Strategy Paper

The Indian Oilseed Scenario: Challenges and Opportunities

by

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Progress Through Science

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Progress Through Science

Trust for Advancement of Agricultural Sciences (TAAS)

GOAL

An accelerated movement for harnessing agricultural science for the welfare of people.

MISSION

To promote growth and advancement of agriculture through scientific interactions and partnerships with stakeholders.

OBJECTIVES

- To act as think tank on key policy issues relating to agricultural research for development (AR4D).
- Organizing seminars and special lectures on emerging issues and new developments in agriculture.
- To institute national awards for the outstanding contributions to Indian agriculture by the scientists of Indian and other origin abroad.
- Facilitating partnerships with non-resident agricultural scientists visiting India for short period.

THE INDIAN OILSEED SCENARIO : CHALLENGES AND OPPORTUNITIES[1]

R.S. Paroda
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1. PREAMBLE

It is indeed a great privilege to be the first speaker in the newly instituted **Dr. M.V. Rao lecture series** by the Indian Society of Oilseeds Research. While thanking the office bearers of the Society, let me congratulate them for having taken this initiative to honour one of the most renowned agricultural scientists, with whom I have had a long association since my student days at Post Graduate School, IARI. He has been my role model, from whom I have learnt a great deal. We, the crop scientists, should be proud of the enormous contributions of Dr. M.V. Rao towards food security in India. All through his life, Dr. Rao has been a great crusader aiming to improve the lives of resource poor farmers.

For this lecture, I have chosen the subject **"Addressing Emerging Concerns of Indian Agriculture"**, whereas this paper published for circulation is mainly on the oilseed production scenario and strategy to improve productivity and long-term self-sufficiency in oilseed sector.

Vegetable oils are critical for the nutritional security of our people in India. Through technological means such as refining, bleaching and deodorisation, newer oils like cotton seed, sunflower, palm oil, soybean and rice bran have become popular in recent times. India occupies a prominent place in global oilseeds scenario with 12-15 per cent of area, 6-7 per cent of vegetable oil production, and 9-10 per cent of the total edible oil consumption and 13.6 per

[1]Delivered as the first Dr. M.V. Rao Lecture organized by the Indian Society of Oilseeds Research on 24th August, 2013 at DOR, Hyderabad.

cent of vegetable oil imports. The oilseeds sector has remained vibrant globally with 4.1 per cent growth per annum in the last three decades. In India, oilseeds account for nearly 3 per cent of the gross domestic product and 5.98 per cent of the value of all agricultural products. India has rich diversity of annual oilseed crops on account of diverse agro-ecological conditions. Nine annual oilseeds, which include seven edible oilseeds, *viz.*, groundnut, rapeseed-mustard, soybean, sunflower, sesame, safflower and niger and two non-edible crops, *viz.*, castor and linseed are grown in the country. Despite having the largest area under oilseeds in the world (26.77 m ha), India currently imports about 50 per cent of total oil requirement at a huge cost of Rs.56,000 crores (2011-12). The proportion of import has increased from a meagre 3 per cent in 1970-71 to almost 56 per cent in 2012-13.

2. PRODUCTION SCENARIO

India attained an average productivity of 1,087 kg per hectare for the triennium ending 2012-13. The average yields of most of the oilseeds are invariably low (Table 1).

Table 1. Oilseeds productivity (kg/ha) in India *vis-a-vis* World (2012)

Crop	India	World	Country with highest productivity*
Groundnut	1179	1676	4699 (USA)
Rapeseed-Mustard	1140	1873	3690 (Germany)
Soybean	1208	2374	2783 (Paraguay)
Sunflower	706	1482	2494 (China)
Sesame	426	518	1315 (Egypt)
Safflower	654	961	1489 (Mexico)
Castor	1455	1162	1455 (India)
Linseed	260	752	1358 (Canada)
Oil palm fruit	12380	14323	21901 (Malaysia)

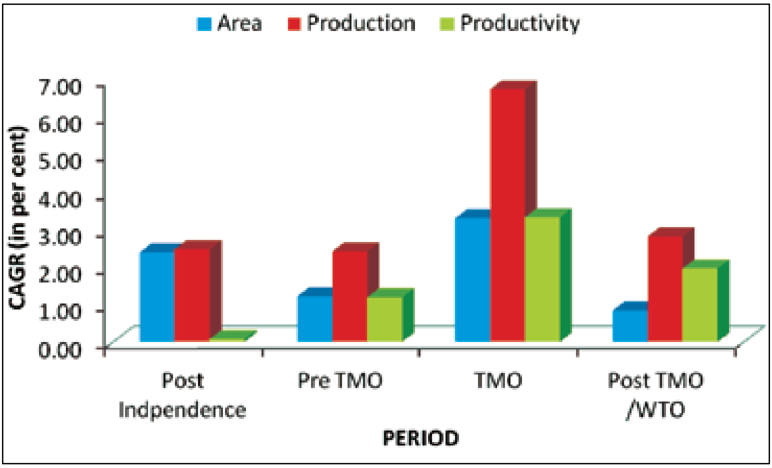
(Source: FAOSTAT, 2012)* from among the countries with >80% global contribution

The cultivation of oilseeds in the rainfed areas (72%), in varying agro-climatic regions, with uncertain returns on investment, are the major factors for low productivity.

The production scenario of vegetable oilseed sector in the country can be categorized into four periods, *viz.*, i) Post Independence (1950 - 1966), ii) Coordinated Research Program (1967 - 1985), iii) Technology Mission (1986 - 1996) and iv) Post-Mission (1996-97 till date).

i) Post Independence Period

This period witnessed mainly an area expansion by five million hectares from 10.73 million ha in 1950-51 to 15.25 million ha in 1965-66 with production of 5.16 and 6.40 million tonnes, respectively for the aforesaid periods. The area increased by 32 per cent while the production increased by 34 per cent with negligible gain in productivity levels, although this period witnessed the release of 40 improved cultivars. The Compound Growth Rate for the period from 1950-51 to 1965-66 indicated that area increased by 2.38 per cent, whereas the production



Post independence = 1950-51 to 1965-66; Pre TMO = 1966-67 to 1985-86; TMO = 1986-87 to 1995-96; Post TMO = 1996-97 to 2012-13

Fig. 1. Compound growth rates on annual oilseeds in India

increased by 2.46 per cent. The growth rate of productivity was a meagre 0.07 per cent (Fig. 1).

ii) Coordinated Research Program Period

Research on oilseeds got an impetus after the establishment of the All India Coordinated Research Project on Oilseeds (AICORPO) in 1967. This project strengthened the base for the development, verification and adoption of location specific technologies for increased productivity, especially the new varieties and hybrids. This period witnessed massive structural reforms in the national network in oilseeds. The area, production and productivity increased by 18, 41 and 19 per cent, respectively for the quinquennium ending 1971-72 as against 1985-86. The annual growth rates registered during the period 1967-68 to 1986-87 was 1.21, 2.41 and 1.19 per cent for area, production and productivity, respectively (Fig. 1). The period also witnessed release of 153 varieties of Oilseeds.

iii) Technology Mission Period

Technology Mission on Oilseeds was initiated by the Late Prime Minister Shri Rajiv Gandhi in May 1986, with very ambitious objectives of (a) self-reliance in edible oils by 1990 (b) reduction in imports to almost zero by 1990 and (c) raise oilseed production to 18.0 million tonnes by 1989-90 and 26.0 million tonnes of oilseeds and 8.0 million tonnes of vegetable oil by 2000 AD. Thrust was given on the main oilseed crops in selected 180 districts in 17 states which contribute the maximum quantity of oilseeds to the nation. The scope of the Mission and strategies to be adopted to achieve the objective were set well before the onset of the Mission in February 1986, which is elaborated in the excerpts from the then Prime Minister's speech quoted below:

"One of our biggest problems today in the agricultural sector is oilseeds. We are setting up a thrust Mission for oilseeds production. When we talk of a Mission, we mean an exercise starting from the engineering of the seeds and finishing with the finished products of the vegetable oil (and the by-products like oil meal) which could be delivered to the consumer. We would

like to put one person in-charge of such a Mission with full funding, with no restrictions on him, whether bureaucratic or otherwise. The only limits will be certain achievements which must come within a certain time frame. This will cut across a number of ministries…"

This one person in-charge at that time was none other than Dr M.V. Rao

The mission started functioning as a consortium of concerned Govt. departments, viz., Agricultural Research and Education (DARE), Agriculture and Cooperation (DoAC), civil Supplies (DoCS), Commerce (DoC), Science and Technology (DST), Biotechnology (DBT), Planning, Health, Irrigation and Economic Affairs. The Mission adopted a four-pronged strategy under the following Mini-Missions.

