REVIEW PAPER

Adoption Behaviour of Oilseed Growers in India

R. Venkattakumar[1] and M. Padmaiah[2]

1 & 2. Sr. Scientist (AE), Directorate of Oilseeds Research, Rajendranagar-500 030 Hyderabad, Andhra Pradesh

Corresponding author e-mail:venkat_4173@yahoo.com

ABSTRACT

India accounts for 12-15 per cent of world's oilseed area, 7-8 per cent of world' oilseed output, 6-7 per cent of world's vegetable oil production, 9-12 per cent of world's vegetable oil import and 9-10 per cent of world's vegetable oil consumption. The country ranks first in the production of castor, safflower, sesame and niger, third in rapeseed-mustard, fourth in linseed, fifth in soybean and seventh in sunflower in the world. In terms of area India ranks first in castor, safflower, groundnut, sesame, rapeseed-mustard and niger, third in sunflower and linseed and fifth in soybean in the world. Oilseeds support about 14 million population in farming and a million in processing. There is a high degree of variation in production of annual oilseeds due to their cultivation predominantly under low and uncertain rainfall conditions in soils which are hungry coupled with poor nutrient supply and crop management. India has produced a record of nearly 30 million tonnes of oilseeds during 2007-08 from an area of 26.7 million ha and productivity of 1115 kg/ha (2007-08). The oilseed production in the country is mainly depending on the vagaries of monsoon and the domestic price support. Despite increase in the domestic production of vegetable oils, there is a, import surge due to increase in the per capita *consumption of edible oil and hence, the self-sufficiency of edible oil revolves around 60 per cent.*

Key words : *Ooilseed; Vegetable oil; Castor; Safflower; Sesame ; Niger; Rapeseed-mustard; Linseed; Sunflower;*

As per the recent projections by DAC-Rabo bank, the *per capita* consumption of vegetable oil likely to rise to 12.60, 14.57 and 16.38 kg/ha by 2010, 2015 and 2020 respectively. This amounts to vegetable oil requirement of 14.8, 18.3 and 21.8 million tonnes respectively by 2010, 2015 and 2020. Assuming an average oil recovery of 30.00 per cent from major oilseeds and proportion of different oilseeds constant in the coming years, the country needs to produce at least 44.8, 55.5 and 66.0 million tonnes respectively by 2010, 2015 and 2020. Given that the oilseeds production of 30 million tonnes in 2007-08, the country needs to almost double the oilseeds production in the next 12 years requiring an annual growth rate of about 6.00 per cent (*Hegde, 2009*). All the technologies developed by the oilseed research network and transferred by the transfer of technology network for oilseeds, are not accepted as such by the oilseed growers due to many socio-economic and cultural constraints. At this juncture, a review on crop-wise adoption behaviour of oilseed growers will certainly provide strategies for a road map in achieving self-sufficiency in oilseed production through effective planning and efficient implementation of intensive technology dissemination efforts. Hence, crop-wise adoption behaviour of oilseed growers have been reviewed and presented in this paper.

Crop-wise adoption behaviour of oilseed growers :

Groundnut :

Knowledge level : All the respondents had knowledge about recommended preparatory tillage, use of improved cultivars, seed rate, sowing time, method of sowing, spacing, irrigation and intercultural operation for cultivation of summer groundnut in Maharashtra (*Ingle, 1995*). Although 62.50 per cent of the groundnut farmers had adequate knowledge on the quantity of spray for plant protection measures and 43.33 per cent on the timing of sprays, majority of farmers had little knowledge on compatibility of chemicals and spraying techniques in the Coimbatore district of Tamil Nadu (*Padmanabhan, 1998*). Majority (93.00%) of the farmers were aware of the groundnut pod sheller, 14 per cent were aware of scientific storage of groundnut pods and less than 5.00 per cent were aware of recommended construction of storage house and groundnut pod plucking machines in Kolar district of Karnataka (*Manjunatha et al, 2001*). Most of the groundnut growers became aware about the improved groundnut production technologies as an impact of frontline demonstrations in groundnut in Banas Kantha district of Gujarat (*Patel et al, 2009*).

