Competitiveness and Efficiency in Groundnut Oil Sector of India

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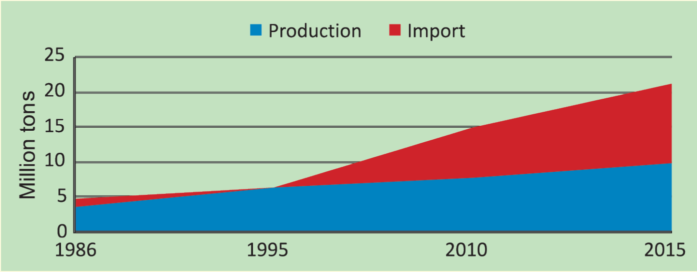
Introduction

Groundnuts are a major source of edible oils in India. One of the central problems of groundnut production and processing sectors are huge inefficiencies due to uncertain production environment owing to rainfed cultivation, less resource base of smallholder farmers and processors, and low adoption rate of improved technology. This policy brief addresses critical issues binding groundnut oil sector inefficiency and international competitiveness. With the widening gap between demand and supply of edible oils in India, policy action is imperative not only to arrest surging imports of edible oils but also to benefit both producers and consumers in terms of broader employment generation and decentralized rural industrialization. Specific policy implications are highlighted in this policy brief, which encompass a) the harnessing of improved varieties with attributes like drought tolerance, high oil content, high productivity for large scale seed multiplication/distribution by both public and private agencies; b) viable village seed banks and seed networks through cycles of *rabi* (postrainy) season seed multiplication to meet the seed requirements of *kharif* (rainy season) and *vice versa;* c) low-cost technologies to increase profitability and reduce risk; d) oilseed clusters to facilitate scale economies and capacity utilization in processing units; and e) capital subsidies to accelerate technological upgrading to shed inefficiency in the processing sector. The expected gains in efficiency in both production and processing of oilseeds are expected to produce measurable producer and consumer benefits, which will justify proposed non-market distorted subsidy for both seeds and technological upgrading in the processing sector.

Widening gap between demand and supply of edible oils in India

In India, demand outstrips supply for edible oils. With the opening of the edible oil sector in mid 1990s, the sector was exposed to international competition. In the recent past, the growth rate of edible oil consumption increased at 4.6% per annum, whereas domestic production increased by 1.3% per annum; consequently, imports increased by 12.2% per annum. Demand for edible oils is expected to increase from 15.1 million tons (mt) in 2010 to 21.2 mt by 2015, and consequently, imports are projected to rise to about 11 mt by 2015 (Graph 1). Low oilseed yield levels, coupled with the non-competitive oilseed processing sector, meant that Indian edible oils were not able to compete with cheap imports in the post-World Trade Organization (WTO) regime. The sector cannot afford to be inefficient, if it is to survive and needs to increase competitiveness and efficiency both in oilseed production and processing sectors.



Graph 1. Edible oil production and imports, and projections for 2015.

Historically, oilseeds are low priority crops compared to major staple food crops like paddy and wheat, and efficacy of government support is also less due to wider diversity and geographical spread (groundnuts, rapeseed, mustard, sunflower and soybeans). There were some earlier attempts to enhance productivity of edible oils, such as the introduction of the Technology Mission on Oilseeds (TMO) in 1986, which is highly successful. Later on, implementation of the Integrated Scheme of Oilseeds, Pulses, Oil Palm and Maize (ISOPOM) since 2004 with more emphasis on R&D and dissemination of best available technology to the farmers fields, was unsuccessful and the gains achieved during TMO period were not sustained due to the decline in domestic and international prices for edible oils, which came with the opening of the sector in mid 1990s. The low prices reduced profit margins for both farmers and processors. There has been little work on competitiveness and the sources of inefficiency in the edible oil sector. This brief specifically addresses this critical gap and systematically examines the factors that influence the drivers of efficiency in both the oilseed and edible oil sectors in India taking groundnuts as case study.

