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Efficiency in Indian Edible Oilseed Sector: Analysis and Implications*

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Abstract

Reversing the declining trend in productivity of oilseeds and improving the efficiency of oilseed processing is a major challenge to the policymakers and researchers. The present study has analyzed technical inefficiencies and factors responsible for inefficiencies in production and processing of four major edible oilseeds, viz. groundnut, rapeseed and mustard, soybean and sunflower. Both primary and secondary data have been used to estimate the inefficiencies. Analysis has revealed the presence of 1/4 to 1/3 technical inefficiencies in oilseed production at the average level and even more at the farm/ processing unit level along with allocative and scale inefficiencies. The combined technical inefficiencies in the oilseed sector have been found to be 1/2 to 2/3, which are enormous. If prevented/ minimized, the oil production in the country could nearly be doubled. Soil quality, seed replacement and education have been found as determinants of technical efficiency in oilseed production, whereas availability of adequate raw material and higher oil recovery determine the technical efficiency in oil production. Lack of assured market for oilseeds and lack of timely and assured supply of quality seeds and raw materials for processing are some of the important factors for the poor performance of the oilseeds industry. Study has reported that the marginal return to water

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is one of the highest in oilseeds. Therefore, cultivation of oilseeds in irrigated land if they really compete with other crops for profitability, needs to be given due consideration.

1. Introduction

India faces a big challenge in meeting the galloping demand for edible oils by achieving self-sufficiency in oilseeds. The short-supply of oilseeds has led to a steep increase in oil prices, pushing it out of reach of the poor households. Strategies for meeting this challenge have included a shift from the import dependency towards domestic production increase through enhanced research and extension efforts. The All-India Coordinated Project on Oilseeds launched in 1967 helped in developing a large number of high-yielding varieties of oilseeds along with production practices suited to various agro-climatic conditions. Only a few major edible oilseeds like mustard, soybean and sunflower have been genetically modified with emphasis on agronomic traits. Further, to improve the status of oilseeds sector, a more comprehensive strategy called Technology Mission on Oilseeds (TMO) covering production, processing, marketing, input supply, etc. was launched in 1986. Besides, in 1989, National Dairy Development Board (NDDB) was assigned the role of market intervention for edible oilseeds and oils for ensuring remunerative prices to farmers, reasonable costs to consumers and attaining of self-sufficiency by the Government of India.

The production performance of oilseeds during the post-TMO period was considerable. Overall, during 1986-2004, the production of oilseeds grew at the rate of 2.84 per cent per annum along with productivity growth of 1.95 per cent and the area growth of 0.84 per cent. As a result, during the early-1990s, India notably improved both its production performance and meeting consumption requirements with a significantly reduced and declining dependence on imports of edible oils. Till the early-1990s, MSP for food grains was kept in check in relation to oilseeds. The total effect led the increased production of oilseeds at the rate of 6.19 per cent per annum with annual growth in area by 2.99 per cent and productivity by 3.13 per cent during 1986-98. But, the mid-1990s saw a significant turn around in terms of cheaper edible oil availability in the international market and a faster economic growth, resulting in increased demand for edible oils. This increased demand was met mainly through imports as production of domestic oilseeds has fallen to 0.68 per cent per annum, far below the domestic growth (4.85%) in demand of edible oils per annum. After mid-1990s, oilseed prices declined relative to other crops, mainly due to the increased domestic oilseed supplies and liberalization of edible oil imports initiated in 1994. The MSP on grains has increased by over 156 per cent against 91 per cent for oilseeds since the mid-1990s (Kumar, 2002). As a result, increasing favourable returns from rice and wheat have drawn area away from oilseeds, lowering the oilseeds production. The gross returns per hectare at MSP during 2002-03 were Rs 24800 to Rs 27900 for wheat and Rs 24080 to Rs 29240 for rice in Haryana and Punjab. The comparative gross return per hectare was Rs 13400 to Rs 22780 for groundnut in Andhra Pradesh and Tamil Nadu, Rs 16800 for mustard in Haryana, and Rs 12390 for soybean in Maharastra (GoI, 2003). The lower domestic prices on account of surge in the import and ineffective implementation of MSP have led to the replacement of oilseed crops with other field crops. However, it was a positive sign to see that the MSP of the major edible oilseeds was moving upwards more decisively. For instance, the MSP for wheat for the 2004-05 marketing season was Rs 6300 per tonne, unchanged from that in 2003-04. However, the MSP of rapeseed was Rs 16000/tonne, up from Rs 13400/tonne in 2003-04 and for safflower seeds, MSP was Rs 15050/tonne, up from Rs 13050/tonne in 2003-04.