Mini-Mission-I: Improvement of crop production and protection technologies for realizing higher yields and profit to farmers.

Mini-Mission-II: Improvement of processing and post harvest technology to minimize the losses and increase the oil yield from both traditional and non-traditional sources of oil.

Mini-Mission-III: Strengthening the input support system to ensure availability of right kind of seeds, fertilizers, pesticides, irrigation, credit, etc. and to bring awareness among farmers about the potential of the farm worthy technology through massive transfer of technology programmes.

Mini-Mission-IV: Improvement of post-harvest operations for effective procurement, handling, disposal including price support system to farmers, financial and other supports to processing.

The constitution of Technology Mission on Oilseeds (TMO) in 1986, spearheaded by Dr M.V. Rao, resulted in the country's oilseed production surpassing the target of 18 mt, fixed for the Seventh Five-Year Plan with an impressive annual growth rate of nearly 6 per cent in the short-run. Thanks to TMO, the import got reduced to almost negligible. Hence, India achieved near self-sufficiency in edible oils during early 1990s, which was popularly referred to as ‘Yellow Revolution”. The growth rate in the *per capita* edible oil consumption during this period was 3.66 per cent with an average *per capita* consumption of 6 kg per annum. The increase in the *per capita* consumption *vis-à-vis* the previous period was 54 per cent.

As a result of concerted efforts under TMO, a quantum jump in oilseeds production from 108.3 lakh tonnes (1985-86) to 247.5 lakh tonnes (1998-99) was made possible through effective coordination among different Ministries, Departments and Organizations like ICAR and SAUs under the able leadership of Dr M.V. Rao. The latter developed high yielding varieties with disease and insect resistance suited to various agro-climatic conditions. Ministry of Agriculture provided needed support for timely supply of inputs like seed and propagation of production technology through State Extension Services, arranging credit facilities, marketing and processing, storage and price support, etc. It is overwhelming to record that the area under oilseed cultivation increased from 190 lakh ha (1985-86) to 260 lakh ha (1996-97) and production increased from 108.3 to 243.8 lakh tonnes during just one decade, registering an increase of 36 per cent in area and 125 per cent in production. Similarly, productivity of all the annual oilseed crops, on an average, increased from 570 to 926 kg/ha, being an increase of 62 per cent during this period. This golden era witnessed the release of 200 varieties and hybrids and performance of improved crop technologies under real farm situations, leading to significant improvements both in yield and profits to the farmers. As a result, India achieved a status of ‘self sufficient and net exporter’ during early nineties, rising from the ‘net importer’ state. At the same time, the imports declined from Rs. 700 crore in 1985-86 to Rs.300 crore in 1995-96.

iv) Post Mission Period

The other dominant feature which has had significant impact on the present status of edible oilseeds/oil industry has been the program of liberalisation under which the Government’s economic policy allowed greater freedom to the open market through open general licensing (OGL) and encouraged healthy competition and self regulation rather than protection and control. Controls and regulations thus got relaxed resulting in a highly competitive market dominated by both domestic and multinational players. At the same time, the increasing *per capita* income led to enhanced consumption of edible oils. The gap between the domestic production and the requirement became widened at an alarming rate. This completely eroded the gains that the country had achieved during the TMO period (Fig. 1). In addition, the increasing biotic and abiotic stresses, strong intervention of market and non-market forces led to a sticky domestic oilseeds production and profitability.

Despite the above developments, performance of oilseeds on the domestic front during the last two decades has been commendable, considering the adverse weather conditions, the global price aberrations and the ever increasing domestic demand. The growth rate of nine edible oils during 2000-01 to 2011-12 *vis-a-vis* 1990-91 to 1999-2000 did provide a fillip for consolidation and revitalization of oilseed economy (Fig. 2). Although enhanced growth rates of 5.94 per cent were

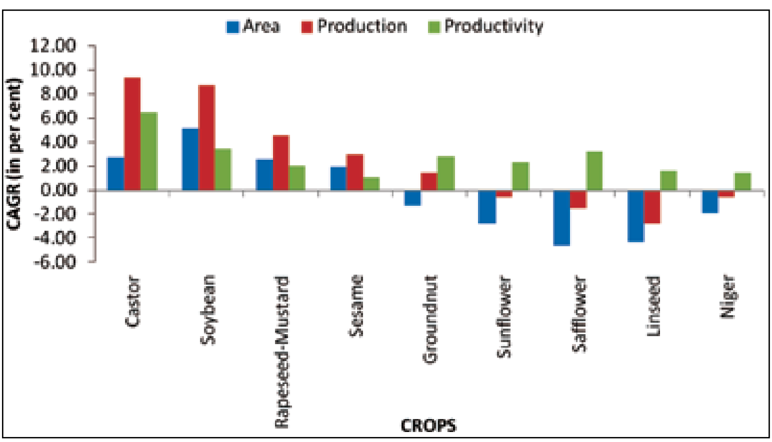


Fig. 2. Compound Growth Rates of Annual Oilseed crops in India (2000-01 to 2011-12)

evidenced on the domestic availability of edible oils for the period ending 2011-12, it could not match the rate of growth of imports of edible oils which was 6.99 per cent. The *per capita* consumption of edible oils grew at a rate of 5.65 per cent. Growth analysis of individual oilseed crops during the decade 2000-01 to 2010-11 suggests that there has been acceleration in area under soybean, rapeseed-mustard and sesame while stagnation/ deceleration has been observed in groundnut, sunflower, niger, safflower and linseed. The growth in area under castor crop, although marginal, resulted in production enhancement through considerable productivity improvement.

The trend of vegetable oils production over the years did help to a considerable extent in reducing imports (Table 2). On the contrary, the Government policy allowed greater freedom to open market and encouraged healthy competition rather than protection or control.

Table 2. Domestic production, imports, *per capita* consumption and self-sufficiency in edible oils in India

Year	Edible Oil (lakh tonnes)	Imports (lakh tonnes)	*Per capita* Consumption (kg/annum)	Self-sufficiency (%)
	a	b	c	D
1986-87	38.7	14.7	6.2	72
1990-91	63.7	5.3	6.5	92
1994-95	71.9	3.5	7.3	95
1998-99	70.0	26.2	9.8	73
2002-03	51.5	43.6	8.8	53
2006-07	80.0	42.7	11.2	65
2007-08	91.4	49.0	12.2	65
2008-09	89.9	67.2	13.5	57
2009-10	82.3	81.2	14.1	51
2010-11	97.8	72.4	13.6	57
2011-12	90.2	99.4	13.8	48

3. DEMAND, IMPORT AND EXPORT SCENARIO

i) Demand Projections

The domestic demand for vegetable oils and fats has also been rising rapidly at an increasing rate due to increase in per capita income and increase in standard of living. Thus, annual demand is increasing at the rate of 6 per cent while our domestic output has been increasing at just about 2 per cent.

The average per capita consumption of edible oils was 3.66 kg / per annum which was much less than the norms prescribed by ICMR/ WHO, with a growth rate of 5.01 per cent. Import bill began to increase at an alarming rate of almost 25 per cent from Rs.31.3 crores to Rs. 692 crores for the triennium ending 1985-86. On the export scenario of edible oilseeds and the products, the rate of growth was a meagre four per cent from 1970-71 to 1985-86 with the export earnings being Rs. 101 and 138 crores for the trienniums ending 1973-74 and 1985-86 respectively. Systematic efforts were made to increase the domestic production of oilseeds, reduce the import bill, and to make the country self-reliant as early as possible in vegetable oils during early eighties through the National Oilseeds Development Project (NODP). There was a visible effect of the measures taken but was not enough to curtail the import bill. Need for a special purpose vehicle to increase the domestic production of edible oilseeds, to combat the swelling imports of edible oils was felt. This paved the way for the genesis of the Technology Mission on Oilseeds in the year 1986.