This brief has two components. It first examines the competitiveness and sources of inefficiency in groundnuts and its oil in India as it is a major source of edible oil. Then it focuses on farmers and processors in a major groundnut growing district, Anantapur in South India, to provide an empirical evidence to: (i) assess the competitiveness of the edible oil complex with special reference to groundnuts in pre-TMO period (1970-1986), TMO period (1987-1995) and post-WTO period (1996-2010); (ii) determine the technical, allocative efficiency and the factors influencing technical efficiency in the production and processing of groundnut; and (iii) evaluate policy options for improving efficiency in both the production and processing of groundnut.

Technology Mission on Oilseeds period: Yellow Revolution

India's agricultural sector was heavily protected with high import tariffs until 1995. Along with other commodities, edible oils were on the negative import list whereby only state agencies were allowed to import edible oils. During pre-TMO period (from 1970-86), growth in oilseed production was only 1.5%, while demand grew by 1.8% per annum (Table 1), resulting in a surge in imports of edible oils to 24.3% of domestic consumption by 1986. To check surge in imports, TMO was introduced in 1986, which increased oilseed production from 12.2 mt in 1986 to 21 mt in 1995. The growth in oilseed production was robust (7.4%) during the TMO period due to increases in both area and yield, and is often referred to as the '*Yellow revolution*' (Reddy 2009). The *Yellow revolution* was successful mainly due to wider adoption of technology, which was facilitated by a higher protection and support in terms of Minimum Support Price (MSP is a price floor, at which government purchases all market arrivals) and high import tariff rates.

Table 1. Annual compound growth rates (%) of edible oil production and consumption.

Period	Edible oil production	Edible oil consumption	Oil imports	Population
Pre-TMO period	1.5	1.8	0.3	2.14
TMO period	7.4	2.8	-32.5	2.04
Post-WTO period	1.3	4.6	12.2	1.87

Post-WTO period: free trade policies and persistent low productivity

In mid 1990s, tariffs on edible oils were liberalized in a phased manner as part of India's commitment to the WTO. Imports of palmolein oil and other edible oils were placed under Open General License (OGL), which facilitated a surge in cheap imports of soybean oil and palm oil. Consequently, domestic prices of all edible oils and oilseeds declined, and the relative profitability of oilseeds decreased compared to competing crops. The import tariffs on edible oils frequently adjusted, varying between near 0% and 100% during 1996 to 2009, with the government intention of making edible oils available at a low price to consumers, while ignoring the long run sustainability of domestic oil seed production and processing sector. Another policy instrument, that is, the government procurement of oilseeds at the MSP, has not been operational in many areas because procurement from the scattered and thinly distributed oilseed growing areas across the country is logistically difficult and costly. Any procurement and public distribution system for oilseeds were projected to ultimately end up with huge losses (Gulati and Kelley 1996). Some argued (Gulati and Kelley 1996) that government efforts to stimulate production were not cost-effective given the non-competitive edible oil sector, and that these efforts also hurt the consumer through high edible oil prices. For these reasons, the prices of oilseeds/edible oils has largely been left to market forces, with low import tariffs to bridge the gap between domestic supply and demand.

As a result of trade liberalization and India's consumer oriented policy, there was a marked decline in real prices and large price fluctuations. In response to low prices, farmers shifted to other crops or kept a portion of oilseed fields fallow, thus reducing the area and production of oilseeds. The growth rate of oilseed production fell to 1.3% per annum and imports of edible oils increased by 12.2% per annum during the post-WTO period. As a consequence of the scarcity of oilseeds for crushing, most of the processing units either closed down or operated at less than full capacity. Cheaper imports of edible oils discouraged farmers and processors and reduced incentives for R&D efforts and investments in new technology. The above series of events resulted in the persistence of inefficient oilseed production and outdated processing technologies since 1996. Ironically, inefficiencies persisted despite the availability of some high yielding technology for oilseed production and emergence of private companies with highly efficient processing units in the market.

