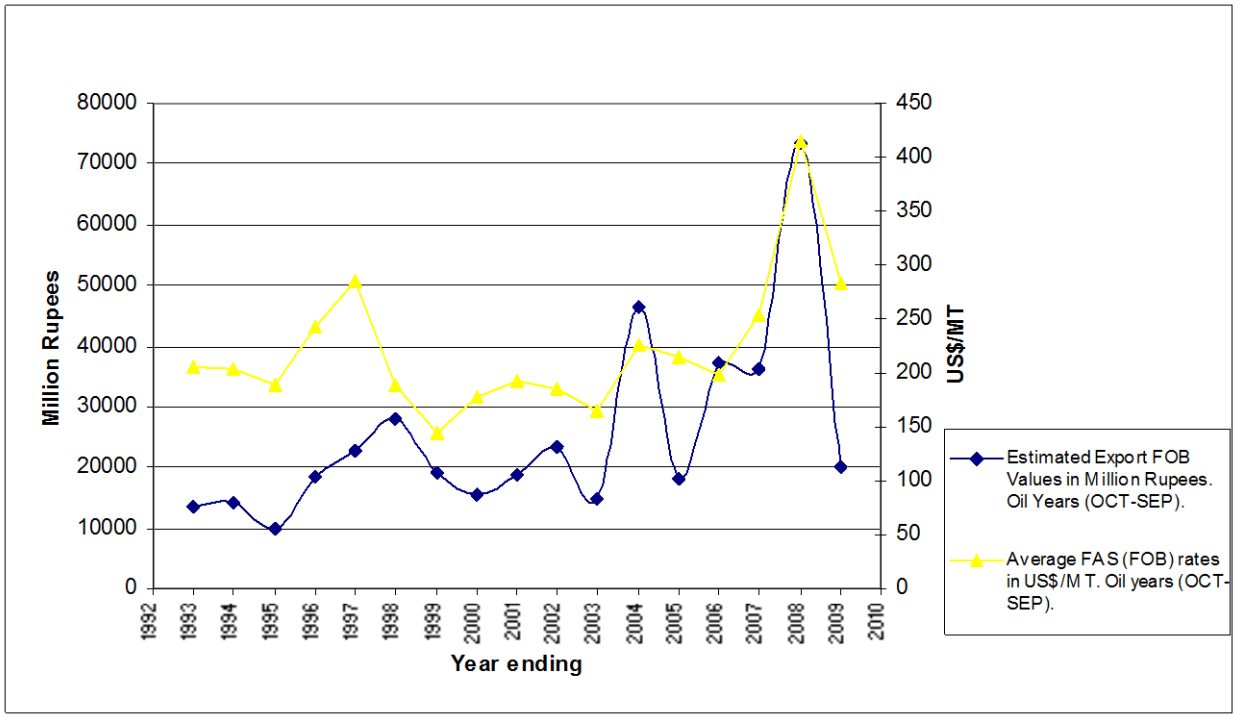

Figure 8. Yearly India Soybean Meal Exports and Average Rates for Soybean Meal. (SOPA, 2009 (2)) and (SOPA, 2009 (3). Data for year ending 2009 is to Dec 08 only.
NB The FOB (Free On Board) abbreviation is an import/export term relating to the point at which responsibility for goods passes from seller (exporter) to buyer (importer). FOB means that the seller (exporter) has liability for goods, insurance and costs of transport until the goods are loaded (or delivered), and so the FOB price takes into account this liability.

This reliance on trade with foreign countries, however, may be a threat to the soybean industry, in view of fast-changing world markets.
In addition, high costs of transportation in India have made soymeal uncompetitive in the global market. Soybean processing units in US and South America, the main producers of soymeal, have the advantage of being located near port areas, thus reducing freight rates substantially. (SOPA, 2008 (4)).

Over the last 4 to 5 years there has been an increase in soymeal used domestically for fodder, from 0 to 25% of total soymeal produced domestically (NRCS, 2008). It has been used as a replacement for the more expensive groundnut meal. This increase in domestic consumption is reflected in the data from the USDA FAS (table VI), and is indicative of possible further expansion of the domestic oilmeal market.