Adoption level : The large farmers had better knowledge and adoption of dryland groundnut technology and adopted high yielding varieties in Anantapur district of Andhra Pradesh (*Rao, 1997*). About 80.00 per cent of the tribal farmers in Madhya Pradesh were using their own local varieties. Only 3.00 per cent of them knew about seed treatment practices and 5.00 per cent of them knew about recommended dose of fertilizers and plant protection measures (*Mishra, 1994*). All the respondents followed adoption of preparatory tillage practices, sowing time, method of sowing, spacing, intercultural operations and harvesting for summer groundnut in Maharashtra (*Ingle, 1995*). In Madurai and Coimbatore districts of Tamil Nadu, 85.00 per cent of the participants adopted the application of Gypsum, followed by plant protection measures (75.00%), seed rate (55.00%), use of high yielding varieties (40.00%), seed treatment (35.00%) and application of micronutrients mixture (20.00%) after the introduction of frontline demonstrations in groundnut (*Baby Kumari and Nanjaiyan, 1998*). Knowledge level of groundnut growers in Gujarat towards weeding, interculturing, soil testing and use of manures and fertilizers was fairly good. They further added that majority of the groundnut growers in Maharashtra (69.00%) fell under medium adopters category, while 16 and 15.00% of them were low and high adopters (*Vakaria et al, 2000*). In Karnataka, majority of the big groundnut growers belonged to medium level of adoption, whereas majority of small farmers belonged to low adoption level with respect to recommended groundnut cultivation practices. (*Nagaraj et al, 2001*). Command area farmers had higher overall knowledge as compared to non-command area farmers in the region of Upper Krishna Project in Karnataka (*Chandrasekhar et al, 2001*). Wide gap existed between potential yield and the yield in the demonstration plots in Saurashtra region of Gujarat, mainly due to variation in soil fertility, bad weather and specific local management problems (*Vagasia et al, 2005*). Popularization of integrated pest management (IPM) practices of groundnut through farmers' field schools (FFS) at selected villages in Rajasthan had resulted in 107.00 per cent seed yield increase over farmers' practices and helping the farmers to distinguish between the beneficial and harmful pests and to resort to plant protection measures on the basis of pest monitoring (*Singh et al, 2009*). Adoption of improved groundnut production technologies under real farm conditions had resulted in 24.00 per cent pod yield increase over the farmers' practices in Banas Kantha district of Gujarat (*Patel et al, 2009*).

Soybean :

Knowledge level : There is a scope for improving the knowledge level of the farmers about improved soybean production technology in Parbhani region of Maharashtra (*Kadam et al 2005*). Rural women gained considerable knowledge of soybean processing technologies, when they were imparted skill training on various soy products like soy nuts, soy milk, soy pakoda and soy paneer through lecture and demonstration methods (*Dupare and Vinayagam, 2007*).

Adoption level ; Seed yield of soybean under demonstration plots was higher in grid region of Madhya Pradesh. It was also indicated that the knowledge gap was reduced after the demonstrations in respect of all the practices except the plant disease control (*Tomar and Sharma, 2002*). Increase in soybean yield of frontline demonstrations over check was due to the impact of improved technology. There was a wider gap in yield that could be realizable and the actual in Bilaspur district of Chhattisgarh (*Tiwari et al, 2003*). Improved technological interventions in soybean resulted in varietal diversification. There was increased awareness and adoption towards recommended production technology and in turn in the yield of the crop. It resulted in increased prosperity of the adopted village (*Anonymous, 2005-06*). There was 36.00 per cent adoption gap in Vindhyan region of Madhya Pradesh, which influenced yield up to 48.00 per cent of the potential yield of soybean (*Sharma et al 2006*). Adoption of whole package technologies of soybean resulted in 48.00 per cent increase in seed yield over the local practices. Similarly adoption of recommended dose of fertilizers and chemical weed control resulted in 36.00 and 27.00 per cent seed yield increase respectively over the farmers' practices in Tikamgarh district of Madhya Pradesh (*Tomar et al 2007*). Adoption of improved soybean production technologies under real farm conditions in

Tikamgarh taluk of Madhya Pradesh recorded 72.00 per cent mean seed yield increase over farmers' practices, with Rs.6787/ha mean additional net returns *(Tomar et al, 2009)*

Rapeseed-mustard

Knowledge level : Education, material possession, mass media exposure, extension agency contact, scientific orientation and risk preference were significantly and positively correlated with the knowledge level of rapeseed-mustard growers in Bhiwani district of Haryana (*Malik et al 2005*).

Adoption level : Technological gap in mustard is influenced by socio- economic and personal factors. Age, cropping intensity, size of holding, irrigation potential and education were the variables that contributed significantly to variation in technological gap (*Jha and Ola, 1998*). Age of respondents showed significant correlation with knowledge, while education, landholding and caste were significantly related to knowledge of some important practices of mustard production in Ambah region of Madhya Pradesh. Type of family and annual income were related to knowledge of only a few practices. Multiple determinations indicated that caste type of family, annual income and landholding together affected the knowledge of plant protection measures by 78.88 per cent (*Singh and Singh, 1999*). There was a wide gap between potential yield and frontline demonstration yield, due to factors including soil fertility, site-specific management problems and rainfed conditions in southwestern region of Haryana. The extension gap was lower than the technology gap, but there was still a need to educate farmers in adoption of improved technology (*Yadav et al, 1999*).