Importance of groundnuts in Indian edible oil sector

Groundnuts are the major source (22% of edible oil production) of edible oils in India, after rapeseed, mustard and soybeans. About 70% of groundnut produced is crushed for oil, and the remaining 30% is used either for seed or is consumed directly. In post-WTO period, India has been a major exporter of both groundnuts ($279 million/annum) and its cake ($21 million/annum), and has been a marginal exporter of groundnut oil ($17 million/annum) (Table 2). India has to increase efficiency and competitiveness of the sector to substitute most of the cheaper edible oil imports like palm oil and soy oil in to the domestic market (cross elasticity of demand between palmoil, soy oil and groundnut oil is higher and consumers substitute groundnut oil with cheaper palmoil and soy oil whenever price of groundnut is too high and *vice versa*) and also meet additional demand for its products in international markets in the likely scenario of higher edible oil and oilseed prices (Piesse and Thirtle 2009).

Table 2. Trends in annual area, production and net exports of groundnut (GN) products in India.

Indicator	Pre-TMO period	TMO period	Post-WTO period
GN Area (million ha)	7.1	7.9	6.0
GN Yield (kg/ha)	819	992	1210
GN Production (mt)	5.8	7.8	7.3
Net Exports (million US $)			
Groundnuts	18.0	52.9	279.0
GN Oil	-0.4	-0.2	17.0
GN Cake	33.9	51.1	21.0

Source: FAOSTAT (2011).

Methodology and Data Sources

The study estimated the Revealed Symmetric Comparative Advantage (RSCA) and the Nominal Protection Coefficient (NPC) for groundnut, groundnut oil and groundnut cake over the period 1980-2009. The study used FAOSTAT (2011) data on domestic and international reference prices at Mumbai, exports, imports and production trends of oilseeds and groundnut products to estimate the RSCA and NPC. The study used the data collected from field survey in a south Indian district (Anantapur) for the year 2007-08. Data on research stations, on-farm demonstrations and district average yields has been used to find yield gaps. Totally 320 farmers and 29 processing units (10 expellers and 19 power-operated *ghanis*) were selected to estimate technical and allocative efficiency of farmers and processors. We use the frontier production function with inefficiency effects, widely known as the Battese and Coelli (1995) model to estimate technical efficiency. In the oilseed processing sector, output considered is Net-Value Added (Rs 1000)/annum (sale value of groundnut oil plus groundnut cake minus cost of groundnuts), while labor (man days/annum), electricity consumption (kwh/annum), depreciation and other costs (the replacement value of machinery divided by life expectancy of machinery in years plus rental value of land and building and interest on working capital; Rs1000/annum) are taken as inputs. In this district, only groundnuts are processed by these units. The technical inefficiency effects variables (to explain inefficiency) included are distance from nearest markets (km) and market size of nearest market (1000 t/annum), age of the processing unit (years) and variable indicating integration of oilseed processing unit with marketing/rice mill/ processing other oils or stand alone.

Results

Competitiveness

Competitiveness can be defined in several ways, ranging from the nominal protection concept to the comparative advantage concept. NPC less than 1 indicates higher competitiveness and more than 1 indicates lower competitiveness in international markets. A country is said to have comparative advantage in its exports if the corresponding RSCA value is positive and *vice-versa*. The results indicate that India is export competitive in groundnut kernel and groundnut cake in most of the years, but not in groundnut oil (Table 3). Major groundnut growing districts in Andhra Pradesh, Karnataka, and Rajasthan are more competitive in groundnut cultivation compared to their competing crops like, redgram and other irrigated/dry crops, hence

Table 3. Competitiveness of groundnut products.