Human consumption of soybean in India may also increase in future years. Soybean provides a rich protein source, for human and animal. Around 40% of the seed is protein, 20% oil, and 35% carbohydrate. Its protein is not only high in quantity but also in quality, containing all the essential amino acids. Soybean also contains isoflavinoids, which may inhibit growth of cancer cells and also lower cholesterol levels. About two-thirds of all manufactured food products contain derivatives or ingredients made from soybean (Reliance Money, 2008).

Soybeans are one of the "biotech food" crops. In 1995 Monsanto introduced Roundup Ready (RR) soybeans that have had a copy of a gene from the bacterium, *Agrobacterium sp.* strain CP4, inserted into its genome, which allows the transgenic plant to survive being sprayed by the non-selective herbicide, Roundup.
India is still a GM soybean free nation (S. Sahai, 2007), whereas over half of the world's 2007 soybean crop (64%) was genetically modified, a higher percentage than for any other crop.
This gives a small advantage to India in terms of the export of oilseed, particularly to European countries where demand for non-GM crops is high. Although, correspondingly 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. (R. Chand, 2007).

ITC is an exporter of soymeal from India. Its Agri Business Division (ABD) exports soybean meal in large volumes to China, Pakistan, Bangladesh, UEA, South East Asia etc. (ITC (Indian Tobacco Company)).
In 2000, with the aim of capturing more of the soybean crop and procuring directly from farmers rather than being dependent on purchasing from village traders or government markets, with little quality control and high transaction costs, ITC set up e-choupal. E-choupal is an internet service which allows farmers to check both future global prices as well as local prices, before going to market. It also gives farmers access to local weather conditions, soil-testing techniques and other expert knowledge that will increase their productivity and thus increase their income. (New York Times, 2004).

11.3 Soybean

As discussed; tariffs imposed on edible oil imports to protect the domestic market (section 9.1), India also often imposes prohibitive barriers on oilseed imports. Therefore, India's domestic crushing industry relies on domestic oilseed supplies (USDA ERS, 2008).

Independent consultant and development professional Ashok Kumar, who represents small soy producers' interests, is working towards opening up crude soybean to global markets. He has initiated a project which works to establish trade links for Farmers' Producers' Groups to export certified, sustainable soybean to global, mainly European, markets.
This could potentially instigate procurement of funds from the international community for research into enhancing the productivity of soybean in India. This initiative may also prompt current buyers of Indian soybean, e.g. ITC, Cargill, to support research into its productivity in India.

South American and United States soybean farmers have come together over the past few years to promote global demand for soybeans in India (ASA (American Soybean Association), 2006).

11.4 Conclusions on Sustainability of Soybean Market

Minimal oilseed is exported from India, most is crushed domestically. There is potential for development of effective global trade solutions in the future.

The majority of soymeal produced is exported, but some is consumed domestically. The amount consumed domestically has increased over recent years, and will likely continue to do so, with increased use as fodder and possibly in the human diet.

The non-GM nature of soybean in India gives an advantage in terms of export.

Soyoil is almost entirely consumed domestically, with additional soyoil being imported to meet domestic demand. Provided import tariffs do not favour import over domestic procurement, the domestic oilseed market may continue to grow, spurred by population and income growth.

12. Conclusions from this Project and Scope for Further Research

- Production cost increases confirmed by farmers are not specific to soybean, but are a result of increased awareness of new technologies. However, some evidence was found of increased fertilizer and pesticide use as a result of an observed need specific to soybean.
- It was noted by the majority of farmers interviewed that soybean actually requires less inputs than alternative Kharif crops, which goes against the general assumption that soybean is a high-input crop.
- Discussions with farmers, as well as data from the public domain, indicate that soybean continues to be the preferred Kharif crop for farmers due to its high net returns.
- It can be predicted that the continuing spread of soybean in India may be stable with respect to the future market environment.

However, soybean production in MP is far from optimum, and greater extension of knowledge on improved agriculture practices for soybean production optimization, as well as increased availability and affordability of farm inputs, is required.

In addition, there was some evidence from the field that long-term soybean production is reducing soil health and increasing problems of pests. This was hypothesized to be the case, and predicted to be brought about by inefficient nutrient management, continued monocropping and use of old varieties, as well as appearance of new pests and unfavourable agroclimatic conditions.
This effect could become more pronounced in the future if inefficient soybean cultivation techniques continue.

