Technical and efficiency changes in oilseed sector in India: Implications for policy

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Abstract

The present study has analysed the trend in the total factor productivity (TFP) of major edible oilseeds in India during 1985-2010, and has decomposed the changes in TFP into its constituent components viz. technical change and efficiency change using Malmquist TFP approach. The study revealed that the productivity growth of groundnut, rapeseed/mustard and soybean has decelerated during period II (1996-2010) compared to period I (1985-1995). During the overall period TFP change was positive for groundnut and rapeseed/mustard, but negative for soybean. Period II has recorded increased TFP changes in two out of three states for groundnut and rapeseed/ mustard. For soybean, TFP change was positive in one out of three major state only. The entire change in TFP in case of all the crops was on account of technical change, with no contribution from changes in efficiency. The depressed productivity growth in many states despite positive TFP growth could be due to slowdown in input intensification. This situation warrants policy focus.

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1. Introduction

The importance of vegetable oils continues to increase in the food basket of Indian consumers. Given the dominant vegetarian diet of Indian consumers, daily requirement of fat for the body needs to be met from sources of plant origin. Moreover, vegetable oil is a major cooking medium in India. As on 2012, India produced 29.8million tonnes of oilseeds from nine annual oilseed crops, from an estimated area of 26.4 million hectares (Directorate of Economics and Statistics, 2014). However, with this much production, India meets only half of the edible vegetable oil requirement. The rest of the vegetable oil requirement is met out through imports. In 2012, India imported vegetables oils estimated at US $ 97.7 billion (Ministry of Commerce, 2014). Thus, vegetable oils constituted the single largest food commodity group imported to India. Realising the importance of achieving greater self-sufficiency in vegetable oils, Government of India has undertaken many initiatives to increase the domestic production. However, oilseed production could not achieve the desired targets. This experience in oilseed needs to be reflected with India's experience in foodgrain production, notably cereals.

In the past half a century, India has made significant strides in foodgrain production. India's foodgrain production as on 2011-12 stands at 255 million tonnes, compared to 74 million tonnes at the start of green revolution (1965-66). During this period, the productivity increased from 644 to 2125 kg/ha. The highest productivity increase has been noted in case of wheat (643 to 3118 k/ ha) and rice (668 to 2462 kg/ha). Maize, a late entrant in this category, has also posted sharp productivity improvement (547 to 2550 kg/ha). This has helped India to meet the domestic demand for foodgrains, despite a two and half fold increase in total population. Further, during this period India has reversed its status from that of a net food importing country to a net food exporting country. As on 2012, India exported 7.1 million tonnes of rice, 3.9 million tonnes of maize and 0.7 million tonnes of wheat. The achievement in productivity was predominantly through technical change along with intensification of agriculture. One critical factor in this direction has been public intervention in research and development. Further, various initiatives in popularising modern agricultural inputs, irrigation development, price policies including minimum support prices etc. have created a favourable environment for capitalising the newfound advantages in technology front. Notwithstanding some of the negative externalities associated with the high input intensification strategy epitomised by the green revolution, the simple fact remained that India could produce enough food for its population.

One noteworthy feature of this development is that the improvement in production and productivity has been mostly limited to dominant cereals, and bypassed other commodity groups like pulses and oilseeds. As a result, India resorted to import of pulses and oilseeds, more severely in the case of the latter, as already noted. The import bill on edible oilseeds is increasing unabatedly. As on 2012, palm oil (74%), sunflower oil (10.6%) and soybean oil (11.8%) together accounted for bulk of total vegetable oil import.

The per capita consumption of vegetable oil in India is low at about 13.5 kg per year, compared to the global average of 17.0 kg per year (OECD, 2010). Over years, the average per capita consumption of vegetable oils has increased. It was to the tune of 3.8 kg/ annum during 1960-85, and has increased to 6.3 kg/ annum during 1985-2000. During the next decade, the per capita consumption escalated 10.8 kg/ annum, at an annual increase of 5.3 per cent. It is expected that by 2050, the per capita annual vegetable oil consumption would be to the tune of 19.1 kg (DOR, 2013). The income elasticity of consumption of the vegetable oil remains quite high at 1.17 in rural areas and 1.14 in urban areas. Similarly, the own price elasticity also are high at -0.68 and -0.85, respectively (Srinivasan, 2005). With the population growth and anticipated improvement in the per capita income, notably of the lower income group of the population, the vegetable oil requirement is projected to be about 34.1 million tonnes by 2030. This is equivalent to 104 million tonnes of oilseeds production (DOR, 2013). The situation warrants greater focus towards boosting domestic production of vegetable oils.

The major annual oilseeds cultivated in India are soybean, groundnut, rapeseed/ mustard, sunflower, safflower, castor, niger, linseed and sesame. More than 80 per cent of production of oilseeds is contributed by three crops, viz. soybean (40.8%), groundnut (23.4%) and rapeseed/ mustard (22.1%) (DES, 2014). Besides the major annual oilseeds, India produces edible oils from perennial crops like coconut and oil palm also. A significant part of the cotton seed oil also goes for cooking purpose.