	RSCA			NPC		
Period	GN kernel	GN Oil	GN Cake	GN kernel	GN Oil	GN Cake
Pre-TMO	0.27	-1.00	0.84	1.02	1.66	0.80
TMO	-0.08	-1.00	0.83	1.17	1.71	0.81
Post-WTO	0.39	-0.99	0.81	0.94	1.06	0.85

emphasis on increasing area under groundnut in these states will increase overall competitiveness of India's groundnut production. The non-competitiveness of the processing sector is reflected in negative RSCA and >1 NPC, even though oilseed farmers are competitive. During the TMO period, India had almost achieved self-sufficiency in edible oils; however, it was at the cost of 60% higher domestic prices than world prices.

Yield gaps in groundnut production

Increasing competitiveness of the groundnut oil sector requires action in two fronts (i) increasing efficiency in groundnut production and (ii) increasing efficiency in oilseed processing. Many studies on groundnut (Reddy 2009; Bhatia et al. 2006; Birthal et al. 2011) revealed that the old and outdated varieties and sub-optimal use of micronutrient (gypsum) are the main reasons for yield gaps. Non-availability of seeds of newly released varieties at villages is also hindering wider adoption of new varieties even though they perform better than old varieties like TMV-2. Generally, under rainfed conditions the recommended seed rate is 90-100 kg/ha and under irrigated conditions it is 140 to 150 kg/ha. Under rainfed conditions, the plant population is sub optimum, whereas under irrigated conditions, it is in excess of the recommended number. Due to high seed and other input costs required at the time of sowing (40-50% of total cost of cultivation) and the crop being mostly grown under uncertain rainfed conditions where yields and profitability vary widely, farmers are not willing to risk their money on high-cost recommended cultural practices, and adoption rates are low. In the study area, yield gap-I (the yield gap between research station with optimal input combination and on-farm demonstration) and yield gap-II (the yield gap between on-farm demonstration and average district yield) for groundnut are 199% and 137%, respectively. The total yield gap is estimated as 336% (Table 4). If we fill these yield gaps at least by a half, the crop will become more competitive, which will help in reducing dependence on edible oil imports. The district average yield of groundnut is 830 kg/ha, compared to on-farm demonstration yields of 1970 kg/ha and the research station yield of 3620 kg/ha in the district. However, the yield gaps widely vary across irrigated, rain fed and different agro-climatic zones (Bhatia et al. 2006). To make groundnut production more competitive, delineation of groundnut production zones and seasons based on agro-climatic suitability and charting zone and season specific plans is essential to exploit productive potential of both high and low productive zones and seasons. Productivity in the rabi season is much higher than in the kharif (rainy season). In some agro-climatic zones of Uttar Pradesh and Gujarat states, groundnut productivity is much higher compared to arid zones like Anantapur district. Nevertheless, groundnuts from these systems not only contribute to a major share of edible oil production but also to improved livelihoods, nutrition for the family, fodder for livestock and indirect income from livestock. Among the most frequent cited constraints to greater use of inputs by smallholders are production and price risks and resource availability. A focus on reducing risk rather than maximizing yield will increase adoption rates of recommended practices, which will be profitable to smallholder farmers in SAT regions. Hence, under rainfed conditions, the research and extension system should focus on low cost technologies that have higher adoption rate. Purchasing external inputs such as 'improved seed' requires a financial commitment by farmers. When the prices and output are highly variable, as is common in groundnut, it becomes risky to make the investment in recommended practices, in spite of high yield responses.

Table 4. Yield gap (kg/ha) analysis of groundnut cultivation (2008).

Item	Min	Max	Mean
Research Station (kg/ha)	2080	4960	3620
On-farm demonstration plot (kg/ha)	960	3050	1970
District Average productivity (kg/ha)	560	1080	830
Yield Gap-I (yield gap between Research Station to on-farm demonstration)	1120 (200)	1910 (177)	1650 (199)
Yield Gap-II (yield gap between on-farm demonstration to district mean)	400 (71)	1970 (182)	1140 (137)
Total Yield Gap (I+II)	1520 (271)	3880 (359)	2790 (336)

Note: Figures in parenthesis are yield gap in % to district average yield.