In Dakshin Dinajpur district, West Bengal, there was a serious gap between potential and on-farm yield of mustard varieties mainly due to lack of awareness, which indicated the necessity of educating farmers about adoption of proper and improved technology of growing rapeseed and mustard in the rice-based crop sequences after rainy season rice, giving priority to location-specific transfer of technology adopting suitable extension strategies (*Zaman et al, 2000*). Average seed yield of mustard in FLD was 25.9 per cent more than farmers' practice in Fatehabad and Hisar districts of Haryana (*Thakral et al, 2001*). Seed replacement rate for rapeseed and mustard in Hisar was found to be 23.37 per cent in comparison to the 16.24 per cent state average (*Chauhan et al, 2002*). Recommended seed rate and doses of fertilizers have been followed to some extent in Dakshin Dirajpur district of West Bengal (*Brahmachary et al, 2003*).

Majority of the farmers in Jodhpur district of Rajasthan cultivated mustard on less than two hectares, used seed of improved cultivars, used the recommended seed rate, adopted the broadcasting method, did not practice crop thinning, applied less dose of fertilizer and sulfur and irrigated more frequently than recommended (*Singh, 2003*). It was found that component-wise technology adoption is statistically significant for mustard in West Bengal. Top dressing of nitrogen is the only component where highest adoption was found. (*Rudhra et al, 2005*). In Cooch Bihar district of West Bengal, skill-oriented training had a positive effect on the motivation of respondents, thus contributed to an increase in the level of adoption of new technology in mustard cultivation as compared to non-trained mustard growers (*Rudhra et al, 2005*). Adoption of improved mustard production technologies under real farm conditions through frontline demonstrations had resulted in significant improvement in the extent of adoption, productivity and profitability of mustard growers in Banas Kantha district of Gujarat (*Patel et al 2009*).

Sunflower :

Knowledge level : Majority of the sunflower growers in Jalgaon district of Maharashtra possessed some knowledge of sowing date of the crop, spacing, time of irrigation, irrigation schedule and stage of maturity. More than 70.00 per centof farmers were aware of pest control measures, time and amount of fertilizer application and improved varieties (*Agarwal et al, 1997*). On-farm extension demonstrations (OFEDs) in Kurnool district had a significant impact on respondents' knowledge level on sunflower cultivation practices (*Rajaratnam and Reddy, 2005*).

*Adoption level :*In Chhindwara district of Madhya Pradesh, improved varieties (100.00%) and time of sowing (82.35%) were the most commonly adopted practices (*Purushottam, 1999*). Sunflower growers in Kurnool and Anantapur districts of Andhra Pradesh adopted weeding and application of fertilizers closely as recommended. They adopted half the recommended dose of organic manures (*Anonymous, 2000-01*).

No major differences were observed in adoption of the improved technologies between the FLD and non-FLD farmers in Latur region of Maharashtra. It shows that there was an effective horizontal spread of the technologies. Majority of the FLD and non-FLD farmers fall under medium level of adoption (*Venkattakumar et al, 2007*). Adoption of improved sunflower hybrid KBSH-41 under real farm conditions resulted in 26.00 per cent seed yield increase over farmers' practices in Tumkur, Sira, Chintamani and Gowribidanur taluks of Karnataka (*Geetha et al, 2009*). Similarly, adoption of improved sunflower production technologies *viz*, whole package, recommended dose of fertilizers, plant protection measures, seed treatment and thinning under real farm conditions resulted in seed yield increase of 31.00, 28.00, 23.00, 22.00 and 56.00 per cent respectively over farmers' practices in Solapur district of Maharashtra *(Rajguru, 2009)*.

Sesame :

*Adoption level :*In Nadia district of West Bengal, improved varieties of sesame were compared with indigenous varieties Kanke-I and Rama, achieved a yield 40-90 per cent higher than the local varieties (*Chattarjee et al 1995*). Adoption of improved cultivar, chemical seed treatment, 40 kg N/ha (urea) and plant protection measures resulted in 50-88 per cent increase in sesame yield over the traditional farmers' practices in East Godhavari district of Andhra Pradesh (*Shriram et al 2000*). An adoption gap was evident for recommended high-yielding varieties, seed treatment, fertilizer application and plant protection measures for all crops and between both beneficiary and non-beneficiary farmers in Jodhpur district of Rajasthan (*Singh and Gajja, 2002*). Knowledge and adoption level of the sesame growers in Rajasthan was not up to the expected level and there existed a knowledge gap of 76.00 per cent and adoption gap of 66.00 per cent. Relatively more adoption constraints were encountered by the respondents with respect to the technologies *viz.*, plant protection measures and seed treatment. They adopted the technologies namely harvesting, post-harvest technology, method of sowing and seed rate with relatively lesser constraints (*Bareth et al 2001*). Majority of the sesame growers were found to be low adopters (62.50%), followed by medium (25.00%) and high (12.5%) adopters towards the recommended integrated nutrient management practices of sesame in Vridhachalam region of Tamil Nadu (*Vengatesan and Santha, 2004*).