During 1999-04, the production of oilseeds declined annually by 1.2 per cent with decline in area under oilseeds by 2.56 per cent. However, the productivity growth of oilseeds remained positive during this period. The oil extraction mills also suffered because of using obsolete technology and, lower percentage of extraction. About 50 per cent mills were forced to close down due to fall in the supply of oilseeds and higher taxes in Punjab (Kumar, 2002). The country spent about Rs 12000 crore on imports of edible oils during 2003-04 (GoI, 2005).

There exists a considerable yield gap in oilseeds production, from 701 kg/ha in mustard cultivation to 815 kg/ha in groundnut cultivation, indicating huge exploitable yield potential to increase the aggregate production (Mruthyunjaya and Kiresur, 2000). The inefficiencies in oilseeds production and processing have also categorically been stated (World Bank, 1997). The country has failed to achieve higher yields on large areas as the oilseeds are largely grown in marginal/ rainfed areas, mostly on tiny holdings. About 80 per cent oilseeds are cultivated in non-irrigated and marginal environments and the yield gap is estimated to be about 30 per cent (GoI, 2003). Oilseed processing is also in disarray with a large number of unorganized small units, shortage of raw materials, excessive installed capacity, not modernized, low recovery, oligopoly market, and low efficiency. Sheer inefficiency and underutilization of processing units cost 40 per cent more to process one tonne of soybean in India than China and 90 per cent more than that in the USA. Reversing the declining trend in productivity of oilseeds and improving the efficiency of oilseed processing is a major challenge to the policymakers and researchers in India.

The present study has analyzed inefficiencies in production and processing of oilseeds in India. It has studied the technical, allocative and scale inefficiencies in oilseeds and oil production, has identified the factors responsible for these inefficiencies and has suggested ways to address them. The study has covered groundnut, rapeseed and mustard, soybean, and sunflower, accounting for more than 80 per cent of the total oilseeds area and 90 per cent of the total oilseeds production in the country.

2. Methodology

2.1. Data and Sampling

The primary data for the selected crops were collected from the oilseed farmers for the years 2002-03 and 2003-04 using a structured questionnaire and multi-stage random sampling. At the first stage, a taluk (block) was selected from a district, depending on the importance of principal crop in the taluk. In the second stage, three villages were selected from each taluk. Finally, ten farmers were personally interviewed from each village. The overall farmers interviewed were 690 for groundnut, 240 for rapeseed and mustard, 270 for soybean, and 510 for sunflower (Table 1).

Table 1. Selection of sample farmers from different states of India

Crop/ State	Number of sample farmers selected
Groundnut	
Andhra Pardesh	210
Gujrat	150
Karnataka	180
Tamil Nadu	150
Total	690
Rapeseed and mustard	
Rajasthan	150
Uttar Pardesh	90
Total	240
Soybean	
Madhya Pradesh	150
Maharastra	120
Total	270
Sunflower	
Karnataka	210
Maharastra	150
Total	360
All crops	1560

A wide range of data were collected at the farm level, covering household composition and structure, crop production and management practices, quality and quantity of input-use, yield, purchasing activities, and sources of income. The cost, return, investment and other processing details of oilseeds were collected from 40 processing units each for groundnut, rapeseed and mustard, soybean and sunflower.