Technical and allocative efficiency in groundnut production

Input use is sub-optimal in groundnut cultivation. Most of the farmers are not using recommended low cost practices like use of micronutrients such as gypsum and removal of Parthenium weed for the control of stem necrosis disease even though research shows that they will increase yields by 15 to 20%. Providing supplemental irrigation during drought stress increases the yield by 20% even with 10 mm of irrigation, but only a few (less than 20%) farmers are irrigating the crop. TMV-2 (released in 1940, covers 75% area) and JL-24 (released in 1978, covers 15% area) still dominate. These need to be replaced by Narayani, ICGV 91114 and K 6, which are high yielding and drought tolerant. After harvesting, farmers stack the produce for many days for future separating of groundnut pods from haulms depending on labor availability. The practice is time consuming, and labor intensive, and thus delays the marketing of the groundnut. Groundnut pods can be separated with mechanical threshers from the third day onwards after harvesting without stacking the produce. This helps early post-harvest processing and reduction in labor cost and post-harvest losses. Generally, farmers sow groundnut as pure crop. However, intercropping groundnut and pigeonpea with row ratio as 11:1 is considered the best risk management strategy under rainfed conditions.

The technical efficiency is defined in terms of the ratio of the observed output to the corresponding frontier output, conditional on the level of inputs used by the farm. Technical inefficiency is therefore defined as the difference between the farmers fields and the frontier level of output. Allocative efficiency is related to a combination of inputs with the lowest cost, and scale efficiency refers to the optimum level of output selection. The farm is allocatively inefficient if it operates off the minimum cost expansion path.

The mean technical efficiency (MTE) of farms ranges from 57% to 79% for small and large farmers, respectively, with an overall MTE of 71% (Table 5). Estimates of allocative inefficiencies in the use of different input levels in groundnut production revealed that the critical inputs like irrigation, fertilizers, seed and machine labor were under-utilized at given production costs. The imbalance in the use of inputs may be due to the rationing of the inputs at flat rates in local markets. As a result, the costs of the most critical inputs (credit, water and fertilizer) are lower, but due to their short supply they are mostly used for competing crops like paddy and other commercial crops, which are given greater importance by farmers (Reddy 2009, Reddy et al. 2011). Adoption of newly released varieties increases efficiency to a significant extent. The positive relationship between farm size and efficiency can be explained to some extent by the resourcefulness of large farmers in adopting scientific methods under generally low resource situations, which is in agreement with what Coelli and Battese (1996) found from studying Indian farms. The TMO and other efforts could not replace old varieties in many groundnut growing areas. In recent years, variety replacement has begun, for instance in 2009-10, about 7% of groundnut area is under new varieties, ICGV 91114 and K 6 in Anantapur. The varieties with high oil content are also available, but not popular among farmers due to lack of awareness and seed availability.

Table 5. Technical efficiencies of farms in groundnut production.

Category of farms	Mean efficiency (%)
Farm size	
Small (less than 2 ha)	57
Large (more than 4 ha)	79
Seed type	
Traditional variety (TMV-2)	63
Improved variety	81
Soil type	
Red loams	77
Other	65
Contact with Extension worker	
Yes	79
No	65
All	71