Safflower :

*Adoption level :*Improved technology had a positive impact in safflower in Marathwada region of Maharashtra (*Shinde, 2002*). Majority of the FLD and non-FLD safflower growers belonged to medium level of adoption of recommended practices at Parbhani region of Maharashtra (*Anonymous, 2004-05*).

Niger :

Adoption level : There is a wide gap between potential and actual yield of niger. Hence, there is an immense need of research efforts for developing high yielding niger cultivars with high oil content to boost up the production and transfer of technology efforts to improve the adoption behaviour of niger growers (P*atil et al, 2003*).

Castor :

Adoption level : Farm-related characteristics such as percent castor area and socio-economic characters, such as schooling, expected loss and credit, significantly influenced the farmers' decision to adopt plant protection measures (*Rao et al, 1997)*. Majority of the respondents (78.00%) had adopted off-season tillage for soil and water conservation and alternate land use technology in Ranga Reddy district in Andhra Pradesh, India (*Prasad et al, 2000*). Recommended seed rate, plant protection and variety for castor were adopted by majority of the respondents. Impact of castor frontline demonstrations conducted at Palem, Andhra Pradesh revealed that 50.00 per cent of the castor growers adopted recommended technologies. Variety/ hybrid, spacing, chemical fertilizers and plant protection measures for the management of *Botrytis* were the technologies popularly adopted by the castor growers (*Anonymous, 2000-01*). Majority of the castor farmers had adopted the recommended practices at a medium level in Renga Reddy district (*Prasad, 2002*). Similarly the impact of frontline demonstrations conducted in Banaskantha and Mehsana districts of Gujarat revealed that majority of the farmers scored more than 50.00 per cent on technology adoption. Variety/ hybrid, spacing and irrigation were the recommended technologies popularly adopted by the castor growers (*Anonymous, 2001-02*). More than half of the castor farmers of

Mehsana District, Gujarat, India, had medium level of overall adoption of improved agricultural technology for castor (*Jadhav et al, 2004*). Adoption of improved hybrids namely DCH-32 and DCH-177 resulted in higher yield and economic returns. Motivating the castor growers for adoption of such hybrids under rainfed conditions would not only bring increase in castor productivity but also improve the socio-economic status of the castor growers of Andhra Pradesh (*Padmaiah, 2007*). The seed yield increase as a result of adoption of improved castor production technologies resulted in seed yield increase ranging from 28.00 to 39.00 per cent over farmers' practices in Uttar Pradesh (*Singh and Srivastava, 2009*).

Linseed :

Knowledge level : Participating farmers had comparatively lower level of knowledge than the linseed-demonstrating farmers in Ranchi district of Jharkhand (*Singh and Singh, 1997*). Besides socioeconomic problems, there is a lack of technical knowledge on linseed production in Raipur district (*Choudhary et al, 2004*).

*Adoption level :*It was found in Ranchi district that linseed-demonstrating farmers had adopted more practices than participating farmers. The extent of adoption of package of practices by participating farmers was satisfactory (*Singh and Singh, 1999*). Adoption of suggested practices was generally good, particularly regarding the adoption of new improved cultivars. Plant protection measures had the lowest percentage of adoption after the demonstrations (*Singh and Singh, 1997*). Gap between realizable and actual yield of linseed is much wider and suggested that considering the larger area under linseed cultivation, special emphasis must be given in Madhya Pradesh, Uttar Pradesh and Maharashtra states, which will improve the vertical expansion in linseed production of the country (*Kerthi et al, 2003*).

General Adoption behaviour of oilseed growers : Improved technology of oilseeds registered a yield advantage between 12.00 and 108.00 per cent under real farm conditions, compared with prevailing practices and provided mean additional net returns of Rs 470 to 10531/ha depending on the crop (*Kiresur and Prasad, 1994*). Irrespective of crop, technology adoption was highest for technologies *viz*, seed, spacing/seed rate and fertilizer. The technology index was highest in case of safflower followed by sunflower, sesame, rapeseed-mustard and groundnut. Cost of production and gross and net returns were higher for adopters than non-adopters of safflower, groundnut and sunflowercrops in Bijapur district of Karnataka (*Purohit and Murthy, 1995*).