As noted earlier, one major constraint in boosting the oilseed production is the low productivity. The mean productivity of soybean, groundnut and rapeseed/mustard in India is 1208, 1323 and 1121 kg per hectare, respectively (DES, 2014) which is well below the world average and the top producers of the respective crops globally (Srinivasan, 2005). There were many concerted efforts from Union and State Governments to enhance the production. The major strategy was bringing in technical progress. The research support in this direction has been spearheaded by National Agricultural Research System (NARS) through Indian Council of Agricultural Research (ICAR) and various State Agricultural Universities (SAUs). Under ICAR system, commodity specific centres are established for conducting research on groundnut, rapeseed/mustard, soybean, oil palm and coconut. Besides this, Indian Agricultural Research Institute (IARI) and the Directorate on Oilseed Research (DOR) also undertakes research on various oilseeds including sunflower, safflower and castor. The technologies generated in these centres are transmitted to farmers mainly through the extension arms of ICAR (*Kishi Vigyan Kendras*, KVKs) and departments of both Union and state governments. Further, there were some targeted programmes to improve the productivity of oilseeds. The most prominent initiative of programme by Government of India was Technology Mission on Oilseeds(TMO), introduced in 1986. The major objective of TMO was to make the country self-reliant as early as possible in both edible oils and non-edible oils and to reduce imports through integrated approach involving different developmental, scientific, input, banking and marketing agencies. The major strategies identified for this were to increase production and productivity of different oilseeds crops in 180 districts through assured input supply and technology packages. It was envisaged to develop location specific technologies and supply adequate quantities of breeder, foundation and certified seeds. The programme was mainly oriented towards annual oilseed crops. Later, the crop coverage was made broad-based by including oil palm also in the list. However, improvement in productivity and production were well below targets.

In this backdrop, the purpose of the present paper is to determine the trends of productivity growth in Indian oilseed sector and decompose it into its constituent components, viz. technical and efficiency for major annual oilseed crops at national and major state level during post-TMO phase. Also the paper reflects on the changes in productivity of oilseeds in recent period *vis a vis* changes in TFP and input intensification. Following the above introduction in Section 1, a brief account of TFP studies on agriculture in India is flagged in Section 2. In Section 3, the data and method are discussed. The results and discussion are provided in Section 4. The study concludes by drawing major implications policy in section 5.

2. TFP studies on agriculture and oilseed sector in India

The changes in TFP in agriculture in developing countries as a whole and in India have received attention of many researchers. Some studies have shown that the TFP is deteriorating in many developing countries and in India even from the start of green revolution. For example, by estimating cross-country production function for 43 countries, Kawagoe *et al.* (1985) have reported technological deterioration for developing countries and progress for developed countries. Deterioration of TFP in African countries has been reported by Nkamleu *et al.* (2003) for the period of 1972-1999. This was attributed either to deterioration of the rate of technical change or rate of efficiency change. On the other hand, for China, productivity improvement on account of TFP changes has been reported. These changes in TFP were attributed either to technical change or to efficiency change, but not to both of them simultaneously (Li *et al.*, 2011).

In case of India, TFP has been studied by a number of researchers for agricultural sector as a whole and for specific crops. For example, Rosegrant and Evenson (1992), Dholakia and Dholakia (1993) and Fan *et al.*, (1999) and have reported an improvement in the TFP index ever since the introduction of the high yielding varietal technology. Evenson *et al.* (1999) showed that the TFP growth in Indian agriculture was to the tune of 1.1 per cent per year since 1956. Fan *et al.* (1999) analysed TFP by considering a wide range of crops and livestock at all India level and at individual crops/ livestock specific levels for a period of 1970 to 1995. They have concluded that the TFP index has grown at an annual average rate of 1.8 per cent during the entire period. However, on a disaggregated sub-period level, growth in TFP depicted variations; but the bottom-line was that TFP was improving over the entire period under analysis. More than one-third to one-fourth of the output growth was due to improvement in TFP. The major drivers of the growth in the TFP were the green revolution package in the form of high yielding varieties, fertilizers and irrigation and growth in infrastructure development. Some studies have analysed TFP growth in livestock sector and compared it with crop sector. For example, Avila and Evenson (2004) has reported growth in TFP for livestock sector at 2.63 per cent per year compared to 1.54 per cent in case of crop sector for the period of 1961-1980.

Lower rate of TFP growth for crop sector compared to livestock sector is reported by Birthal *et al.* (1999) also. The TFP growth for agricultural sector in Indo- Gangetic Plain (IGP), the major area of green revolution in India, was1.2 per cent per annum for the entire crops sector (Kumar *et al.*, 2004). However, there was wide regional variation in the estimates. It ranged from as low as 0.37 per cent per year for Middle IGP to as high as 3.4 per cent in case of the Lower IGP. Correspondingly the contribution of TFP in productivity growth was 57 per cent for lower IGP compared to only 17 percent in the case of the middle IGP. One major lacuna of these sets of studies is that it hides the larger variation at the disaggregate level, due to the limitation of the data and, therefore, may not serve in arriving at crops specific policies. In order to address this problem, individual crops specific studies have been undertaken by some researchers.