Groundnut Processing Sector

Input-output data has been collected to assess the technological gaps between power-operated-*ghanis* and baby-expellers operating in the villages. Power-operated *ghanis* are numerically large in number (estimated number vary between about 60,000 to 100,000 in India) even though their contribution to oilseed processing is low in India. These are run either by diesel or electricity. The oil extraction ratio is about 37%. Most of the power-operated *ghanis* are constructed locally and suffer from obsolescence in design, high wear and tear of critical parts, high power consumption and frequent breakdowns. They leave a high level of residual oil in the cakes compared to expellers. About 60% of *ghanis* are closed down and the capacity utilization of the remaining units is about 20-40%. In most cases they operate for only 3 to 4 months at the peak of the harvest season. Overall, about 50 to 70% of edible oil comes from the *ghanis* in rural India depending on the location and type of oilseed. Baby-expellers consist of a cylindrical cage in which a helical worm shaft runs by electric motor. The cage contains openings for the drainage of the expelled oil. The flake and cooked material, adjusted to a moisture content of 2% to 5%, is fed in at one-end and is subjected to increasing pressure by the screw, which expels the cake through a constricted opening at the far end of the cage. The improved baby-expellers have additional advantages, such as better quality oil and cake and fetch higher price and are readily marketable, low wear and tear of critical parts, higher energy efficiency and long life. The market share for expellers is much higher than it was previously, but there is still large scope for expansion. The baby-expellers with a 1-2 t/day capacity with extraction ratio of about 40% with single run as against 37% recovery in power-operated *ghanis* with multiple runs are more suitable in rural India. Baby-expellers are also preferred to large expellers (with 10 t/day capacity), as the latter are running under capacity (capacity utilization is only 33%) due to shortage of oilseeds to run throughout the year. The wider adoption of baby-expellers also meets the objective of decentralized rural industrialization and rural employment generation in the small scale sector.

Technical and Allocative Efficiency in baby-expellers and *ghanis*

The average annual capacity of *ghanis* and expellers is 26.8 t and 88.2 t, respectively (Table 6). The total operating cost is higher for expellers (Rs 303 thousand/annum), while it is Rs 90.3 thousand/annum for *ghanis*, with cost-benefit ratios of 1.43 and 0.93, respectively. The margin over costs is higher for expellers (Rs 4.9 thousand/t of groundnuts processed) than *ghanis* (Rs 3.1 thousand/t). A lower margin in *ghanis* is due to high labor charges, low throughput in peak season and high operating costs due to multiple runs of the raw material to increase oil recovery percentage. This clearly indicates the superiority of baby-expellers over *ghanis* in economic returns and operating performance. Net profit over variable costs/annum is also higher for expellers (Rs 362.9 thousand/annum) than *ghanis* (Rs 23.6 thousand/annum). However, net returns over total costs are negative for *ghanis*, which explains no new investments in *ghanis* over the past decade.

Mean Technical Efficiency (MTE) is very low in the processing sector at 41%; expellers are more efficient (63%) than *ghanis* (30%). The size, distance of groundnut markets, age of units and vertical/horizontal integration of processing units were important factors in determining the efficiency of processing units (Table 7). Besides the inefficiency, considerable allocative inefficiency exists in groundnut processing. Labor and electricity are under-utilized to the extent of 154% and 340%, respectively. It reflects underutilization of capacity as most of the units work only about 3-4 months a year due to the lack of available raw material (groundnuts) and the seasonality of groundnut production. However, some baby-expellers run more than 4 months per year, as they store the raw material for long periods depending on the availability of working capital. Therefore, there is a possibility for significant improvements in the productivity of groundnut processing units through better capacity utilization (increasing working days) and operating throughout the year. Shortages of raw materials can be addressed by increasing the area under the cultivation of groundnut and other non-conventional oil-bearing material like *jojoba* seeds and other oilseed crops like sunflower and mustard, both in rainy season and postrainy season, depending on suitability.

Table 6. Cost benefit analysis of processing firms.