Exploitable yield reservoir : The yield gap that exists between the yields obtained in FLD plots and that of national average was ranging from 28 per cent for rapeseed-mustard to 163 per cent for sunflower. If these yield gaps are bridged through effective and efficient transfer of technology measures, the production of oilseeds could be 43.92 million tonnes instead of 24.29

Table 1. Exploitable Yield Reservoir in Oilseeds (1996-97 to 2006-07)

	FLD average yield (1996-97 Crops (kg/ha)	National average yield (kg/ha) to 2006-07)	Yield gap (%) (2006-07)	National average production ('000 t) (2006-07)	Expected production ('000 t)
Groundnut	2249	866	160	4863.5	12628.4
Rapeseed-mustard	1405	1095	28	7437.8	9540.0
Sunflower	1492	567	163	1227.5	3229.9
Safflower	1272	637	100	240.3	479.5
Soybean	1819	1063	71	8850.8	15149.9
Sesame	644	363	77	618.4	1096.9
Niger	489	258	90	120.9	229.3
Castor	1840	1213	52	762.3	1156.3
Linseed	949	385	147	167.9	414.2
Overall				24289.4	43924.4

Yield Gap =Increase in FLD average yield over national average yield expressed in percentage; Expected production=Expected production, if yield gap is bridged through complete adoption of improved practices.

million tonnes in 2006-07 (Table 1). This shows that there is an urgent need for effective transfer of technology mechanism to create awareness among the oilseeds growers about the improved oilseed production technology and convince them towards complete adoption of the technology.

Constraints in Public sector transfer of technology: Major responsibility for transfer of oilseed technology lies with the line departments of the public sector but there are many lacunae that hamper these efforts, which are responsible for huge yield gap in oilseeds. Some of these constraints are, multiplicities of technology transfer; narrow focus of the agricultural extension system; lack of an effective feedback system; little attention given by the state departments of agriculture (SDAs) in developing a cadre of well-qualified subject matter specialists (SMS) with both technical competence and professional skills to disseminate the improved oilseed technologies either to the oilseed growers or to their field staff; no sustained support for the Farmers Training Centres (FTCs) that were established during sixties; non-availability of sufficient operational funds for most of the line departments to carryout routine extension activities and upgrading their human resources and lack of effective research-extension linkage mechanism. These constraints need to be addressed on priority basis (*Venkattakumar and Hedge, 2008*).

Strategies for effective transfer of oilseed technology to utilize exploitable yield reservoir: In this present scenario of extension management, new types of extension activities as the likes of following are required for carrying out dissemination of improved oilseed technologies; bringing-in effective public-private partnership for transfer of oilseed technologies in the areas *viz,* knowledge and capacity building of oilseed growers, participatory technology assessment and refinement, organizing self-help groups for management of seed money, participatory seed production and marketing and use of effective information and communication technologies (ICTs) for faster dissemination of information pertaining to improved technologies, storage, processing, marketing and procurement etc; generation and replication of success stories under real farm situations and use of mass media *viz,* video programmes, print media, radio or television for popularizing these success stories, instead of the technologies alone; importance for cropping system demonstrations *viz,* relay, sequential and intercropping systems; use of revolving fund for promoting self-help groups in disseminating improved technological packages instead of distributing subsidies; cluster area approach in transfer of oilseed technologies including organizing FLDs; narrowing down various levels of gaps through efficient resource use management and effective integration of all research and development agencies involved in development of a particular oilseed crop in a given locality (*Rai, 2002 and Sanghi, 2002*). There is a need for paradigm shift in public sector transfer of technology from top-down, blanket dissemination of technologies towards facilitating learning and understanding. The approaches for oilseed transfer of technology need to emphasize on learning and skill development rather on knowledge and technology *per se* which is generally contextual at given time and space and hence limited for its transferability. Greater attention will have to be paid towards information-based technologies. With the availability of modern electronic media and extensive telecom infrastructure in the country, the public as well as private extension systems should launch new strategies for oilseed technology transfer with a view to reach the farming community with greater ease (*Pathak, 2009*).

CONCLUSION

Oilseeds are the important agricultural commodity next only to cereals in India. There is huge demand for edible oil in the country due to increase in the per capita oil consumption. To meet this demand and to reduce the huge foreign exchequer in importing edible oil, there is an urgent need to increase the domestic oilseed production of the country. An assessment of exploitable yield reservoir available in oilseeds implies that there is a scope for doubling the oilseed production of the country. However, this can be possible by complete adoption of improved oilseed production technologies by the oilseed growers. A thorough review on adoption behaviour of oilseed growers reveals that there is scope for improving the adoption behaviour of oilseed growers. This foot needs intensive transfer of technology efforts. However, there are certain lacunae exist in public sector in transfer of technology efforts. The strategies to improve transfer of technology efforts targeting oilseeds are also suggested.