2.2. Method of Analysis

Model Specification

The study employed a stochastic frontier production to estimate the technical and allocative efficiencies of resource-use in oilseed production and processing[1]. The model was specified as Equation (1):

$$Y = f(X, \beta) + (\upsilon_i - u_i) \qquad \ldots (1)$$

where, Y is the yield per hectare, X is the vector of inputs (input-use per hectare), and β is the vector of parameters of production functions. The error-term consists of two components; υ_i which represents the component beyond the control of a producer and u_i which represents the inefficiency components. υ_i is a symmetrical random-term and is assumed to be normally distributed $[N(0, \sigma^2_v)]$. u_i is a firm-specific (non-negative) inefficiency effect assumed to follow a truncated (at zero) normal distribution, N (μ, σ^2_u). υ_i and u_i are distributed independently of each other and of inputs (X_i). Here, a producer faces own stochastic production frontier f (X_i, β) exp (υ_i); a deterministic part $f(X_i, \beta)$ common to all producers and producer-specific part exp (υ_i).

The farm-specific technical efficiency is given by Equation (2):

$$TE_i = \frac{f\,(X_i, \beta)\exp(\nu_i - u_i)}{f\,(X_i, \beta)\exp(v_i)} = \exp(-u_i) \qquad \ldots(2)$$

$$0 < TEd \leq 1$$

Y_i attains its maximum value of f (X_i, β) exp (v_i) and TE_i=1 if u_i =0. Otherwise $u_i \neq 0$ provides the shortfall of observed output from the maximum potential (frontier) output. The farm is allocatively inefficient if it operates off the least cost expansion path and can be expressed formally as Equation (3):

$$MP_{ij} / MP_{i1} = P_j / P_1 \exp(w_{ij}) \qquad \ldots(3)$$

$$j = 2,3,\ldots, m$$

[1] A detailed review of methodology of frontier production functions and their empirical applications in agriculture is given in Bettese (1992) and Coelli (1995).

where, MP_{ij} is the marginal product of the jth input and P_j is the price of the jth input, and w_{ij} (j = 2,3,..,m) represents allocative inefficiency.

The farm is scale inefficient if it fails to equate the marginal cost (MC) with the output price, which can be modelled as Equation (4):

$$\delta C_i / \delta Y_i = P_y \exp (S_i) \qquad \ldots(4)$$

where, S is the scale inefficiency parameter. w_{ij} (j = 2,3,..,m) are identically and independently distributed normal variates with mean m and a variance-covariance matrix, Σ, and S is an identically and independently distributed normal variate with zero mean and a finite variance, σ^2. The parameters of the model can be obtained by maximizing the concentrated likelihood function after substituting the stochastic terms with their non-stochastic counterparts[2].

Model Estimation

The stochastic frontier production function used to analyze resource-use efficiency in oilseeds production is given by Equation (5):

$$\ln Y_i = \beta_0 + \beta_S \ln S + \beta_L \ln L + \beta_F \ln F + \beta_C \ln C + v_I - u_i \qquad \ldots(5)$$

where,

Y_i = Actual output of the ith farm, measured in quintals/ha

S = Seeds used, in kg/ha

L = Human labour, mandays/ha

F = Quantity of chemical fertilizers (N+P+K) used in kilograms/ha

C = Expenditure incurred on animal and machine labour, and pesticide and FYM, in Rs/ha

The Cobb-Douglas production function estimated for oilseed processing units is given by Equation (6):

$$\ln Y_i = \beta_0 + \beta_L \ln L + \beta_E \ln E + v_i - u_i \qquad \ldots(6)$$

where,

Y_i = Value of output of the ith processing unit, Rs/year

L = Human labour, mandays/year

E = Value of energy (electricity/ diesel), Rs /year

The frontier production function and derived systems of equations relating to allocative and scale inefficiencies discussed above were estimated using the maximum likelihood method.

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[2] Please see Kumbhakar (1987), Changmai (1993) and James (1996) for details on derivation/construction of maximum likelihood function and estimation procedure.