Joshi *et al.* (2003) have reported a compounded annual TFP growth rate of 2.43 per cent for rice and 2.99 per cent for wheat during the period of 1970-1999. The contribution of TFP to output growth was to the tune of 56 per cent in case of rice and close to 70 per cent in case of wheat. The authors have also noted a decline in TFP in Indo-Gangetic plain during the later periods compared to early 1980s, and attributed the output growth observed during the latter periods to improved and judicious application of inputs, when input intensification has been found to be stagnating. In a study of TFP growth in the Indo- Gangetic plains, Kumar *et al.* (2004) noted that all the crops have benefitted from technological changes in some parts of the country at some points of time. The TFP of rice has registered higher growth during the period of 1986-2000 compared to 1971-86; however it has shown signs of deceleration in green revolution states like Punjab and Haryana, and improvement in the eastern parts of India where green revolution kind of technology is a late entrant. Concurring to this, Suresh (2013) also has reported a revival of TFP of rice in Eastern part of India .On the other hand, the TFP in case of wheat has decelerated at all India level and in many states. Chand *et al.* (2011) have reported a TFP growth of 0.67 per cent and 1.92 per cent for wheat for the period 1975-2005.

The studies on TFP of oilseed crops are only a few. For example, Kumar *et al.* (2008) have noted a sluggish TFP growth of 0.33 per cent per year during 1986-2000, an improvement over the preceding period of 1971-86. However, there were wide variations- the Eastern and Western parts of the country have reported a revival of the TFP during the latter period compared to the former when it was stagnating, whereas in the Southern and Northern states the TFP growth has slipped to the negative realm. In their study of TFP Chand *et al.* (2011) have reported that at national level the growth in TFP was to the tune of 0.77 in case groundnut, 0.71 in case of soybean, and 0.79 in case of rapeseed/ mustard. The TFP growth has decelerated during 1996 to 2005 compared to 1986-1995 for soybean and rapeseed/mustard, but has improved in case of groundnut. The authors have estimated the TFP by using the Divisia-Tonquivst index, and, therefore, the separation of TFP into its constituent components are not available.

3. Data and Methodology

3.1 Crops and Data

The Directorate of Economics and Statistics (DES) under Ministry of Agriculture, Government of India collects basic input and output data for various crops through its "Comprehensive Scheme for Cost of Cultivation of Principal Crops". This data has remained as the single largest source for estimating changes in inputs and outputs in crop cultivation. Under the scheme, detailed data on input use, output realised and cost of cultivation is reported for major cultivating states. The data is used for arriving at various cost figures for recommending various price policies to Government of India by Commission for Agricultural Costs and Prices. For the study three crops were selected, viz. groundnut, rapeseed/mustard and soybean. These three crops together accounts for more than 85 per cent of total oilseed produced in India. Among the major cultivating states, top three states in terms of production were selected for analysis. They include Andhra Pradesh, Gujarat and Tamil Nadu for groundnut; Haryana, Rajasthan and Uttar Pradesh for rapeseed/mustard and Madhya Pradesh, Maharashtra and Rajasthan for soybean. Considering the TMO, initiated in 1986, as the most important land mark in oilseed development in India, the period of analysis was restricted to 1985-86 to 2009-10. During the entire period under analysis, the agricultural growth in India performed distinctly in tune with the policy shifts (Suresh *et al.*, 2014). One of the major policy shifts that India has witnessed is structural reforms in Indian economy through liberalisation policies, acceding to WTO agreements and thereby on Agreements of Agriculture. The impact of the reform has been felt after the mid 1990s. It has turned out that agriculture in general has witnessed different growth experience post 1995. Therefore the entire study period has been divided into: Period I from 1985-86 to 1994-95 and Period II from 1995-96 to 2009-10. The data was not reported for some of the years, and they were approximated by suitable interpolations.

Various methods are available for analysing the TFP, viz. growth accounting framework, index method and non-parametric methods. Fare *et al* (1994) identifies four important advantages of using Malmquist Productivity Index, a non-parametric method, compared to other approaches. They include: (1) it requires data on only quantity, and not prices. Information on prices are generally not available for every input and output for many countries; (2) the linear programming based approach doesn't assume an underlying production function, and, therefore the stochastic properties associated with the error term; (3) no prior assumption regarding the optimising behaviour of the DMUs; and, (4) Since the approach allows for both movement towards the frontier and shift in the frontier, it is possible to decompose the TFP into its components viz. technical change and efficiency change. On this premise, this study uses the Malmquist productivity index. The analysis was carried out using the software DEAP 2.1 (Coelli, 1996).