REFERENCES

1. Agrawal, R.B., Patil, R.L and Lambe, S.P. (1997). Knowledge and adoption level of sunflower growers in Jalgaon district. *PKV Research Journal*. **21** (2): 199-200.
2. Anonymous (2000-01).Annual Report. Directorate of Oilseeds Research, Rajendranagar, Hyderabad, India. P (55-57).
3. Anonymous (2001-02). Annual Report. Directorate of Oilseeds Research, Hyderabad- 500 030, India. P (65)
4. Anonymous (2004-05). Annual Report. Directorate of Oilseeds Research, Rajendranagar, Hyderabad. P (29-30).
5. Anonymous (2005-06). Annual Report. National Research Centre for Soybean. Indore. Madhya Pradesh. P (62-66).
6. Baby Kumari, P and Nanjaiyan, K. (1998). Extent of adoption of demonstrated groundnut cultivation practices of FLD farmers. *Madras Agric. J.,* **85** (7-9): 347-348.
7. Bareth, L.S., Indodia, S.L and Dhriti Solanki (200). Technological constraints in adoption of sesame (*Sesamum indicum* L.) production technology in *Rajasthan. J. Oilseeds Res*. **18** (1) : 95-98.
8. Brahmachari, K., Ali, M.H and Nath, T.K. (2003). Socio-technical analysis of the extent of adoption of modern agricultural technology in Dakshin Dinajpur district of West Bengal. *Environment and Ecology*. **21** (1): 152-155.
9. Chandrasekhar, S., Vaster, G., Prasanna Kumar, T., Lakshminarayanan, M.T and Mallikarjuna G.B. (2001). Knowledge of recommended groundnut cultivation practices among command and non-command area farmers of Upper Krishna Project, Karnataka. *Mysore J. agric., Sci*., **35**: 368-373.
10. Chatterjee, S.N., Ghosh, R.K and Mukherjee, A.K. (1995). To study the sustainability of sesame high yielding varieties through farmers participatory on-farm research. Proceedings of national symposium on sustainable agriculture in sub-humid zone. March 3-5. 1995: 474-476.
11. Chauhan, R.S., Rai, K.N and Chamola, E.D. (2002). Estimation of demand and supply and adoption of quality seeds in Haryana. *Indian Journal of Agricultural Economics*. **57** (3): 467-478.
12. Choudhary, V.K, Verma, R.K and Lalwani, N.R. (2004). Constraints analysis of linseed production in Raipur district of Chhatishgarh region. *Plant Archieves*. **4** (1): 123-127.
13. Dupare, B. U and Vinayagam, S. S. (2007). Impact of training on knowledge of soybean processing technology of rural women. In: ISOR.2007.Extended Summaries: National Seminar on Changing Global Vegetable Oil Scenario: Issues and Challenges Before India. January 29-31, 2007. Indian Society of Oilseeds Research, Hyderabad. P (404-405).
14. Geetha, K.N., Shadakshari, Y.G., Shankarayana, V., Sashikanth, B.P., Jagadish, K.S., Kamra, K and Putturayaswamy (2009). Response of sunflower hybrid KBSH-41 at farmers' fields. *J. Oilseeds Res*. **26** (Special Issue). pp (567-568).
15. Hegde, D.M.(2009). Can India achieve self-reliance in oilseeds? In: Souvenir: National symposium on Vegetable Oils Scenario: Approaches to meet the growing demands. January 29-31, P (1-15).
16. Ingle, P.O., Kude, N.R and Dhanokar, C.R. (1995). Constraints in adoption of recommended technologies of cultivation of summer groundnut. *J Maharashtra Agric., Univ.,* **20** (1): 108-111.
17. Jha, B.K and Ola, S. 9(1998). Contribution of selected socio-economic and personal characteristics of farmers towards technological gap in scientific cultivation of mustard. *Journal of Applied Biology*. **8** (1): 159-161.
18. Jhadav, D.L., Kawale, A.B., Dudhate, D.G, Kapse, P.S and Prajapati, M.R.(2004). Extent of adoption of improvedagricultural technology by the farmers of the Mehsena district of Gujarat state. *Journal of Soils and Crops*. **14** (1): 105-107.
19. Kadam, R.P., Wangikar, S.D, Pawar, G.S and Bhosale, P.B. (2005). Knowledge level of farmers about improved soybean production technology. *Journal of Soils and Crops*. **15** (1): 210-212.
20. Kerthi, S. A, Malik, Y. P. and Ravi, J. (2003). Impact of technology transfer for sustainable productivity of linseed in major states. In: ISOR.2003.Extended Summaries: National Seminar on Stress management in oilseeds for attaining self-reliance in vegetable oils. January 28-30, 2003. Indian Society of Oilseeds Research, Hyderabad. P (468-469).
21. Kiresur, V and Prasad, M. V. R. (1994). Potentials of improved oilseed crop production technologies in India- an assessment through frontline demonstrations. 1994. *J. Oilseed Res.* **11**(2): 245-258.
22. Malik, R.S., Sherawat, R.S., Sube Singh and Loveraj Singh (2005). Relationship of farmers' trait with knowledge of rapeseed-mustard production technology. *J. of Oilseeds Res*. **22** (1): 159-161.