Vegetable oils do provide much needed food security measured in terms of calorie requirements for our poverty assessment. Rapid growth of food demand in the developing countries, in conjunction with the high calorie content of oil products, has contributed to the increased calorie consumption in developing countries. One out of every four calories added to the consumption in developing countries originated in this group of products. In future, vegetable oils are likely to retain, and indeed strengthen, their primacy as major contributors to further increases in food consumption of the developing countries: Three decades ago, 136 kcal/person/

day or 6.5 per cent of the total availability of 2110 calories were contributed by oil products in the developing countries. Oil consumption per capita had grown to 10.4 kg by the year 2000, contributing 272 kcal to total food supplies, or 10 per cent of the total 2650 kcal consumed. Average per capita consumption of edible oils for the period 2002 to 2012 rose to 29.4 g/day (10.7 kg from edible oils and 1.2 kg from vanaspati). Increase in average per capita consumption of the edible oils was 5.25 per cent during the period. The consumption levels of edible oils are beginning to increase to alarming levels as against the recommended 30g per day to meet average physiological needs.

The demand for vegetable oils is both income and price elastic. Demand for food grains is constant and stable and can only meet the population growth, whereas demand for vegetable oil increases with increase in population, increase in standard of living (income) and increased use for industrial, pharmaceutical, nutraceutical, cosmetic purposes (Fig. 3).

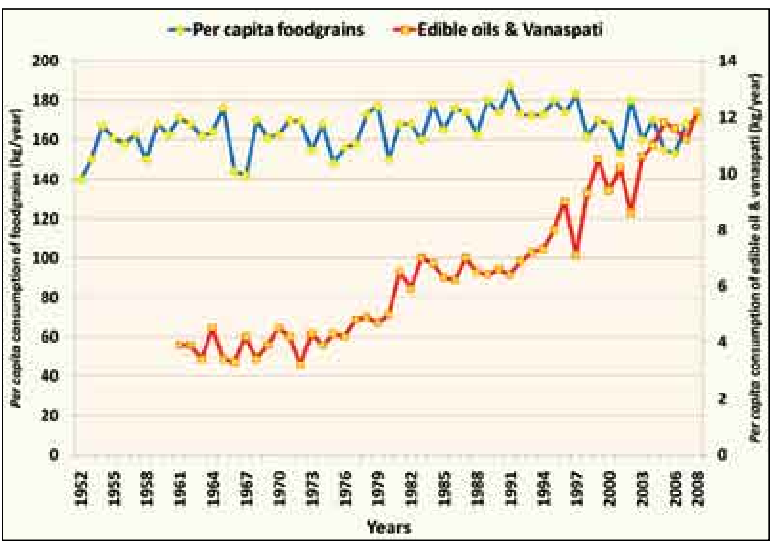


Fig. 3. *Per capita* consumption of food grains and edible oils

(Source: Various issues of Five year Plan Documents, Min. of Finance, DGCIS and Economic Survey, GOI)

Thus, the vegetable oil consumption trends for vegetable oils continuously increases at increasing rate (Fig. 4).

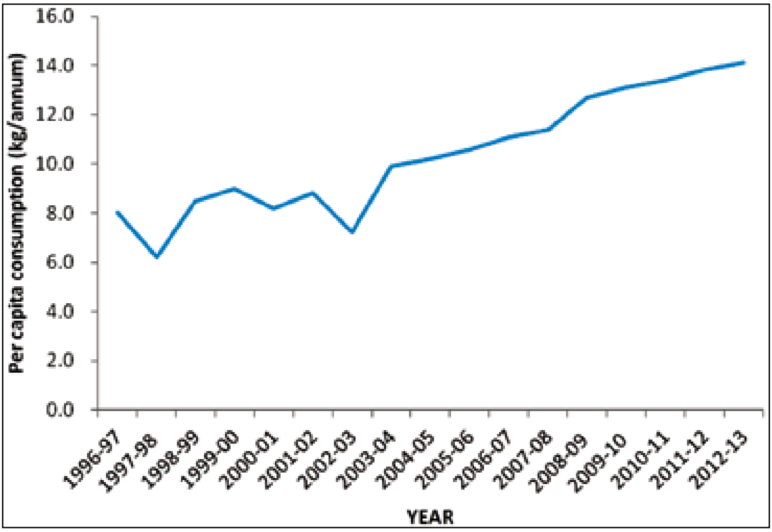


Fig. 4. Trends in *per capita* consumption of edible oils in India

(Source: Various issues of Five year Plan Documents, Min. of Finance, DGCIS and Economic Survey, GOI)

Taking into consideration a host of factors viz., domestic production, import dependency, trade buoyancy, pattern of per capita consumption, changes in dietary standards, growing trend of out-of-house consumption, the swiftly rising demand for vegetable oils for non industrial uses and production of biofuel; the projections have been made for the Indian vegetable oilseeds. The projections are based on the assumptions that the per capita consumption would be increasing annually at 3 per cent till 2015, followed by an increase at a declining rate of 2.5 per cent from 2015 to 1.75 per cent in 2020, with a further decline in the incremental consumption to negligible levels by the year 2050. The estimated per capita consumption is accordingly placed at 16.43, 17.52, 18.62 and 19.16 kg/annum for the year 2020, 2030, 2040 and 2050, respectively.

A newer dimension of vegetable oil requirement for industrial use is estimated to grow by 15 per cent in 2020, 20 per cent in 2030 and 25 per cent post 2040, thus requiring around 3.57, 6.34, 9.69 and 10.61 million tonnes in 2020, 2030, 2040 and 2050 respectively (Table 3). The Indian trade industry, therefore, predicts much greater expansion. The total vegetable oil requirement is thus estimated at 25.26, 29.47, 34.27 and 35.90 million tonnes during 2020, 2030, 2040 and 2050, respectively, which is a gigantic task for the country to increase its domestic production. The contribution of vegetable oil availability from secondary sources including arboreal tree species (20 per cent) is estimated at 5.05, 5.89, 6.85 and 7.18 million tonnes during 2020, 2030, 2040 and 2050, respectively. Thus, the total domestic vegetable oilseeds requirement from nine annual oilseed crops is estimated at 67.37,

Table 3. Demand Projections of Vegetable Oils in India

	2020	2030	2040	2050
Projected population (billion)	1.32	1.43	1.55	1.68
Per capita consumption considering 50, 60, 70 and 75 per cent above the prescribed consumption levels during 2020, 2030, 2040 and 2050, respectively				
Per capita consumption (kg/annum)	16.43	17.52	18.62	19.16
Vegetable oil requirement for direct consumption (million tonnes)	21.69	23.13	24.58	25.29
Vegetable oil requirement for non industrial use (million tonnes)	3.57	6.34	9.69	10.61
Total vegetable oil requirement (million tonnes)	25.26	29.47	34.27	35.90
Vegetable oil availability from secondary sources (million tonnes)	5.05	5.89	6.85	7.18
Total vegetable oil requirement from annual oilseed crops (million tonnes)	20.21	23.58	27.42	28.72
Total vegetable oilseeds requirement from nine annual oilseed crops (million tonnes)	67.37	71.45	80.65	82.06