The output variable was productivity per hectare (kg/ha). Six input variables were used in the analysis. They included usage of chemical nutrients (NPK, kg/ha), animal labour (pair hours/ha), human labour (man-hours/ha), animal labour (pairs/ ha) and real costs of machine labour and irrigation[1]. To avoid extreme variations, the triennial ending averages were used.

3.2 Malmquist Productivity Index

Caves *et al.* (1982) introduced the Malmquist Productivity Index (MPI) based on distance functions. The output oriented Malmquist TFP index measures the maximum level of outputs that can be produced using a given level of input vector and the given production technology relative to the observed level of outputs (Coelli *et al.*, 2005). It measures the radial distance of the observed output vectors in the period t and t+1 relative to a reference technology. The Malmquist productivity index for the period t is represented by,

$$M^t = \frac{D_0^t \ (x^{t+1}, y^{t+1})}{D_0^t \ (x^t, y^t)} \qquad \dots \qquad (1)$$

which is defined as the ratio of two output distance functions with respect to reference technology at the period t. It is also possible construct another productivity index by using period t+1's technology as the reference technology, which can be depicted as,

[1] The real cost were derived by deflating with price index for diesel and respectively.

$$M^{t+1} = \frac{D_0^{t+1}(x^{t+1},y^{t+1})}{D_0^{t+1}(x^t,y^t)} \quad \ldots \qquad (2)$$

Thus, there exists arbitrariness in the choice of the benchmark technology depending on the time period t or t+1. Fare *et al.* (1994) have removed this arbitrariness by specifying the MPI as the geometric mean of the two period indices, defined as:

$$M_0\ (x^{t+1}, y^{t+1}, x^t, y^t)\ =\ \left[\left(\frac{D_0^t\ \ (x^{t+1},y^{t+1})}{D_0^t\ \ (x^t,y^t)}\right)\left(\frac{D_0^{t+1}(x^{t+1},y^{t+1})}{D_0^{t+1}(x^t,y^t)}\right)\right]^{\frac{1}{2}} \ldots \qquad (3)$$

where, the notations x and y are the vector of inputs and outputs, D_0 represents the distance and M_0 represents the Malmquist index. Fare *et al.* (1994) by using simple arithmetic manipulations have shown the MPI as the product of two distinct components, viz. technical change and efficiency change as indicated below:

$$M_0\ (x^{t+1}, y^{t+1}, x^t, y^t)\ =\ \frac{D_0^{t+1}(x^{t+1},y^{t+1})}{D_0^{t+1}(x^t,y^t)}\left[\left(\frac{D_0^t\ \ (x^{t+1},y^{t+1})}{D_0^{t+1}(x^{t+1},y^{t+1})}\right)\left(\frac{D_0^t\ \ (x^t,y^t)}{D_0^{t+1}(x^t,y^t)}\right)\right]^{\frac{1}{2}} \ldots \qquad (4)$$

where,

$$\text{Efficiency change} = \frac{D_0^{t+1}(x^{t+1},y^{t+1})}{D_0^t\ \ (x^t,y^t)} \ldots \qquad (5)$$

and,

$$\text{Technical change} = \left[\left(\frac{D_0^t\ \ (x^{t+1},y^{t+1})}{D_0^{t+1}(x^{t+1},y^{t+1})}\right)\left(\frac{D_0^t\ \ (x^t,y^t)}{D_0^{t+1}(x^t,y^t)}\right)\right] \ldots \qquad (6)$$

As noted earlier, the efficiency change can further be decomposed into pure efficiency change and scale efficiency change. Many researchers have used this methodology for analysis of TFP. A detailed account on the MPI can be had from Fare *et al*. (1994) and Coelli *et al*. (2005. Introduction of linear programming based Data Envelopment Analysis (DEA) popularised the Malmquist index of productivity measurement. DEA involves construction of piece-wise linear frontier based on the distribution of the data of the input and outputs of various entities/ decision making units (DMUs) using linear programming framework. This frontier constructs a piecewise surface over the data such that the observed data lies on or below the constructed production frontier (Coelli *et al*, 2005). The efficiency measure for each DMU is calculated relative to this production frontier.

4. Results and Discussion

4.1 Trends in Productivity of Oilseeds

During 1985-86 to 2009-10, oilseeds have registered an improvement of productivity from 644 to 1026 kg/ ha, at a growth rate of 1.9 per cent per year (Table 1). The period II has recorded a subdued growth (1.4%) in productivity compared to period I (3.15%). The deceleration of the productivity growth during the period II could be due to the slump in input intensification or weakening of TFP or both. Table 1 also provides national and major state level trends in yields. Only groundnut and rapeseed/mustard has recorded a statistically significant productivity growth for the overall period at national level. For groundnut the higher productivity growth was recorded in Gujarat. Period II saw a sharp deceleration of productivity growth in Tamil Nadu. In case of rapeseed/mustard, states have recorded a diverging growth performance. While Rajasthan has recorded an acceleration of productivity growth during period II compared to period I, the trend reversed for Haryana and Uttar Pradesh. In case of soybean, the overall productivity growth at the rate of 1.71 per cent was not statistically significant. Moreover, the growth in the productivity during period I at 4.08 per cent has slipped during period II. The weakening of the trend in the productivity growth during period II has been observed for all the states.