Item	Baby Expeller	Ghanis
GN (t/annum)	88.2	26.8
Oil (t/annum)	35.3	9.9
Cake (t/annum)	52.9	16.9
Labor (Man days)	197	295
Electricity (kwh/annum)	13,230	5364
Depreciation, interest on working capital and other costs (Rs 1000/annum)	233.9	30.0
Total cost (Rs 1000/year)	303.1	90.3
Oil sale(Rs 1000/annum)	2893.0	813.7
Cake sale (Rs 1000/annum)	1217.2	388.6
GN cost (Rs 1000/annum)	3677.9	1118.4
NVA (Rs 1000/annum)	432.2	83.9
Extraction ratio	0.40	0.37
Margin (Rs 1000/t)	4.9	3.1
Profit over variable cost (Rs 1000/annum)	362.9	23.6
Profit over total cost (Rs 1000/annum)	129.1	-6.4
B/C ratio	1.43	0.93

Price of groundnut kernel: Rs 41.7 thousand/t, cake: Rs 23 thousand/t and oil: Rs.82 thousand/t.

Table 7. Technical efficiencies of oilseed processing units.

Type of unit	Mean Efficiency (%)
Type	
Expellers	63
Ghanis	30
Integration	
Yes	45
No	34
Distance from market	
< 5 Kms	54
> 5 Kms	35
Age of the unit	
< 5 Years	46
> 5 Years	35
All	41

Table 8. Cost benefit analysis of new investment in setting up baby (small scale) expeller.		
Cost benefits of new investments	Conversion of ghanis to baby-expellers	New baby-expeller
Fixed investment required (Rs 1000)	295.0	430.3
Break even period (years with 0% discount rate)	3.8	5.5
Internal Rate of Return (IRR) for 9 years of operation	20.5%	9.1%
Net Present Value NPV (Rs 1000) with discount rate of 8% per annum	142.4	17.1

These figures indicate that there is a considerable scope to increase efficiency of groundnut production and processing with existing technology. Overall, the study indicates that there is more opportunity to increase efficiency in processing units compared to groundnut production. There is evidence that units with less than five years of operation that are located near markets, and are integrated, are more efficient than their counterparts. Integration in terms of processing of other oilseeds/rice milling/ retail/wholesale marketing is widely practiced to fully harness available resources throughout the year through economies of scope. About 50% of the units reported this type of integration. This indicates the existence of scope economies among integrated firms and the sharing of common resources for different uses. Lack of financial capital necessary to adopt new technologies in small units is a more important barrier to technology adoption than any other reason in developing countries. The breakeven point for the new investment required to upgrade from *ghanis* to expellers is 3.8 years, while the breakeven point for investments to build the new baby-expeller is 5 to 6 years (Table 8). The Internal Rate of Returns (IRR) is 20.5% in the former case and only 9.1% in the latter case. Net Present Value for switch over from *ghanis* to baby-expellers is reasonably higher. Hence, switch over from *ghanis* to baby-expellers through technological upgradation with capital subsidies is the best and most economically feasible option in the short run, given the low and uncertain supply of groundnuts throughout the year. Further, baby-expellers should be integrated with other related activities like flour milling/ retail/wholesale marketing to improve efficiency and economies of scope in the long run.

Policy Implications

The competitiveness indicators show that groundnut kernel and groundnut cake are competitive, but groundnut oil is non-competitive during the post-WTO period. In groundnut production, varieties developed five decade ago, which are still popular among farmers, with less than optimal inputs, resulted in persistent higher level of yield gaps (about 300%) between research station and farmers, fields. Under uncertain rainfed conditions to bridge higher yield gaps, research and extension systems should focus on low cost technology with flexible, incremental approaches that take into account local resources and profitability for wider adoption of recommended technology instead of focusing on maximizing yield. Even though efficiency in groundnut production is about 71%, the current level of efficiency can be further improved by replacing the dominant old varieties like TMV-2 (still occupy more than 85% of area) in the study area with new proven drought tolerant varieties like ICGV 91114. During the post-WTO period (since 1995), the protection to oilseed sector reduced significantly with the reduction of import tariffs, and reduction in emphasis on R&D expenditure resulted in low productivity growth and failure of yellow revolution mid-way. To harvest fruits of any R&D effort like Technology Mission on Oilseeds (TMOs), the sector needs higher level of protection and support over a reasonably long period so that R&D efforts reach farmers and diffuse to a reasonably wider geographical area, so that they are self-sustained even after the withdrawal of protection. To up-scale new seed varieties, proper incentives need to be provided to seed production, distribution agencies and farmers for replacement of old varieties with new varieties on farmers' fields.