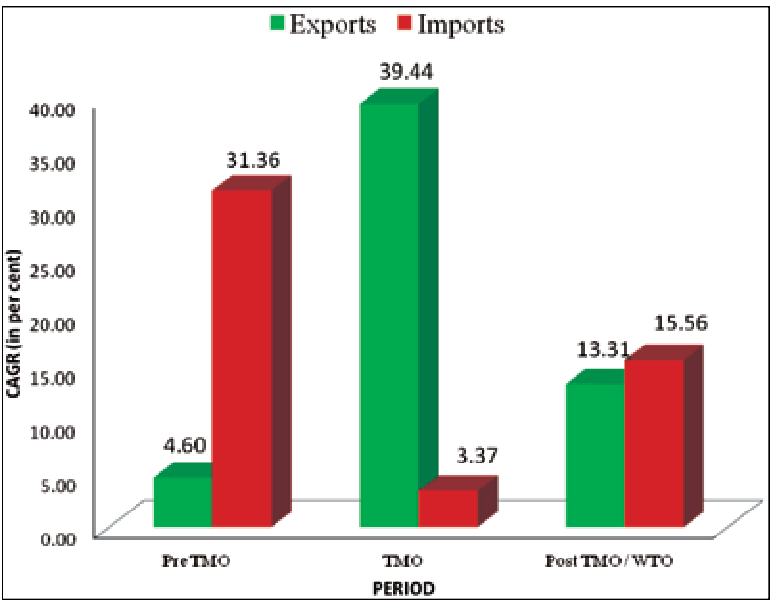
71.45, 80.65 and 82.06 million tonnes by 2020, 2030, 2040 and 2050, respectively. As per the population estimates, the Indian middle-class population is expected to touch one billion over the next two decades. The middle class population would be the major consumer of edible oils in the country. Further, the urban population in the country is increasing by more than 3 per cent annually. The report by McKinsey Global Institute predicts that 590 million people or 40 per cent of India's population will live in cities by 2030, up from 340 million today. This would have tremendous effect on increased consumption of edible oils, looking down to the social status and the size of the strata to the total population in the country. Higher economic growth and concomitant rise in incomes, coupled with change in tastes and preferences in both urban and rural areas are expected to increase the demand for high-value commodities, especially the edible oils.

ii) Import Situation

The success of Technology Mission on Oilseeds was evident from the drastic doubling of the oilseeds production and reduction in import during the triennium ending 1993-94. Except for this period, there has always been a large gap between the domestic demand and production. After China, India is the world's largest importer of vegetable oil. Besides meeting the shortfall in production, to check the inflation, state owned trading companies started increasing their overseas purchases. To aid the process and for consumer protection against price rise, in the year 2005, import duty was raised on crude palm oil/crude palmolein from 65 per cent to 80 per cent and on refined palm oil/RBD palmolein from 75 per cent to 90 per cent. Subsequently, in August 2006, the import duty was reduced on crude palm oil/crude palmolein from 80 per cent to 70 per cent and on refined palm oil/RBD palmolein from 90 per cent to 80 per cent. In the year 2007, the custom duty on crude and refined palm oil/palmolein was further reduced to 45 per cent and 52.5 per cent, respectively. The custom duty on crude as well as refined sunflower oil was further reduced to 40 per cent and 50 per cent, respectively. In 2008, the custom duty on all major crude and refined oils was reduced to 'Nil' and 7.5 per cent, respectively.

In 2008-09, the Government of India introduced a scheme of distribution of up to 10 lakh tonnes of imported edible oils. Four Public Sector Undertakings (PSUs), namely, Projects Equipment Corporation (PEC), Minerals & Metals Trading Corporation (MMTC), State Trading Corporation (STC) and National Agricultural Corporation Marketing Federation (NAFED) were entrusted the job of import, refining, packing and distribution of subsidized edible oils to the states. The scheme continued from August 2009 to October 2010 for import of 10 lakh tonnes of edible oils with a subsidy of Rs. 15/- per kg. The scheme is believed to have helped to soften the prices of edible oils in the domestic market, but on the contrary, raised import bill significantly, which now touches almost 56,000 crores annually.

The cascading effect of the "Yellow Revolution" was also evident in the balance of payments scenario. There was a complete reversal

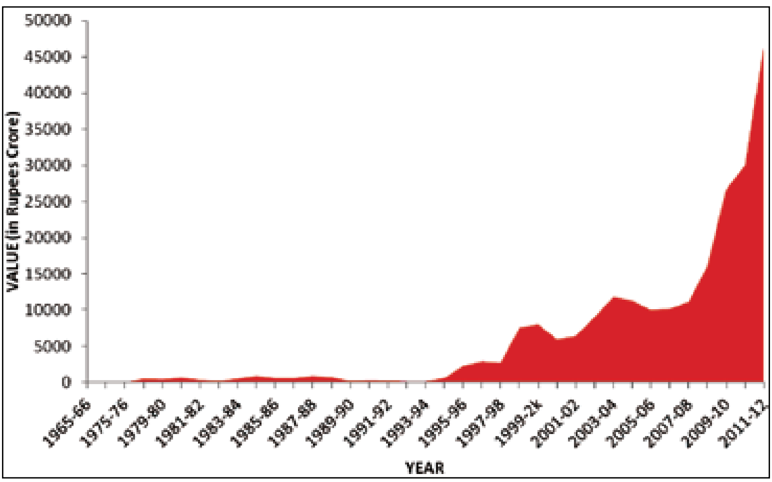


Pre TMO = 1966-67 to 1985-86; TMO = 1986-87 to 1995-96; Post TMO = 1996-97 to 2012-13

Fig. 5. Compound annual growth rates of exports and imports of oilseed/oilseed products (%)

in the dependency on imports and the country was close to reaching self sufficiency in oilseeds. The globalization/WTO era failed to consolidate the gains achieved during the TMO period (Fig. 5) due to operationalization of market/non market forces in addition to biotic/abiotic problems.

As stated above, the country is meeting now more than 50 per cent of its oil requirement through imports resulting in huge drain on our foreign exchange (Fig. 6). The current import bill is around Rs. 56,000 crores annually, which is indeed phemenonally higher than in the past.



Pre TMOP period **TMO Period** **Post TMOP period**

Fig. 6. Imports of oilseeds and oilseed products (Rs. Crore)

(Source: Various issues of Economic Survey, Govt. of India)

iii) Export Trend

On the other hand, India made excellent inroads through export of oil meals and castor oil to the tune of Rs. 23,000 crores thus plugging almost 50 per cent of the import bill. The advantage of exports can further be consolidated with proper policy back-up and value addition. Overall trend of vegetable oilseeds and their products export as well as import has been increasing since 1987 except for a brief period in mid 1990's (Fig. 7).

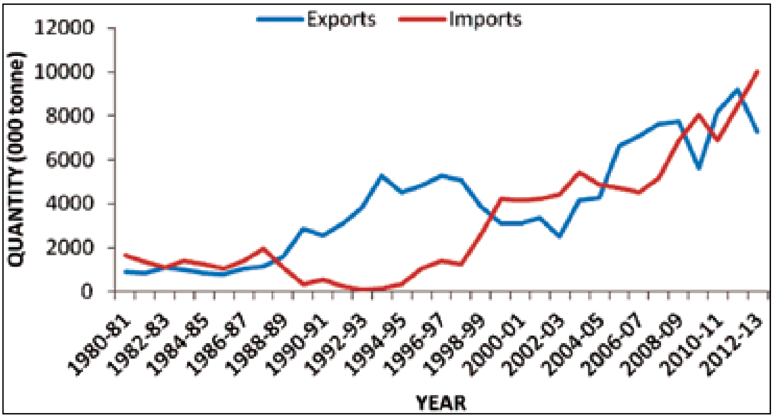


Fig. 7. Trends in quantities of exports and imports of edible oilseeds and products

(Source: Various issues of Five year Plan Documents, Min. of Finance, DGCIS and Economic Survey, GOI)

4. FUTURE ROAD MAP

I. Policy Issues Needing Perspective Changes

The Government of India, in compliance with the requirements of WTO Agreements, and to meet the domestic demands of vegetable oils, took certain decisions during 1994-2000, opening flood-gates to oil imports, which were available at cheaper prices. Edible oils, except coconut oil and palm oil, were placed under Open General License (OGL). The import duty was reduced in steps, from 65 to 15 per cent. The resulting heavy imports of edible oils led not only to vast drainage of foreign exchange but reflected cascading effect on Indian oil economy. There was a crash in the domestic prices causing serious impact on Indian oilseed industry with considerable disincentive to the oilseed farmers. A major concern for the policy planners is the fact that domestic prices of oilseeds and vegetable oils are not remunerative to enthuse farmers for increasing oilseeds cultivation. The uncertainty is also due to non-implementation of Minimum Support Prices due to lack of procurement policy. The fluctuating and counter directional policies with respect to imports and domestic prices have left the stakeholders unsure of any long-term planning by both producers and processors, which ultimately hurts the national interest. It is obvious that we need forward looking policies on mitigation of various kinds of risks in oilseed production efficiency and profitability to ensure healthy oilseed economy. All options for risk mitigation like timely availability of inputs and credit, MSP and procurement crop insurance long-term policy, linking farmers to market, buffer stock options, and other commodity price stabilization schemes, etc. need to be put in place for oilseeds sector as a matter of priority.