23. Manjunath, B.N., Lakshminarayana, M.T and Vaster, C.S.(2001). Knowledge groundnut growers against post-harvest technologies in Kolar district of Karnataka state. *Karnataka Journal of Agricultural Sciences*. **14** (4): 1113-1114.
24. Mishra, C.M. 1994. Tribal farmers' knowledge on groundnut practices. *Madras Agric. J.*, **81** (11): 637.
25. Nagraj, K.H., Lalitha, B.S., Krishnamurthy, B and Anand, T.N. (2001). Adoption of improved cultivation practices of groundnut by big and small farmers. *Mysore J. Agric., Sci*. **35**: 88-92.
26. Padmaiah, M (2007). Performance of castor hybrids in Andhra Pradesh. In: ISOR.2007.Extended Summaries: National Seminar on Changing Global Vegetable Oil Scenario: Issues and Challenges Before India. January 29-31, 2007. Indian Society of Oilseeds Research, Hyderabad. P (401).
27. Padmanaban, N.R. (1998). Frequency and knowledge on pesticide use. *Madras Agricultural Journal*. **85** (5/6): 313-315.
28. Pate, B.I., Patel, D.B., Patel, A.J., Patel, J.R and Patel, V.B. (2009). Impact of frontline demonstrations in groundnut. *J Oilseeds Res*. **26** (Special Issue). P (556-557).
29. Pate, V.B., Patel, B.I., Patel, D.B., Patel, A.J. and Vihol, K. H. (2009). Performance of mustard in Banas Kantha district of Gujarat. *J Oilseeds Res*. **26** (Special Issue). P (564-566).
30. Pathak, D.N. (2009). Transfer of Technology. In: Hegde, D.M. (Ed.). 2009. Vegetable oils scenario: Approaches to meet the growing demands. Indian Society of Oilseeds Research. Hyderabad.
31. Patil, H. S., Dhadge, S. M., Purkar, J. K., Duhoon, S. S., M Lende N. S and Kenjale. H. B. (2003). Current status and strategies of oilseed production with critical reference to Niger in India. In: ISOR.2003.Extended Summaries: National Seminar on Stress management in oilseeds for attaining self-reliance in vegetable oils. January 28-30, 2003. Indian Society of Oilseeds Research, Hyderabad. P (470).
32. Prasad, M.S. (2002). Adoption of recommended package of practices of dry land crops in relation to socio-economic and personal characteristics of farmers. *Indian J. of Dryland Agril. Res. and Dev.* **17** (1): 39-43.
33. Prasad, M.S., Sundaraswamy, B and Ansari, M.R. (2000). Extent of adoption of dryland agricultural technologies. *Karnataka Journal of Agricultural Sciences*. **13** (4): 1029-1032.
34. Purohit, K. V. M and Murthy, H. G. S. (1995). Impact of watershed development programme on the production of oilseeds in Bijapur district of Karnataka-an economic analysis. *National Bank News Review*. Mumbai. **11**(1): 23-28.
35. Purushottam Thakur (1999). Factors influencing adoption of farm practices of sunflower technology. *Agricultural Science Digest*. **19** (4): 241-244.
36. Rai, S.D. (2002). Technology transfer by public sector. In: Rai, Mangala, Singh, Harvir and Hegde, D.M. (Eds). Oilseeds and oils: Research and development needs. Indian Society of Oilseeds Research. Hyderabad. Pp 438-445.
37. Rajaratnam, T. and Reddy, M.S. (2005). Impact of sunflower on-farm extension demonstrations on sunflower cultivars. *Mysore Journal of Agricultural Sciences*. **39** (4): 535-538.
38. Rajguru, A.B., Shinde, S.K and Sawant, P.H. (2009). Adoption of production technologies of sunflower by farmers through frontline demonstrations. *J. Oilseed Res.* **26** (Special Issue). P (635-637).
39. Rao, C.A.R., Rao, M.S and Reddy, Y.V.R. (1997). Predicting the adoption of plant protection measures by farmers using a logical model. *International Journal of Pest Management*. **43** (4): 299-302.
40. Rudhra, B.C., Biswas, S and Mukhopadhyay (2005). Impact of adoption of improved package of practices for mustard cultivation in Cooch Behar district of West Bengal. *Environment and Ecology*. **22** (3): 508-512.
41. Sanghi (2002). In: Rai, Mangala, Singh, Harvir and Hegde, D.M. (Eds). Oilseeds and oils: Research and development needs. Indian Society of Oilseeds Research. Hyderabad. Pp 438-445.
42. Sharma, H.O., Mahesh Patidar and Nahatkar, S.B. (2006). Constraints of soybean production technology in Vindhyan plateau agro-climatic region of Madhya Pradesh. *Research on Crops.* **7** (1): 100-110.
43. Shinde, B.B. (2002). Impact of technology in oilseeds production in Marathwada region. *J. Maharastra Agri. Univ*. **27** (2): 198-199.
44. Shriram, C., Sudhakar, N., Dattatri, K., Reddy, K.M and Reddy, G.R. (2000). Performance of improved varieties of sesamum under rainfed conditions. *Indian J. of Dryland Agril. Res. and Dev*. **15** (1): 84-85.
45. Singh Saroj, Verma, P.V and Gaur, R.B. (2009). Transfer of IPM technology: An experience in groundnut. *J. Oilseeds Res.* **26** (Special Issue). P (570-572).