The efficiency in groundnut processing is staggeringly low (only 41%) compared to other industries in India (Majumdar 1998). The mean efficiency of *ghanis* (traditional small-scale village level units, which are numerically large in number in the edible oil industry) is 30%, which is significantly lower than baby-expellers (63%). The co-existence of inefficient *ghanis* along with more efficient expellers in rural areas may be due to the lack of short-run flexibility needed to convert *ghanis* into baby-expellers due to higher adjustment costs. The processors have to wait for 3.8 years to breakeven for the investment incurred from converting *ghanis* into baby-expellers. The breakeven period for installing a new expeller is about 5 years. The Internal Rate of Returns (IRR) for installing a new baby-expeller is below the opportunity cost resulting in no new investments in the expeller industry for a long period. Small-scale operators cannot wait for such a long breakeven period. Hence, to increase efficiency in the processing sector, small processors require capital subsidies upfront to finance fixed costs in installing expellers. Small processors also require huge working capital to store the groundnuts/ other oilseeds needed to run the units beyond 3-4 months after harvest period. The ongoing government programs including ISOPOM largely concentrated on oilseed production with little emphasis on the processing sector, which needs to be corrected. As the efficiency of groundnut processing units substantially increases with bulk market arrivals in the nearest markets and market size, one way to address the optimum market size is the development of oilseed clusters with best transport and infrastructure facilities (which will encourage groundnut along with other oilseed crops like sunflower/ mustard) to reduce transaction costs for both farmers and processors. This will also increase year-long availability of raw material in sufficient quantity to run processing units with full capacity in the long run. The development of clusters will also facilitate contract farming, which will promote wider adoption and diffusion of improved varieties with desirable quality traits like high oil content preferred by processing sector and high-end consumers (Reddy 2011). This also increases the scale and scope economies and profitability of processing sector, and also reduces breakeven time for installing expellers and attracts new investment in the sector.

Essential policy action points emerge from the study; first, there is a need to replace old varieties like TMV-2 and JL-24 with improved varieties like ICGS 11, ICGS 44, ICGV 91114, Narayani and K 6, which are characterized by high productivity, drought tolerance and also with high oil content. This can be done by providing sufficient incentives to both public and private seed production and distribution companies. The seed production and distribution requirements and subsidy are to be considered for the seeds of the varieties/ hybrids in consultation with ICRISAT/ICAR, keeping the yield potential and suitability in mind. Second, seed multiplication at farmers' fields as well as both public and private seed companies needs to be encouraged in rabi/summer season to meet the seed requirements of kharif season and *vice versa* to maintain viability and germination % of the seeds. Third, there is a need to encourage oilseed production in clusters; this would facilitate diffusion of newly released high yielding varieties (through seed networks) and increase scale economies in small farm holdings. Fourth, economies of scale and scope in processing units may be induced through enhanced capacity utilization by encouraging growing of off-season oilseeds and other oilseed crops in identified oilseed clusters to make processing competitive. Fifth, need to give capital subsidies to switch over from *ghanis* (which are numerically large in number with low efficiency) to baby-expellers (which are technologically and economically more efficient) to accelerate technological upgradation and shed inefficiency in the processing sector. This is also in line with the broader national objective of decentralized rural industrialization and employment generation, instead of promotion of a few large-scale oilseed processing units with lower capacity utilization. The gains in efficiency in both production and processing of oilseeds will ultimately reduce domestic prices of edible oils for consumers (Brennan and Bantilan 2003) and also increase competitiveness and reduce surge in large scale import of edible oils, which will justify non-market distorted seed subsidy to seed production and distribution companies and capital subsidy to processing units.

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