Determinants of Technical Efficiency

To analyze determinants of technical efficiency of oilseed production, a simple linear regression of the form given in Equation (7) was estimated using ordinary least square (OLS) technique:

$$TE = b_1\ AGE + b_2\ EDUC + b_3\ FARSIZ + b_4\ NOCROP + b_5\ DSEEDQ + b_6\ DSOIL + b_7\ REGDU1 + b_8\ REGDU2 \ldots + u_i \quad \ldots(7)$$

where,

b_i = (I= 1,…, n) are coefficients

TE = The level of technical efficiency obtained from the estimation made in the previous section.

AGE = Age of the respondent (family head/ decision-maker)

EDUC = Schooling of respondent (family head/decision-maker)

FARSIZ = Landholding in hectares

NOCROP = No. of crops grown in the same season

SEEDQ=Dummy for seed quality, if quality of seed good '1', otherwise 0

SOILQ= Dummy for soil quality, 1 if quality of soil good, 0, otherwise.

REGDU1, REGDU2,…= Regional Dummies

The determinants of technical efficiency in oilseed processing were estimated as follows:

$$TE\ (Processing) = b_1\ MACP + b_2\ RMA + b_3\ DIST + b_4\ OILR + u_i \quad \ldots(8)$$

where,

b_i = (i= 1, …, 4) are coefficients

TE (Processing) = Technical efficiency level in processing units k

MACP= Machine power in KW

RMA= Raw materials availability (tonnes per year)

DIST= Distance of the processing firm/industry from the mandi/output market

OILR = Oil recovery (%)

3. Major Findings

3.1. Economic Efficiency in Oilseed Production and Processing

Technical efficiency is defined as ability of a farmer to produce maximum potential output (Y_{max}) given the technology and level of input use. Thus, the farm-specific technical efficiency is the ratio of the output obtained on the farm, Y_f to maximum potential output, Y_{max}. The allocative efficiency is related to least cost combination of inputs and scale efficiency refers to optimal level of output selection. The estimates of technical, allocative and scale efficiencies (constituents of economic efficiency) have been discussed below by crops and states.

The mean technical efficiency (TE) in different states ranged from 0.64 to 0.75 for groundnut, 0.65 to 0.67 for rapeseed and mustard, 0.59 to 0.73 for soybean and 0.69 to 0.76 for sunflower (Table 2). The variations in technical efficiencies across states and oilseed crops were also reflected in the minimum and maximum value of TEs on the farms. The results suggest, in general, the presence of 1/3 to 1/4 technical inefficiencies at the average level (and even more at the farm level) in the production of oilseeds. The average technical inefficiency estimates have been found to vary in the past studies from 8 to 53 per cent.

Considerable inefficiencies were also recorded in the optimum use of different input and selection of output levels in oilseed cultivation. The critical inputs like seed, fertilizers, and irrigation were underutilized and varied from 32 to 99 per cent in groundnut, 40 to 87 per cent in rapeseed and mustard, and 25 to 98 per cent in sunflower (Table 3). The underutilization of inputs (allocative efficiency) generally reflects poor resource-base of the farmers. Since the allocative inefficiency indicates operating off the expansion path, it always increases cost. Conversely, it reduces profit. The human labour was overutilized to the extent of 34 to 62 per cent in groundnut, 6 to 9 per

Table 2. Technical efficiencies in oilseeds production by crops and states

Crop/ State	Mean	Standard deviation	Minimum	Maximum
Groundnut				
Andhra Pradesh	0.644	0.04	0.47	0.686
Gujarat	0.749	0.111	0.427	0.891
Karnataka	0.679	0.058	0.512	0.763
Tamil Nadu	0.735	0.114	0.416	0.913
Rapeseed & mustard				
Rajasthan	0.67	0.19	0.17	0.88
Uttar Pradesh	0.65	0.16	0.21	0.90
Soybean				
Madhya Pradesh	0.59	0.29	0.25	0.95
Maharashtra	0.73	0.19	0.33	0.93
Sunflower				
Karnataka	0.692	0.112	0.418	0.824
Maharashtra	0.756	0.036	0.662	0.806