46. Singh, B and Gajja, B.L. (2002). Adoption gap in improved practices of bajra, til and guar crops in arid zone. *Current Agriculture*. **26** (1/2): 107-109.
47. Singh, B. (2003). Adoption of improved package of practices of mustard crop in arid areas. *Current Agriculture*. **27** (1/2): 121-122.
48. Singh, M.P and Singh D.P. (1999). Factors affecting adoption behaviour of mustard growers. *Current Agriculture*. **23** (1/2): 87-92.
49. Singh, N.D and Srivastava, S.K. (2009). Improvement in productivity and profitability of castor (*Ricinus communis* L.) through transfer of technology. *J. Oilseeds. Res*. **26** (Special Issue). P (553-554).
50. Singh, R.K and Singh, R.P. (1997). Impact pf frontline demonstrations on adoption of package of practices for linseed production. *Journal of Research*. **9** (2): 193-196.
51. Sreenivasa Rao (1990). A critical analysis of dryland agricultural technology with reference to groundnut cultivation in Anantapur district of Andhra Pradesh. Unpublished PhD thesis. Acharya Ranga Agricultural University, Rajendranagar, Hyderabad-600 030.India.
52. Thakral, K., Bhatnagar, P and Puria, S.S. (2001). Assessment of frontline demonstrations on mustard in northeastern region of Haryana. *Annals of Agri-Bio Research*. **6** (1): 73-76.
53. Tiwari, R.B., Vinay Singh and Chauhan, D.P.S. (2003). Impact of frontline demonstrations of soybean in transfer of improved technology. *Mah. J. Ext.Edu*. **22** (1): 139.
54. Tomar, L.S and Sharma, B.P. (2002). Yield and technological knowledge gap in soybean cultivation in arid region of Madhya Pradesh. *JNKVV Research Journal*. **36** (1/2): 115-117.
55. Tomar, R.K.S., Rai, H. S., Pathak, K. N and Singh, R. V. (2007).Impact of technological practices on the productivity of soybean in frontline demonstrations. In: ISOR.2003.Extended Summaries: National Seminar on Stress management in oilseeds for attaining self-reliance in vegetable oils. January 28-30, 2003. Indian Society of Oilseeds Research, Hyderabad. P (453).
56. Tomar, R.V.S., Sahu, B.L and Rupendra Kumar (2009). Productivity improvement in soybean (*Glycine max* L.) through integrated crop management in frontline demonstrations. *J. Oilseeds Res.* **26** (Special Issue). P (568-570).
57. Vaghasia, P. M., Savalia, R. L and Kelaiya, G. R. (2005). Evaluation of frontline demonstrations in groundnut in Saurashtra region of Gujarat. *J. Oilseed Res*. **22** (1): 238-239.
58. Vekaria, R. S., Pandya, R.D and Thumar, D.N. (2000). Knowledge and adoption of behaviour of rainfed groundnut growers. *Agril. Ext. Review*. **12** (1): 10-14.
59. Vengatesan, D and Santha Govind (2004). Adoption of integrated nutrient management practices in sesame crop (*sesamum indicum* L.). Sesame and Safflower Newsletter. 19 (45-47).
60. Venkattakumar, R and Hegde, D.M. (2008). Exploitable Yield Reservoir in Oilseeds. DOR Newsletter. 14 (2): 1-3.
61. Venkattakumar, R., Padmaiah, M., Ramanajaneyulu, G.V and Ramana Rao, S.V. (2007). In: ISOR.2007.Impact of sunflower demonstrations- an evaluative study. Extended Summaries: National Seminar on Changing Global Vegetable Oil Scenario: Issues and Challenges Before India. January 29-31, 2007. Indian Society of Oilseeds Research, Hyderabad. P (413-414).
62. Yadav, Y.P, Bikram Singh and Anil Kumar (1999). Evaluation of frontline demonstrations on mustard in southwestern region of Haryana. *Journal of Research*. **29** (1/2): 39-42.
63. Zaman, A., Sahana, B.C., Chattopadhyay, A and Choudhari, S.K. (2000). Evaluation of frontline demonstrations of mustard varieties in old alluvial region of West Bengal. *Journal of Interacademicia*. **4** (3): 450-453.