(Table 1 somewhere here)

4.2 Trend in Total Factor Productivity

The trend in the movement of TFP was analysed for all the three crops for the national level and for state levels. The temporal movement of the TFP changes for all three crops at national level indicated that for groundnut and rapeseed/mustard, the movements were smoother compared to that of soybean (Figure 1).

(Figure 1 somewhere here)

The TFP changes and its associated movements in technical and efficiency changes are provided in Table 2. The analysis indicated that entire change in TFP is due to technical change. The efficiency has not shown any movement during the entire period for any crops[2]. This is true in case of both pure and scale efficiencies. This reveals lack of changes in efficiency in resources use, over a period of time. This could probably be pointing to weak extension intervention for oilseeds in India. Traditionally, the extension system has been focusing

[2] Only one year (in groundnut only) has recorded a change in efficiency. However, that was not strong enough to affect the overall average efficiency change for the periods.

towards cultivation of cereal crops, viz. rice and wheat in major cultivator states. In this process, marginal areas and crops has been neglected in technology diffusion. It is generally noted that the incentive price system in India has favoured cultivation of rice and wheat, leaving behind other crops like coarse cereals, pulses and oilseed in disadvantages situation. This could be reflecting in non-improvement of efficiency.

(Table 2 somewhere here)

The mean TFP change for groundnut was to the tune of 0.3 per year at national level. Among the major groundnut growing states, Gujarat has recorded the highest change in TFP to the tune of 1.9 per cent per year. While Andhra Pradesh also recorded a moderate change in TFP of 0.4 per cent per year, Tamil Nadu posted negative TFP change to the tune of -1.2 per cent. Rapeseed/ mustard is entirely a winter crop grown mostly in North Indian states. The overall average TFP change for this crop was low (0.1 %). The decline in TFP growth for this crop at national level is due mostly to the sharp decline in TFP in Uttar Pradesh at the rate of -3.6 per cent per year. This highlights the need for more location specific research for mustard taking into consideration the agro-climatic characteristic. Soybean also has posted a negative change in TFP at the rate of 4.4 per cent per year.

It has become evident that one of the factors that have been limiting the TFP growth is the lack of progress in efficiency front. Literature reveals that the TFP changes in rice and wheat also were driven mainly due to the technical change with relatively less contributions from efficiency changes (Bhushan, 2005; Chaudhary, 2012; Suresh, 2013). The less significant role of efficiency changes in productivity improvement is reported for some other Asian countries, as in case of Philippine rice sector (Umetsu *et al*., 2003). However, the case of no-improvement in efficiency of cultivation for entire oilseed sector warrants focused attention.

4.3 TFP Trends in the Selected Sub-periods

The result for the sub-periods is provided in Table 3. In tune with the overall results, the change in the TFP has been contributed entirely by the technical changes during both the sub-periods, for all the three crops, at national level as well as at state levels. At national level groundnut has shown an improvement in TFP from -1.6 per cent during period I to 1.4 per cent during period II, registering the highest progress in TFP among all the crops at national level. An improvement in the TFP during the period II is noted in case of Gujarat and Tamil Nadu. In case of rapeseed/mustard the TFP has declined at national level during period II, from 2.0 to-2.2 per cent per year. The decline in the overall TFP index during period II was largely due to sharp decline in the TFP indices in Uttar Pradesh. On the positive side, Rajasthan has recorded a revival of the technical change and therefore the TFP. The probable impact of TFP changes are quite visible in yields in terms of improved productivity growth during period II in Rajasthan and a decline in productivity growth in Uttar Pradesh (Table 1).

(Table 3 somewhere here)

In case of soybean, the time series data of input use is available for both the time periods only in case of Madhya Pradesh. Therefore, the TFP trends for period I has been estimated only for Madhya Pradesh. For period II, the indices are estimated for all the three states[3]. At national level, the TFP change in case of soybean continues to be negative, at -4.4 per cent. However, there was a moderation in the negative rate of TFP change during period II (compared to period I). States like Maharashtra and Rajasthan has been recording negative TFP growth. Despite the favourable TFP changes, the growth in productivity in case of soybean in Madhya Pradesh has slowed down during the period II compared to period I, perhaps due to the deceleration of input application (Table 4). The state has recorded a decline in the application of fertilizer, irrigation, human labour and machine labour during period II compared to period I.