II. Trade-related Policy Initiatives

Import policy has played a key role in determining the overall level and type of India's edible oil imports for decades. The Government of India, with a view to meet the demand of edible oils and to control the rise in prices, has been allowing import of edible oils. In pursuance of the policy of liberalization, there have been progressive changes in the import policy in respect of edible oils during the past few years. Edible oils, which were on the negative list of imports, were first dechannelized partially in April 1994 with permission to import edible vegetable palmolein under OGL at 65 per cent duty. This was followed by enlarging the basket of oils under OGL import in March 1995, when all edible oils (except coconut oil, palm kernel oil, RBD palm oil and RBD palm steering), were brought under OGL import at 30 per cent duty. The duty was then further reduced to 20 per cent plus two per cent surcharge in the regular budget for the year 1996-97. The balancing act of the government to protect the interests of domestic oilseeds growers, consumers and processors and to regulate large imports of edible oils to the extent possible, the duty structure on edible oils has been getting revised frequently since 1994.

India was pursuing the policy of Import Substitution Industrialization (ISI) strategy until 1994-95, under which the oilseed/edible oil sector was protected through quantity restrictions (QRs). All imports of edible oils and oil meals were totally channelized through STC and the Hindustan Vegetable Oils Corporation (HVOC), which remained limited to the packaging of oils and channelling to the state governments for sale through the Public Distribution System (PDS).

It may be recognized that ISI strategy pursued until 1994-95 delivered significant benefits to the Indian economy. India was able to transform from a deficit to a virtually self-sufficient state in edible oils by the early 1990s. India has become a major exporter of oilseed meals, especially soymeal, a high-protein animal feed for which demand is increasing in the global markets. In fact, exports of oilseed cakes, the production of which exceeds domestic demand, were promoted by a variety of export incentive schemes established by GOI throughout the 1980s and early-1990s in an effort to generate foreign exchange. The exports of oil meals gained substantially, both in volume and share, because of the increasing demand for Indian oil meals in world market, which is mainly flooded with oil meals of genetically modified (GM) oilseeds. Indian oil meals command a premium because of its non-GM nature. Soymeal export is currently of US $2 billion annually. It is worth mentioning that the growth in the livestock industry will be a major force driving future demand for oil cakes with high income elasticity of demand for milk and milk products, meat, eggs, fish, etc. The accelerating growth in income will be a major factor for boosting domestic demand for livestock products in future, which in turn would promote a large scale shift towards improved animals or crossbreeds, including improved management and feeding practices (e.g. feed stalling for dairy).

III. Support Price

Unlike food crops, oilseed crops are grown solely for economic benefit and the growth in oilseed crops occurs when they have an edge over the competing crops, in terms of profitability. Under the harsh growing conditions faced by Indian agriculture, oilseeds have a clear edge over many minor millets and pulses in terms of higher productivity. However, increase in cultivable area under oilseeds largely depends on higher profitability. Unfortunately, the support price declared each year by the Government of India is evidently in clear favour of rice and wheat compared to oilseeds mainly on account of food security considerations (Fig. 8). Similar consideration for oilseeds is therefore, warranted.

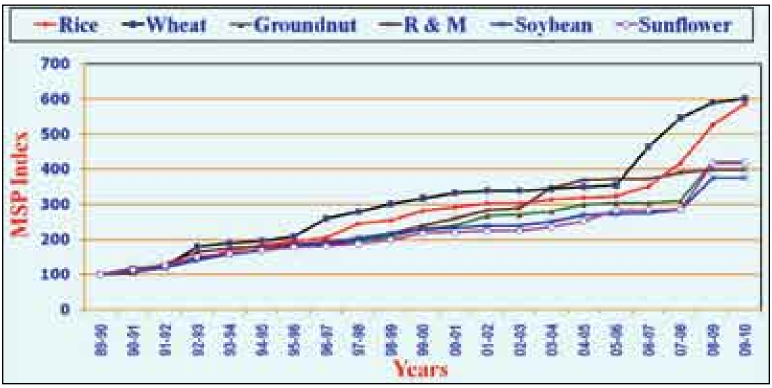


Fig. 8. Minimum support price of different crops in different years

(Source: Commission of Agricultural Costs and prices, GOI, New Delhi)

Given the fact that input prices across crops remained the same, the relative prices should have been accordingly adjusted. On the contrary, the MSP index analysis clearly indicated that it mainly favoured wheat and paddy against pulses, coarse cereals and oilseeds. Over and above the relative discrimination in MSP for oilseeds, there was no mechanism for implementation of MSP without assured procurement. Hence, most of the times the wholesale prices were much lower than MSPs and the farmers were left at the mercy of the market forces to dispose the produce for the commodity that had no direct utility at farm level. During TMO period, there was effective implementation of MSP through NDDB that gave confidence to farmers about the minimum expected returns. It, therefore, fortifies revival of an institutional mechanism to implement MSP effectively for reaping the benefits by oilseed growers.

IV. Need for Institutional Linkages

The research, development and technology dissemination infrastructure existing in the country for oilseed crops is the legacy of the past policies and interplay of public and private interest in the sector. Apart from the institutions as such, some institutional support programmes (National Dairy Development Board (NDDB), National Agricultural Marketing Federation (NAFED) and the flagship programme of the government in oilseed sector; Integrated Scheme on Oilseeds, Pulses, Oilpalm and Maize (ISOPOM) have been tried in the past. These programs need to be studied for understanding their significance and impact so that efficient and functional institutional support is provided in future for the required growth of oilseeds sector. It must be recognized that the core strength for the success of technology mission on oilseeds was due to effective dovetailing and coordination among institutions linked with production, processing, input supplies, trade and pricing. Some systems need to be revisited again to give much needed push to oilseeds sector.

V. Eco-regional Approach for Productivity Enhancement

The concept of eco-regional approach can effectively be utilized for the oilseed crops. It refers to the practice of delineating efficient zones for specific crops for realizing potential yields with high input-use efficiency. Supporting services like input supply, marketing and processing have to be linked to these ecological zones besides strengthening research and extension systems and infrastructural facilities. The importance of crop ecological zoning in oilseeds is evidently based on following facts:

- 4 districts contribute 33 per cent of groundnut area
- 4 districts contribute 37 per cent of sunflower area
- 9 districts contribute 31 per cent of mustard area
- 12 districts contribute 41 percent of soybean area

Concerted efforts on two categories of crop-wise eco-regions, viz., high area – low productivity and low area – high productivity zones will enhance efficiency in our efforts to increase production and productivity of oilseed crops.

The classical examples in high productivity of spring season sunflower in Indo-Gangetic Region of Punjab, Haryana, Western Uttar Pradesh and Bihar; high productivity of safflower in Malwa region (Madhya Pradesh) and Gujarat, high productivity of sesame in West Bengal in summer season, high productivity potential of soybean in Punjab, Haryana and Eastern UP, etc. are mainly due to the optimum ecological conditions which are beyond input and management. Hence, providing necessary input supply, technology, market and extraction facilities in these areas can help realise quantum jump in productivity with ease.