Table 3. Allocative and scale inefficiencies in oilseed production in different states

Crop/State	Seeds	Human labour	Fertilizers	Irrigation	Scale inefficiency
Groundnut					
Andhra Pradesh	0.494	-0.446	0.667	0.994	0.0817
Gujarat	0.517	-0.516	0.812	0.887	0.121
Karnataka	0.315	-0.617	0.714	0.714	0.189
Tamil Nadu	0.756	-0.342	0.558	0.913	0.213
Rapeseed & mustard					
Rajasthan	0.425	-0.063	0.678	0.871	0.118
Uttar Pradesh	0.398	-0.087	0.864	0.482	0.093
Soybean					
Madhya Pradesh	0.338	0.872	-0.984	0.776	-0.776
Maharashtra	0.412	0.754	-0.887	0.841	-0.527
Sunflower					
Karnataka	0.471	-0.426	0.764	0.982	0.111
Maharashtra	0.246	-0.673	0.842	0.624	0.089

Allocative inefficiency: +ve values indicate underutilization and –ve values indicate overutilization of respective inputs
Scale inefficiency: +ve values indicate underproduction and –ve values indicates over production

cent in rapeseed and mustard, and 43 to 67 per cent in sunflower. The level of crop output was suboptimal to the extent of 8 to 21 per cent in groundnut, 9 to 12 per cent in rapeseed and mustard, and 9 to 11 per cent in sunflower. The overutilization of labour and underutilization of major purchased inputs like seeds, fertilizes, and irrigation, and underproduction (level of output) of oilseed crops may be due the fact that these crops are grown mainly in marginal and rainfed lands and on labour-abundant smallholdings. In soybean cultivation, seeds, human labour, and irrigation were underutilized to the extent of 34 to 87 per cent, fertilizer was overused between 89 and 98 per cent, and the level of crop output was non-optimal (overproduced) to the extent of 53 to 78 per cent. The underutilization of human labour and overutilization of fertilizers in soybean may be due to the fact that the soybean is grown as a major commercial crop in highly mechanized belts of Mahya Pradesh and Maharastra.

Since the oilseeds are grown mainly under the rainfed conditions (except rapeseed and mustard) and irrigation turns out to be a critical input underutilized across all oilseed crops in all the states, we have estimated marginal rate of return from water-use in oilseed cultivation (Table 4). The marginal rate of return was considerably high in all states across all oilseed crops and it varied between 1.45 and 3.77, indicating significant scope for

Table 4. Marginal rate of return from water-use in oilseed production

Oilseeds	State	Per cent irrigated area under crop	Marginal rate of return (MVP/MC)
Groundnut	Andhra Pradesh	19.4	3.2
	Gujarat	28.6	3.77
Rapeseed & mustard	Rajasthan	66	2.92
	Uttar Pradesh	72	1.45
Soybean	Madhya Pradesh	9	2.43
	Maharashtra	16	1.61
Sunflower	Maharashtra	56	2.61
	Karnataka	20	3.01

Table 5. Technical efficiency in oil production

Crops	Mean	Standard deviation	Minimum	Maximum
Groundnut	0.74	0.172	0.165	0.865
Rapeseed & mustard	0.69	0.211	0.237	0.769
Soybean	0.64	0.113	0.384	0.847
Sunflower	0.70	0.087	0.250	0.824

Table 6. Allocative and scale inefficiencies in oilseeds processing

Inputs	Groundnut	Rapeseed & mustard	Soybean	Sunflower
Human labour	-0.342	-0.254	-0.215	-0.189
Electricity	0.864	0.738	0.882	0.722
Scale efficiency	0.983	0.916	0.975	0.906

Allocative inefficiency: +ve values indicate underutilization, and –ve values indicate overutilization of respective inputs

Scale inefficiency: +ve values indicate underproduction, and –ve values indicate overproduction

improving water-use efficiency for raising productivity and profitability in oilseed cultivation.