4.4 Productivity, Technology Changes and Changes in Input Use in Oilseeds

The analysis on changes in productivity of oilseed as provided in Table 1 has clearly indicated that productivity growth of oilseeds and that of all three oilseeds under consideration has declined during the period II compared to the previous period at national level. At state levels also, decline in the productivity growth has been noted in case of all the crops, except for Gujarat in case of groundnut. On the otherhand, the technical changes and consequently the changes in TFP has been positive during period II in many states- Gujarat and Tamil Nadu in case of groundnut; Haryana and Rajasthan in case of rapeseed/mustard and in Madhya Pradesh in case of soybean. The depressed productivity growth in many states amidst positive TFP

[3] Due to data availability TFP indices at national level has been recorded only in case of Madhya Pradesh

changes is intriguing. In this context the trend in the usage of inputs in oilseed cultivation was examined. Table 4 provides the trend growth in the application of major inputs in oilseed cultivation, for both the sub-periods. The input groups included are chemical nutrients, human labour, machine labour and irrigation. The discernible pattern is that rate of growth of input has been declining in many states with a few exceptions. This is particularly so in case of chemical nutrients, irrigation and machine labour. During period II, the trend growth in chemical nutrient applied has declined in all the states, except for Gujarat in case of groundnut. Incidentally, Gujarat also has recorded the highest growth in TFP and associated productivity for groundnut. The rate of growth of real expenditure on irrigation and machine labour has also declined in all the states. Given the already low level of input application, the low rate of input intensification would be detrimental to productivity growth. This decline could be partly due to increase in the unit cost of the inputs, as could be noted from many statistical documents. The increase in the cost of cultivation despite a decline in the input use, both at level as well at rates, could be probably due to the increase in the unit cost of the respective inputs. This trend is clearly reflected in cost share and factor share of inputs in cost of cultivation (Table 5). For analytical purpose, the entire inputs are grouped into three, viz. current inputs, capital inputs and labour[4].

(Table 4 somewhere here)

Table 5 provides information on the trend growth of three group of inputs used in oilseed cultivation at national level, their share in cost of cultivation (cost share) and in value of output (factor share). The data is reported for three points of time, 1985-86, 1995-96 and 2009-10 for national level[5]. As far as groundnut is concerned, there was a decline in the share of current inputs and capital inputs between 1985-86 and 2009-10. This is accompanied with an increase in the share of wages in total cost of cultivation. This could be probably due to increase in the agricultural wage rates during recent periods. These trends are broadly reflected in factor shares as well. Rapeseed/mustard and soybean has registered wide differences in input composition during this period. Rapeseed/ mustard recorded an increase in the share of current inputs and capital inputs and almost continued the statuesque of the labour inputs during period 1. The trend in current and capital inputs during period II contrasts sharply with that during period I. Soybean has registered a decline in the share of the current cost, accompanied by a moderate

[4] Current inputs were seed, fertilizer, manure, insecticides, interest on variable cost; Capital inputs were draft animal, irrigation, machinery, depreciation, interest on fixed capital; Labour input is human labour.
[5] The national level averages were arrived at by weighted average method, weight being the respective areas.

increase in share of capital and labour during period I; however, period II saw a reduction of the share of current inputs. The general trend, with some minor exception, is decline in the share of the current inputs (most noticeably fertilizers and manures), and capital inputs and an increase in share of labour in cost of cultivation. The results broadly suggest that, given the already low level of input application, it could be this decline in the speed of intensification of oilseeds that is responsible for much of the stagnation in the productivity growth in case of oilseeds in many states. This partially addresses some of the concerns regarding stagnation of agricultural growth in India and whether such a stagnation was due to technology fatigue or policy fatigue (Narayanamoorthy, 2007 and Planning Commission, 2007). The reduced changes in TFP are a cause in some crops and regions; but the role of reduced input intensification needs to be appreciated.

(Table 5 somewhere here)

5. Summary and Implications for Policy

The study has analysed the changes in the TFP of major oilseed crops in India, viz., groundnut, rapeseed/mustard and soybean for the period of 1985-2010 and has decomposed the changes in the TFP into efficiency change and technical change. Also the study has analysed the changes in the use of inputs in oilseed cultivation. The entire period under the study has been subdivided into two- period I spanning from 1985 to 1995 and Period II spanning from 1996 to 2010. It has become evident that there is an across the spectrum slowdown of productivity growth during period II compared to period I. During the overall period, the productivity growth of oilseeds in general has reduced from 3.15 per cent to 1.4 per cent per year. The productivity growth in case of groundnut, rapeseed/mustard and soybean during period II has been to the tune of 1.2, 1.9 and 0.5 per cent compared to 1.8, 2.2 and 4.1 per cent during period I, respectively. The deceleration of productivity growth has been noted in all the states in case of soybean, and two out of three states in case of groundnut and rapeseed/mustard.

Among the three groups, groundnut and rapeseed/mustard have registered positive changes in the TFP during the overall period at national level. In case if groundnut, Andhra Pradesh and Gujarat has reported positive TFP changes, whereas in case of rapeseed/mustard Haryana and Rajasthan have reported positive changes. A comparison between two time periods indicates that at national level during period II, TFP has improved in case of groundnut and soybean and deteriorated in case of rapeseed/mustard compared to the previous period. During period II, all the states recorded positive changes in TFP in case of groundnut. In case of rapeseed/mustard, only Rajasthan has shown an improvement. Soybean has recorded a positive change in Madhya Pradesh.