VI. Natural Resource Management

With the current practices of crop cultivation under sub-optimal management, especially without nutrient application, significant soil nutrient mining is occurring. Correcting the present limitation and imbalance in soil nutrients can provide rich dividends. Declining per capita arable land and extending oilseeds cultivation to poor and marginal soils result in low productivity. Moreover, productivity of oilseed crops is limited owing to their cultivation under rainfed conditions. Currently only 28 per cent of area is irrigated under oilseeds. Water requirement in oilseeds is, therefore, a key factor for ensuring higher yields. With dwindling water resources both in quantity and quality, water for irrigation will be costly and face severe competition from different enterprises within agriculture sector. Castor in Gujarat and Rajasthan is cultivated under irrigation while in Andhra Pradesh it is mainly cultivated under rainfed condition. Safflower cultivation is limited to vertisols and rabi season under receding soil moisture conditions. Sunflower is cultivated in all seasons and all soil types. Forty per cent of area under kharif sunflower is rainfed. Watershed management with appropriate rainwater harvesting both *in situ* with proper disposal and storage farm ponds provide excellent opportunity to mitigate the expected dual problems of long droughts and floods with advantage. Site specific land configuration and management for effective soil and moisture conservation and its economic use can operationalize the drought mitigation strategy. Enhancing drought tolerance in oilseed crops is therefore, a priority with associated practices to improve profitability through achieving 'more crop (oil) per drop' of water, resource use efficiency and preferential edge over other competing crops.

Besides, due to the low fertilizer use efficiency, the investments are not remunerative. Improving nutrient use efficiency of fertilizers through better product development and method of application should now be a priority for achieving profitable oilseeds production. Improving soil fertility to reduce external applications is an achievable solution through site specific management. Exploiting nutrient interactions as per the soil test and crop response results in higher efficiency and reduced cost. Organic manures are central in the integrated nutrient management (INM) of oilseeds under rainfed situation alongwith other components such as secondary and micronutrients, like use of sulphur bio-inoculants, crop residues, etc. Precision crop management with conservation agricultural practices and customized fertilizer application schedules would usher higher efficiency and profitability. Emphasis on integrated natural resource management in oilseeds should, therefore, be our high priority.

VII. Crop Improvement Strategy

The gains in productivity of oilseed crops have been achieved primarily through exploitation of available genetic variability. Conventional breeding coupled with modern tools such as biotechnology should now be the primary focus in crop improvement programs. Heterosis breeding should be the major focus in crops like sunflower, castor, rapeseed-mustard, safflower, and sesame. To facilitate better exploitation of the available gene pools and overcome the production constraints, research emphasis needs to be on (i) augmentation/ identification of trait specific germplasm; (ii) prebreeding and genetic enhancement; (iii) allele mining, (iv) functional genomics, proteomics, metabolomics, and interactomics; (v) marker assisted breeding and gene pyramiding; and (vi) trait improvement through genetic engineering.

i) Role of Biotechnology

The two main options of biotechnological approaches for crop improvement include molecular marker based selection and transgene manipulations. Both these approaches, though not mutually exclusive, have distinct niches with respect to their role in crop improvement. At present, biotechnological research on minor oilseed crops (safflower, castor, niger, sesame, linseed and sunflower) is in its infancy. Therefore, it is essential to initiate concerted efforts using tools of biotechnology in these crops. Some of the crop-specific needs that are to be addressed through biotechnological interventions include: pests, like bud fly in linseed; Antigastra and phyllody in sesame, necrosis, leaf spot and powdery mildew in sunflower, wilt and Alternaria in safflower and Botrytis and lepidopteran pests in castor, quality aspects such as presence of anti-nutritional compounds (oxalic acid and phytates) in sesame, oil quality in mustard, toxic proteins (ricin and *Ricinus communis* agglutin) in castor and herbicide tolerance in soybean. Apart from these crop-specific issues, there are research areas of generic nature such as abiotic stress (drought, salinity, cold) tolerance, increased oil content, altered fatty acid profiles to suit different industrial and human consumption requirements, etc. Understanding the molecular basis of trait manifestations such as stress tolerance, oil accumulation, and interactions among different metabolic pathways under varied environmental conditions and at crop growth stages are expected to pave the way for development of designer oilseed crops to meet both domestic and industrial requirements. The success of 'doubled haploids' in developing superior inbreds is a potential area for immediate gain in oilseed crops limited by availability of superior inbred development. The required infrastructure and support need to be ensured for operationalization.

ii) Transgenic Approach

Transgenics are a reality in crops like canola and soybean and what the introgressed traits can do in sustaining and increasing the productivity of crops is already well demonstrated. Transgenic technology has removed the phylogenetic barriers for transfer of useful genes across organisms. Modifying the fatty acid profile of the oil to suit industrial, pharmaceutical, nutritional, cosmetological requirements using genetic engineering approaches has been a priority in application of biotechnology in oilseed crops. Similarly, imparting biotic and abiotic stress tolerance, improved resource use efficiencies through transgenic approaches have been the areas of focused attention for sustained productivity levels under changing as well as challenged environmental situations.

Transgenic technology, as any other technology (including space technology, nuclear technology) is facing stiff-resistance from a section of the society. There are a number of social and food safety related issues that are being associated with de-regulation of transgenic plants. It is the responsibility of scientists, policy makers, industry and knowledgeable people to allay the fears in public mind through scientific knowledge and empirical evidence regarding safety of GM crops. Once the biosafety of transgenic plants is established, they should be treated as any other variety or hybrid.

During the last decade, there has been considerable progress towards harnessing transgenic technology for oilseed improvement in India (Table 4).

At National Research Centre on Plant Biotechnology (NRCPB), *Alternaria* resistant transgenic mustard expressing either glucanase gene from tomato or other anti-fungal genes such as annexin and osmotin and aphid tolerant plants expressing either wheat germ agglutinin or snow drop lectin gene have been developed. Similarly, aphid tolerant mustard transgenic plants have been developed at the Bose Institute, Kolkata using lectin gene from garlic. At the University of Delhi, transgenic male sterility system has been developed in Indian mustard using the popular barnase-barstar system and the experimental hybrids obtained through this technology have already been tested in multi-location trials.

At Directorate of Groundnut Research (DGR), Junagadh, transgenic groundnut plants have been developed with coat protein

Table 4. Biotechnological Interventions in Oilseed Crops in India

Crop	Institute	Genes being used	Trait
Groundnut	DGR and UoH	Annexin	Leaf spot resistance
	ICRISAT	Rice *Chitinase*	Leaf spot and rust resistance, Aflotoxin reduction
	ICRISAT	*Coat protein and replicase*	BND, clump virus resistance
	ICRISAT	*DREB1A* from rice	Drought tolerance
	UAS, Bangalore	*Cry1X*	*Spodoptera* and pod borer resistance
	UAS, Bangalore	*EPSPS*	Glyphosate resistance
	UAS, Bangalore	*Tobacco 1,3 beta glucanase*	Leaf spot, *Aspergillus* resistance
	NABI, Manali	*Cry1EC*	*Spodoptera* resistance
Mustard	DU	*Barnase- Barstar*	Male sterility
	NRCPB	Rice *Chitinase*	*Alternaria* resistance
	Bose institute	Lectin (*ASAL1*)	Aphid resistance
	BARC	Synthetic *Cry1Ac*	Diamond back moth resistance
	NRCPB	*Glucanase*	*Alternaria* resistance
	NRCPB	*Wheat germ agglutinin*	Aphid resistance

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Table Contd...