Besides the inefficiencies in oilseed production, considerable inefficiencies (technical, allocative and scale) existed in oilseeds processing too. The mean technical efficiency in oil production varied from 64 to 74 per cent with a minimum of 17 per cent and maximum of 87 per cent (Table 5). It implies that, on an average, there was considerable potential in improving technical efficiencies in oilseed processing, say by about 1/3 to 1/2.

Human labour was overutilized in the processing across all oilseeds to the extent of 19 to 34 per cent (Table 6). This may be due to the use of labour-intensive technologies and small-scale processing units.

Table 7. Determinants of technical efficiency in oilseed cultivation in India

Crop/State	Const.	Age	Education	Landholding	No. of crops	Seed quality	Soil quality
			Groundnut				
Andhra Pradesh	0.678*	0.001	0.002*	-0.012	0.003**	0.007*	0.003*
	(0.2503)	(0.0009)	(0.0008)	(0.0093)	(0.0017)	(0.0026)	(0.0011)
Gujarat	0.597*	0.001**	0.002	-0.006*	0.012*	0.016**	0.179
	(0.2244)	(0.0005)	(0.0016)	(0.0023)	(0.0046)	(0.0085)	(0.1392)
Karnataka	0.61*	-0.001	0.002	0.003**	-0.006*	0.005*	0.123*
	(0.2463)	(0.0008)	(0.0015)	(0.0015)	(0.0023)	(0.002)	(0.0468)
Tamil Nadu	0.71*	0.002	0.003*	0.001*	-0.002	0.034***	0.18**
	(.2879)	(0.0017)	(0.0011)	(0.0004)	(0.0018)	(0.0243)	(0.1029)
			Rapeseed & mustard				
Rajasthan	0.511*	-0.008***	0.003	0.011**	-0.038*	0.001*	0.047**
	(0.2002)	(0.0058)	(0.0027)	(0.0055)	(0.0145)	(0.0004)	(0.0261)
Uttar Pardesh	0.623*	-0.001	0.007**	0.003	0.023*	0.018*	-0.027**
	(0.2493)	(0.0008)	(0.004)	(0.0026)	(0.0086)	(0.0069)	(0.0151)
			Soybean				
Madhya Pradesh	0.89*	0.002	0.001**	-0.006*	0.041	0.067***	-0.082*
	(0.3338)	(0.0017)	(0.0005)	(0.0023)	(0.0348)	(0.0409)	(0.0306)
Maharashtra	0.764*	0.001*	0.005	-0.001*	0.037**	0.072**	0.072***
	(0.2820)	(0.0004)	(0.0044)	(0.0004)	(0.0212)	(0.0408)	(0.0447)
			Sunflower				
Karnataka	0.848*	0.003	0.004**	-0.013*	0.009**	-	0.019*
	(0.3920)	(0.0025)	(0.002)	(0.0026)	(0.0051)	(0.0105)	
Maharashtra	0.79*	-0.004***	0.003	-0.005***	0.012***	-	0.009
	(0.3374)	(0.003)	(0.0027)	(0.0031)	(0.0087)	(0.0077)	

Notes: *, ** and *** indicate statistical significances at 1, 5 and 10 per cent levels, respectively.
The values within the brackets denote standard errors.

The other critical input was energy in the form of electricity, which was also underutilized to the extent of 72 to 88 per cent. The utilization of this input may be improved with an assured and timely supply of electricity to oilseed processing units, located mainly in remote areas, and modernization of oil processing technologies. Overall, production capacity was underutilized and the scale of oil production was less than optimum by the processing units to the extent of 91 to 98 per cent. Therefore, considerable scope exists in improving the productivity and profitability of oilseed processing units through better capacity utilization and improved turn over.

3.2. Determinants of Technical Efficiency in the Oilseed Sector

Since the performance of oilseed sector could be improved considerably with improved technical efficiency in resource-use through optimal input selection and use, analysis of determinants of technical efficiency was crucial. The results relating to determinants of technical efficiency by crops and states have been presented in Tables 7 and 8.