The growth in TFP was entirely due to the technological change. The contribution of efficiency change was completely absent, pointing to the deficiencies in efficiency determining factors. Such factors could be weak extension mechanisms, poor development of infrastructure and institutions and insufficient knowledge on improved management practices. Further, there was a slowdown in input intensification in oilseed cultivation during period II compared to period I. Given the already low level of input in oilseed cultivation, the slowdown of input intensification would have adverse consequences for yield improvement.

The study points to some interesting policy implication in the current context. There is a widespread belief that technical progress has been slowing down in Indian agriculture. In case of oilseeds, some crops are registering positive TFP changes in recent periods driven by technical change. The trends vary across crops and geographic locations. However, there is no conclusive proof for across the spectrum slowing down of TFP growth or technical changes in oilseed. The TFP changes were entirely due to the technical change only, without contribution from changes in efficiency. The stagnant efficiency in production of oilseeds needs to be addressed with a view to bring about positive changes in it. Oilseeds attract less attention from the extension agencies. It needs concerted efforts to improve the information flow from extension agencies for oilseed cultivation. Further, the stagnation in the productivity could be potentially due to sluggish intensification. Therefore, attention should be given for promoting sustainable intensification of oilseed cultivation, improving the technical changes in oilseeds through focused research approaches and improving the efficiency in production.

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Fig. I. Trend in movement of total factor productivity of major oilseed crops in India

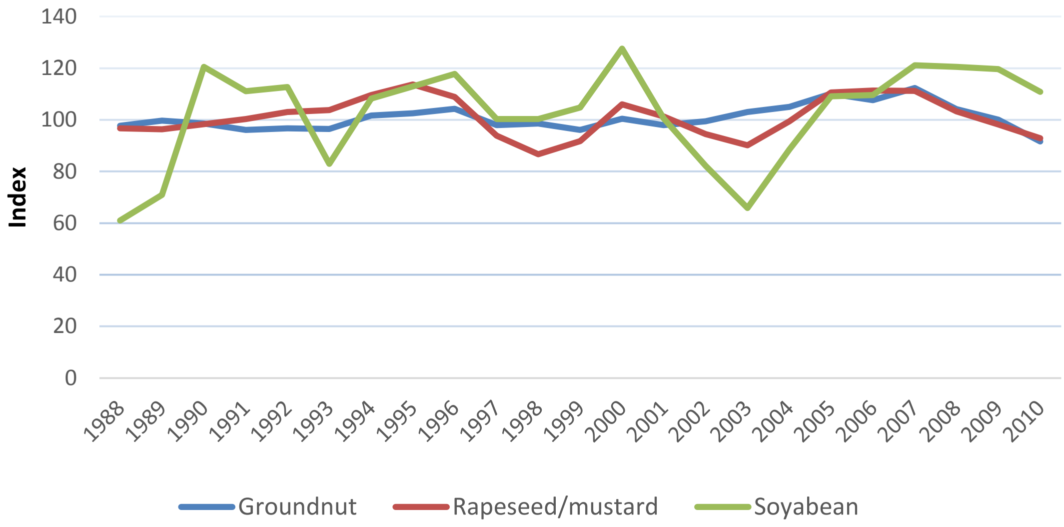

Table 1: Trend in productivity of groundnut, rapeseed/mustard and soybean at national level and in major states levels, 1985-2010

Crop/ States	Productivity (Average productivity kg/ha, TE ending)			Trend growth rate (per cent per year)		
	1985-86	1995-96	2009-10	Period I	Period II	Overall
Groundnut						
Andhra Pradesh	856	1011	1035	0.90	-0.50	-0.30
Gujarat	619	691	1379	3.46**	3.77*	3.87***
Tamil Nadu	1112	1624	2034	3.46***	1.21***	2.22***
All India	852	992	1204	1.82**	1.21**	1.21***
Rapeseed/ mustard						
Haryana	838	1346	1530	4.92***	0.80	1.82***
Rajasthan	778	843	1152	0.30*	2.74***	1.51***
Uttar Pradesh	644	1014	1131	4.39***	1.71**	1.92***
All India	706	905	1109	2.02*	1.92***	1.71***
Soybean						
Madhya Pradesh	746	920	1143	3.25**	0.70	1.61***
Maharashtra	363	1136	1040	16.18***	-0.40	4.81***
Rajasthan	764	1035	1163	4.60***	1.11	1.61***
All India	756	1003	1100	4.08***	0.50	1.71
Oilseeds						
Productivity	644	831	1026	3.15***	1.41***	1.92***

***, ** and * indicates the statistical significance at 1, 5 and 10 per cent levels, respectively.

Table 2: Trend in total factor productivity and its components of major oilseeds, across states, 1985-86 to 2009-10