Crop	Institute	Genes being used	Trait
	NRCPB	*Snow drop lectin*	Aphid resistance
Soybean	DSR, Indore	Marker and reporter genes	Transformation protocol development
	MKU	Full length and truncated movement protein	Viral resistance (Development stage)
	Bharatidasan University	*Alpha tocopehrol methyl transferase*	Vitamin E in oil
Castor	DOR	*Cry1Aa*, *Cry1Ec*, *Cry1abcf*	Lepidopteran defoliators
	DOR	Multiple genes (*ERF1*, *EBP1*, *BIK1*, *Chitinase*, *RsAFP2*, *AcAMP1*)	Botrytis tolerance
	DOR	Silencing of ricin and RCA	Reduction of endosperm toxins
Sunflower	DOR	TSY-Coat protein gene	SND resistance
Safflower	DOR	*OrfH522*, u-*nad3*	Male sterility
	DOR	*DAGAT1* and *GPAT9*	Increased oil content

genes for incorporating resistance to PBND and PSND (currently being evaluated in glasshouse), mtlD gene for enhancing tolerance to drought and salinity, defensin gene for enhancing resistance to fungal diseases and annexin and PR 10 genes for enhancing tolerance to abiotic stresses. Also, transgenic groundnut plant expressing annexin gene has been developed at the University of Hyderabad as well as at DGR, Junagadh to fight against the leaf spot disease. Transgenic groundnut plants with resistance to *Spodoptera*, fungal disease and glyphosate tolerance have been developed at UAS, Bangalore. At NABI, Mohali, *Spodoptera* resistant plants have been developed by deploying *cry1EC* gene. At ICRISAT, transgenic groundnut lines with aflatoxin resistance conferred by rice chitinase gene and bud necrosis virus resistance imparted by expressing viral coat protein gene have been developed and characterized. Similarly, improved drought tolerance has been achieved by deploying DREB gene. Limited field trials are being carried out to select the lines for further studies and commercialization.

In soybean, efforts are on to develop good transformation protocols for the Indian genotypes at Directorate of Soybean Research (DSR), Indore. At Bharatidasan University, transgenic soybean lines with enhanced vitamin E in the oil are being developed while at Madurai Kamaraj University, viral resistance is being achieved by expressing the movement protein of the virus.

At the Directorate of Oilseed Research, transgenic castor lines with resistance to defoliators have been developed by deploying different *cry* genes with specificities against target pests (semilooper and *Spodoptera*). Limited field trials have been conducted with this material to select lines with higher pest mortality potential and the selected events will be further tested in confined field trials. Also, multigene constructs have been developed to counter *Botrytis* disease and these constructs are being validated now for their efficiency in controlling necrotrophic fungi. Similarly, RNAi gene constructs developed for suppressing genes encoding ricin and RCA are being validated using model plant system. In safflower, attempts are being made to develop transgenic male sterility and fertility restoration using *orfH522* and *u-nad3* genes. Over-expression of the rate limiting enzymes (DAGAT and GPAT9) in a seed specific manner is being attempted to increase the oil content in safflower which currently is about 30 per cent in the cultivated safflower varieties or hybrids. The problem of sunflower necrosis disease, which once threatened the very cultivation of sunflower crop, is also being tackled through transgenic approach using coat protein in sense and anti-sense orientation. The material is in advanced stages for commercialization and biosafety tests.

Albeit the progress made, there are still gaps which require attention for efficient utilisation of the technology. The main prerequisite for exploiting the power of transgenic technology is the availability of efficient, and preferably genotype independent, transformation protocols. Therefore, concerted efforts should be made to develop transformation protocols in all oilseed crops. Considering the financial and technical requirements needed for development of transgenic plants, there should be prioritization of crop and trait to be tackled through this technology. On the technology front, concerted efforts are being made in model plant systems to develop methods and strategies to have the transgenes inserted in targeted regions of the genome to avoid positional effects as well as insertional inactivation of unintended genes. Also, it is envisaged that technologies for cis-genesis, intra-genesis, gene-stacking, marker-free transgenesis, zinc-finger nucleases, RNA dependent DNA methylation, etc. once perfected in model crops should be adopted in improvement of oilseed crops. This information could be used in developing and realizing designer transgenic oilseed crops to meet pharmaceutical, nutraceutical and industrial demands.

In spite of the progress made in the use of transgenic technology in the oilseed crops, current policy controversy, is a setback, delaying the fruits of results to reach stakeholders.

iii) Exploring Frontier Sciences

Significant innovations in frontier science and technologies such as nanotechnology, genetic engineering and biotechnology, synthetic lipid science and technology, information science and modeling, simulation and forecasting and the recent developments in related sciences such as hydroponics, vertical farming and protected agriculture; precision agriculture systems; biosecurity and biodiversity management provide unlimited opportunities for supporting higher production and product development to meet the changing requirements through precision farming and protection/conservation practices. Post production, developments in dynamic integration of production, processing, quality with global trade would make production of vegetable oils profitable and competitive. Oilseeds production will also benefit from innovations in industrial sector for oilseeds processing and small farm mechanization, ex-ante approaches for quantification of economic output. These frontier sciences will have to be harnessed and integrated into ongoing research programs for productivity improvement; increasing the resource use efficiency, improving processing, value addition, diversified uses, improved access to stakeholders through ICT, enhanced delivery systems, better targeting of technologies for yet better production and marketing environments, including supply chain mechanisms. The traditional knowledge should also be valued for its wisdom for technology generation, refinement and adoption.

VIII. Public Private Partnership and Linkages

Oilseeds, unlike other food crops, depend on other enterprises for its ultimate use/consumption. The necessity of extraction of oil from seeds provides inter-dependence of industry and oilseed producers in-between consumers, thus making success in vegetable oil production business inter-dependent at each stage of production, processing and pricing policies.

The potential of public-private partnership (PPP) through linkages in all aspects of oilseeds production and marketing needs to be harnessed for a win-win situation. The grey areas for PPP in oilseeds include incentives for seed production, forward/backward linkages for processing, value addition, contract research in niche areas, contract farming, joint ventures for higher order derivatives and speciality products, etc.

The edible oil industry is largely dominated by the bulk segment which creates an opportunity for the Agri-Business sector. The unbranded segment accounts for anywhere between 80 and 90 per cent of the total consumption which can be targeted for better value addition and thus, minimize health hazards that otherwise occur on account of adulteration of edible oils. The share of raw oil, refined oil and vanaspati in the total edible oil market is estimated at 35 per cent, 55 per cent and 10 per cent, respectively. The former group is a viable Agri-Business venture. The shift in consumer preference for branded edible oils has resulted in the corporate sector targeting on packaged edible oil segment in the last few years. Hence, PPP mode for R&D efforts towards value addition emerges as new priority to move forward.

IX. Diversification and Value Addition

Profitability of oilseeds solely from the primary products like seed and oil will not be sustainable. Besides the primary product oil, oilseed crops provide immense scope for diversified uses with high value speciality products and derivatives. From the vegetable oil consumption point of view either for edible or for fuel purpose, the situation is envisaged towards valuing oil for its intrinsic value for calorie or for desired fatty acid that is beyond the realm of individual crop as perceived now. Designer oils with requisite blends can meet the expectation and to that extent individual oilseed crop's potential would be seen for the yield of oil or the desired fatty acid and not as oil from specific crop. Thus, the present wide diversity of oilseed crops may narrow down to a few high oil yielding crops. As for unique non-oil value aspects for specific aroma or non-oil uses (medicinal, ornamental or other uses), the individual oilseed crops would be grown for speciality purpose irrespective of productivity level.

Major opportunities for oilseed crop diversification and value addition include introduction as catch crop in paddy fallows to utilize residual moisture and fertility; component crop in major wide spaced field crops such as sugarcane, pigeonpea, cotton, maize, etc. for sunflower; and as main crop with groundnut, soybean, finger millet, pigeonpea, cluster bean, short duration pulses, etc. for castor and sunflower; with chickpea and coriander for safflower; rabi castor under limited irrigation protection and sunflower for Indo-Gangetic plains of Punjab, Haryana, Western Uttar Pradesh in spring, and Bihar, Odisha and West Bengal in rabi/summer. Soybean also offers opportunity for rice wheat cropping system in the north.

X. Adaptation to Climate Change

The low productivity and uncertain production of oilseeds is mainly due to their cultivation under rainfed conditions (about 70%). The inherent tolerance of oilseeds to drought and other edaphic stresses is construed as though they are low input requiring crops. On the contrary, oilseeds need higher inputs for increased productivity. Adaptation strategy for drought, high temperature and rainfall variations must, therefore, be put in place as a matter of priority.