Climatic change is likely to have substantial impact on soybean production. Increasing CO_2 levels will increase productivity, due to increase in photosynthesis. However, this increase will be offset by increases in temperature, which will significantly reduce the grain yield due to accelerated development and early flowering, and thus decreased time for grain weight accumulation, i.e. reduced grain-fill period. (R. K. Mall et al., 2004).
Moisture stress, due to swings in the continuity of monsoons, is likely to continue to adversely affect soybean development and growth at critical life stages. (M. Lal et al., 1999).

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Appendix I – Farmers' Questionnaire

A. Introductory questions

1. Name, Village name?
2. Size of farm?
3. Area under soybean?

4. Year soybean cultivation began?

5. Reasons for adopting soybean as crop?

6. Previous land use?

7. Other crops grown in Kharif as well as soybean? Intercropping? Crop rotation?

B. Yield and cost of production

1. Soybean yield ten years ago and today?

2. Reasons for decrease/increase in yield?

3. Cost of soybean cultivation ten years ago and today?

4. Reasons for increase in cost?

C. Fertiliser input amount and cost

1. Fertiliser used for soybean, ten years ago and today? Amounts of each fertiliser, or total amount? NB MP soybean tends to be deficient in S and Zn as well as N and P

2. Reasons for an increase in fertiliser use?

3. Fertiliser prices, or total cost of fertiliser, ten years ago and today?

4. Easily accessible? Where purchased, ten years ago and today?

5. Any INM package of practices used for soybean cultivation? Are you aware of such practices? Reason for not implementing such practices?

6. Treatment of soybean seed prior to sowing with any bacterial cultures, e.g. *Rhizobium Japonicum* and Phosphate Solubilizing Bacteria (PSB)? Are you aware of such treatments? Reason for not implementing such treatments?

D. Pesticide input amount and cost

1. Pesticides used soybean, ten years ago and today? Amounts of each pesticide, or total amount? Manual weeding?

2. Reasons for an increase in pesticide use?

3. Pesticide prices, or total cost of pesticides, ten years ago and today?

4. Easily accessible? Where purchased, ten years ago and today?

5. Any IPM package of practices used for soybean cultivation? Are you aware of such practices? Reason for not implementing such practices?

6. Treatment of soybean seed prior to sowing with any fungicide, e.g. *Thiram 75% DS or Trichoderma viride*? Are you aware of such treatments? Reason for not implementing such treatments?

E. Seed input amount and cost

1. Varieties of soybean grown today and ten years ago?

2. What is the seed rate, 75-100Kg/ha?

3. Seed replacement rate for soybean today and ten years ago? (i.e. % area sown, out of total area of soybean planted in the season, by using certified/quality seeds other than the farm saved seed?)

4. Reasons for increase in seed replacement?

5. Seed price, or total seed cost, ten years ago and today?

6. Easily accessible? Where purchased, ten years ago and today?

F. Irrigation input amount and cost

1. Amount of irrigation used for soybean, ten years ago and today?

2. Reasons for an increase in irrigation use?

3. Problems with water logging/drought?

G. Labour input amount and cost

1. Amount of manual labour (e.g. for ploughing, sowing, pesticide/fertiliser application weeding, irrigation, harvesting, threshing) used for soybean, ten years ago and today?

2. Reasons for decrease/increase?

3. Manual labour price, or total cost of manual labour, ten years ago and today?

H. Energy input amount

1. Amount of mechanical labour used for soybean increased/decreased over the last ten years?

2. Reasons for decrease/increase?

K. Selling price of soybean/net return for soybean

1. Selling price, or net return, received for soybean, ten years ago and today?

2. Where sold, ten years ago and today?

L. Impacts of an increase in cost of soybean cultivation

1. What have been the impacts of the increase in cost of soybean cultivation?
   e.g.
   i. Reduction of investment in soybean cultivation whilst area constant or increased
   ii. Diversification of crops in other seasons
   iii. Intercropping between soybean rows
   iv. Adopting other monsoon crops

Appendix II – Field Data: Farmers' Questionnaire Response

Field Data: Farmers' Questionnaire Repons