As expected, the results varied significantly across crops and states. Soil quality, seed replacement and education variables seemed to be the important variables in oilseed production (Table 7). Therefore, they need appropriate attention for raising technical efficiency in oilseed production. For the oilseed processing units, availability of adequate raw materials (RMA) and higher oil-recovery (OILR) were the important determinants of technical efficiency (Table 8). Therefore, modernization of oilseed processing units and an assured supply of quality oilseeds for processing, need due attention.

Table 8. Determinants of technical efficiency in oilseeds processing in India

Variables	Groundnut	Rapeseed & mustard	Soybean	Sunflower
Constant	0.619*	0.624*	0.569*	0.178
	(0.2458)	(0.2321)	(0.2125)	(0.151)
MACP	0.087**	0.001**	0.005*	0.002
	(0.0459)	(0.0005)	(0.002)	(0.0016)
RMA	0.046*	0.011	0.002***	0.003*
	(0.0176)	(0.0096)	(0.0015)	(0.0012)
DISTM	0.008	0.018**	0.007	0.005***
	(0.0071)	(0.0099)	(0.0054)	(0.0032)
OILR	0.078*	0.067*	0.049**	0.088**
	(0.0291)	(0.0263)	(0.0249)	(0.0478)

Notes: *, ** and *** indicate statistical significances at 1, 5 and 10 per cent levels, respectively.
The values within the brackets denote standard errors.

4. Conclusions and Policy Implications

The technical inefficiencies in oilseeds production, on an average, have been found to be 1/4 to 1/3 and even higher at the farm level/ processing unit level along with allocative and scale inefficiencies. The combined technical inefficiencies in the oilseeds sector have been found as 1/2 to 2/3, which are enormous. If prevented/ minimized, the oil production in the country could nearly be doubled. At present, biotechnological applications are directed towards rapeseed, soybean and sunflower only, these need be extended to other oilseed crops. In the case of sunflower and safflower, insect pests pose a serious threat; transgenics may be developed. Under-utilization of resources reflects a poor resource-base of the farmers having implications for optimum utilization of inputs and optimum production of output, both on-farm and in processing unit to reduce allocative and scale inefficiencies. Soil quality, seed replacement and education determine technical efficiency in the oilseeds production whereas availability of adequate raw materials and higher oil recovery determine the technical efficiency in oil production. Lack of assured market for oilseeds and timely and assured supply of quality seeds and raw materials for processing have been found as important factors for the poor performance of oilseeds industry. Perhaps, contract farming needs to be promoted for oilseeds cultivation by the processing industry to ensure supply of quality seeds and other inputs to farmers and timely and adequate supply of quality oilseeds for processing at mutually beneficial prices and cost.

In recent years, the edible oil industry has taken initiatives to increase oilseed production. The state of Punjab has started contract farming on 1000 acres in the Fazilka district. The Solvent Extractors Association of Punjab is now in the process of finalizing a project with Punjab Agro-Industries Corporation under which oilseeds – sunflower, mustard, castor and others–would be produced through contract farming. The central and state governments may encourage the private entrepreneurs and farmers into seed production business. These governments may also use the extension machinery to create awareness among farmers about seeds of high-yielding varieties. The seed production has been primarily left with the public sector agencies, with many limitations. While there is enough breeder seed production, further seed multiplication through foundation and certified seed production are the key constraints for availability of quality seeds at farmers' level (Kumar and Jha, 2004). The other major finding of the study is that the marginal return to water is one of the highest in oilseeds. Therefore, cultivation of oilseeds in the irrigated land if they really compete with other crops for profitability needs to be given due consideration. Since most of the oilseeds are grown in the marginal lands and rainfed conditions, the engineering traits that confer resistance to environmental stress, such as drought, frost, waterlogging or salinity could contribute to the increased productivity enhancement (Hegde, 2003).

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