States	Efficiency Change	Technical Change	Pure efficiency change	Scale efficiency change	TFP Change
Groundnut					
Andhra Pradesh	100.0	100.4	100.0	100.0	100.4
Gujarat	100.0	101.9	100.0	100.0	101.9
Tamil Nadu	100.0	98.8	100.0	100.0	98.8
All India	100.0	100.3	100.0	100.0	100.3
Rapeseed/ mustard					
Haryana	100.0	102.7	100.0	100.0	102.7
Rajasthan	100.0	101.4	100.0	100.0	101.4
Uttar Pradesh	100.0	96.4	100.0	100.0	96.4
All India	100.0	100.1	100.0	100.0	100.1
Soybean					
Madhya Pradesh	100.0	95.6	100.0	100.0	95.6
Maharashtra	-	-	-	-	-
Rajasthan	-	-	-	-	-
All India	100.0	95.6	100.0	100.0	95.6

Note: Index 100= no change, less than 100= deterioration and greater than 100 = an improvement

Table 3: Trend in technical change, efficiency change and total factor productivity change during the sub-periods in oilseeds, across states

States	Efficiency change		Technical change		TF P change	
	Period I	Period II	Period I	Period II	Period I	Period II
Groundnut						
Andhra Pradesh	100.0	100.0	99.9	99.8	99.9	99.8
Gujarat	100.0	100.0	98.8	104.3	98.8	104.3
Tamil Nadu	100.0	100.0	96.5	100.2	96.5	100.2
All India	100.0	100.0	98.4	101.4	98.4	101.4
Rapeseed/ mustard						
Haryana	100.0	100.0	103.7	101.3	103.7	101.3
Rajasthan	100.0	100.0	99.3	101.4	99.3	101.4
Uttar Pradesh	100.0	100.0	103.1	91.1	103.1	91.1
All India	100.0	100.0	102.0	97.8	102.0	97.8
Soybean						
Madhya Pradesh	100.0	100.0	86.3	100.6	86.3	100.6
Maharashtra	-	-	-	94.1	-	94.1
Rajasthan	-	-	-	92.2	-	92.2
All India	100.0	100.0	86.3	95.6	86.3	95.6

Note: As in Table 2

Table 4: Trend growth in rates of application of chemical nutrients (kg/ha), human labour (labour hours/ ha), machine labour (Rs/ ha, real prices) and irrigation (Rs/ ha, real prices) in oilseed cultivation, across period, 1985-2010

Crop	State	Fertilizers (Nutrients, kg/ha)		Human labour		Machine labour		Irrigation	
		Period I	Period II	Period I	Period II	Period I	Period II	Period I	Period II
Groundnut	Andhra Pradesh	8.1	2.2	0.1	-0.3	10.9	-3.8	6.5	-1.5
	Gujarat	-0.9	2.3	-2.2	0.5	2.0	0.2	-6.7	-8.4
	Tamil Nadu	6.2	2.4	0.6	-2.2	8.7	3.4	1.4	-6.4
Rapeseed/Mustard	Rajasthan	20.1	3.7	-1.5	-1.2	9.4	-3.1	8.1	0.4
	Haryana	9.2	4.9	0.4	1.1	5.7	-1.7	5.6	2.4
	Uttar Pradesh	17.4	0.3	-1.8	1.1	15.7	-4.1	6.2	2.7
Soybean	Madhya Pradesh	10.5	-1.7	0.9	-1.8	15.9	-4.0	16.7	-7.2
	Rajasthan	NA	-13.4	NA	0.6	NA	-2.4	NA	1.7
	Maharashtra	NA	3.0	NA	0.1	NA	8.0	NA	5.4

Note: NA indicates non-availability of data

Table 5: Trend in input use, factor share and cost share in oilseed production in India

Cost/ cost share/ factor share	Groundnut			Rapeseed/ mustard			Soybean		
	1985-86	1995-96	2009-10	1985-86	1995-96	2009-10	1985-86	1995-96	2009-10
Costs (Rs/ha)									
Current	1202.4	3171.6	7004.7	182.9	1196.9	1872.2	579.1	1878.0	3541.5
Capital	857.4	2217.6	5087.8	884.7	3441.8	6945.0	461.2	1769.3	5794.3
Labour	789.6	2586.8	7071.3	514.4	1657.1	4056.1	349.9	1505.0	3656.7
Cost share									
Current	31.5	30.4	27.9	7.5	15.3	10.4	29.2	25.3	17.0
Capital	22.4	21.2	20.3	36.6	44.5	38.6	23.3	23.8	27.3
Labour	20.6	24.2	27.7	21.5	21.1	22.3	17.6	20.3	18.0
Factor share									
Current	27.0	28.7	25.1	4.7	9.4	6.0	23.7	20.7	15.2
Capital	19.1	19.8	18.2	22.9	27.2	22.4	18.9	19.5	24.5
Labour	17.7	22.7	26.2	13.4	13.0	12.9	14.3	16.6	15.9