Oilseeds production is constrained by several biotic stresses like insect pests and diseases that are being further aggravated by changing climatic conditions. *Botrytis*, root rot and capsule borer have emerged as major threats to castor production. Sunflower production is limited by diseases like *Alternaria* leaf blight, sunflower necrosis, downy mildew and powdery mildew while mealy bug is an emerging pest. The foliar diseases, *Alternaria* and *Cercospora* leaf spots and *Macrophomina* root rot are becoming increasingly important while wilt and aphid continue to challenge safflower production. Global warming induced climate change is expected to trigger major changes in population dynamics of pests, their biotypes, activity and abundance of natural enemies and efficacy of crop protection technologies. Studies on the epidemiology of plant diseases including variation in pathogen population in the light of climatic change are necessary to develop integrated disease management (IDM) modules. Studies on wilt disease etiology in the context of reniform nematode in castor and sunflower and root-knot nematode in sunflower coupled with identification of sources of resistance deserve attention. There is a need to generate information on the likely effects of climate change on pests so as to develop robust technologies that will be effective. The approach to pest management has seen a significant change over the years from chemical control to IPM with emphasis currently on bio-intensive integrated pest management (BIPM) involving use of pest-resistant varieties, bio-agents, bio-pesticides and natural products like botanical pesticides and pheromones. Several eco-friendly products of biological origin have been developed at the DOR for management of important pests of oilseed crops like castor semilooper, sunflower head borer, tobacco caterpillar as well as wilt of castor and safflower. However, the relative efficacy of many of these pest control measures is likely to change as a result of global warming necessitating identification of temperature tolerant strains.

XI. Transfer of Technology

Concerted efforts are urgently needed for the dissemination of technologies and new approaches on a participatory mode to be strengthened for effective delivery mechanism by show-casing the potential technologies/products. The Farmer-Institution-Industry linkage mechanism should be strengthened besides the existing formal delivery mechanisms so that the gap between the potentially attainable yield and the yield realized on the farmers' fields is reduced and it makes the industry more vibrant and profitable on account of assured quality supply, reduced obstacles in supply chain, enhanced capacity utilization and increased economic surplus with benefits to both the producer and the consumer. The potential Information and Communication Technology (ICT) tools should be harnessed on a dynamic and interactive mode. This can minimize the dissemination loss while sharing information and provide benefits to all the stakeholders involved in oilseeds. Also a dedicated TV channel on agriculture will help in faster dissemination of knowledge. Creation of agri-clinics with provision of outsourcing through involvement of new breed of young well trained technology agents would go a long way in outscaling innovation for greater impact.

5. SPECIFIC RECOMMENDATIONS

Following research, development and policy strategies would be needed urgently for increasing both oilseeds production and vegetable oils availability in the country.

I. Research

- Greater emphasis on innovation to achieve quantum jump in productivity using new science and translational research.
- Integration of all oilseed research institutes under NARS for holistic research approach on systems mode.
- Develop short duration, high yielding genotypes for better adaptation to climate change through integration of modern biotechnological tools like MAS and transgenic breeding, supplementary to conventional breeding and develop cultivars with in-built resistance to biotic and abiotic (specially drought and heat) stresses. In this context, greater use of germplasm through pre-breeding will be highly desirable.
- Develop small farm machinery for different operations specific to each crop so as to ensure timely farm operations and efficient use of costly inputs.
- Increased emphasis needs to be given on post harvest technology and value addition for diversified uses in order to ensure higher profitability.

II. Development

- Establishing strong linkages for successful operation of 'seed village concept' with producers, technocrats, certifying agencies and concerned State Departments of Agriculture for timely procurement and distribution to ensure higher seed replacement by improved varieties/hybrids.
- Promote oilseeds cultivation in new and non-traditional areas and seasons for ensuring crop diversification and additional area for expansion. Eastern region offers option for potential area expansion especially in paddy fallows. Similarly, soybean offers great opportunity for diversification of rice-wheat cropping system in Northern India.
- Adopt location specific efficient dry farming technologies for drought proofing and sustainable oilseeds production. Integrate oilseeds production with watershed programmes

for holistic development and to ensure life support irrigation for assured harvest.

- Increase area under protective irrigation and promote efficient irrigation methods, especially micro-irrigation, for achieving higher production and stability.
- Promote adequate and balanced fertilization with emphasis on use of sulphur and limiting micronutrients through proper soil amendments, based on soil testing.
- Effective transfer of technology with assured input, market and technological backstopping by both public and private sector agencies.
- Promote intercropping systems involving oilseeds for achieving higher efficiency of resources, profitability and risk minimization.
- Adopt need-based plant protection measures through effective and bio-intensive integrated pest management (IPM).
- Largescale production of promising small farm equipments through involvement of state governments that will help in improving efficiency in farm operations. Also provision of credit and incentives for manufacturing of small farm equipments and machinery by smallscale industries and promotion of custom hiring to ensure resilience in farming.
- Greater thrust on use of soybean as food rather than only as oil and feed will help the nation in addressing current major concerns for protein malnourishment, while ensuring nutrition security.
- Exploit additional features of crops like high value safflower petals and fiber from linseed for realizing additional profits. Also, there is a need to accelerate area expansion of oil palm plantations and extend assured irrigation, power, local processing facility and competitive prices for realizing higher production of vegetable oil per unit area per unit time.
- Avoid use of rice bran directly as feed in order to promote greater extraction and use of rice bran oil.

- Promote scientific processing of cotton seed for higher oil recovery and to get high protein retention (42%) compared to traditional processing practices (22%).
- Improve efficiency of extraction of oil through solvent extraction for hard seeds (<20% oil) and expeller extraction for soft seeds (35 to 40% oil).

III. Policy

- Regulate import of vegetable oils through adoption of appropriate import policy aiming at increased domestic production. Hence, vegetable oils should be viewed beyond export – import balance with the goal of achieving self sufficiency to a greater extent. The need for achieving self sufficiency in vegetable oil should be seen in the context of improved livelihood, higher profitability of oilseed farmers and for processing industry.
- Ensure market intervention for effective implementation of MSP through needed procurement of oilseeds, being a major national priority.
- Appropriate regulations to amend the Agricultural Produce Marketing Act for making it pro oilseeds producers and enhance proper trading and fair pricing to both producer and consumer.
- Encourage establishment of large scale 'captive plantations' and specialized 'seed gardens' of oil palm by declaring oil palm as a plantation crop and also ensure proper pricing policy for profitability.
- Creation of enabling environment to strengthen private participation in collaborative research, development, extension and marketing operations.
- To avoid diversion especially of edible oils for biodiesel production and other industrial uses.
- Similar to sugarcane model, oil expeller industry should promote local/regional oilseeds production for assured and adequate supply of raw material as per pre-determined assured prices. The industry should also be involved

in supporting technology development and extension activities.

- Revival of Oilseed Mission, through a special purpose vehicle, with greater thrust on 5 Ps: Priorities, Policies, Productivity, Profitability and Private sector participation, with emphasis on increased oilseed production in the country be the highest priority of the Government.
- Greater emphasis and investments on public awareness about rationalization of vegetable oil consumption for proper health becomes our national priority.

6. CONCLUSION

Increased availability of vegetable oils would involve greater commitment of various stakeholders (farmers, scientists, policy makers, NGOs, private sector industry, etc.) Assessing the problems and prospects of all these stakeholders and the establishment of strong as well as viable linkages among them towards the goal of improving vegetable oils situation in the country is indeed a challenging task. The success of 'Yellow Revolution', achieved through mission mode approach of TMOP during eighties, fully justifies revival of Oilseeds Mission approach with greater zeal and commitment of all to tide over the present crisis of largescale import of edible oils. In my view, we must have clear national policy of bridging the yield gaps and increased oilseeds production with specific aim to reduce our vegetable oil imports, as was achieved during earlier TMOP. No doubt to achieve this, we would need clear policy directions and also missionary zeal and commitment of all concerned. I am sure we all collectively can do it.

I salute Padma Shri Dr M.V. Rao for his committed efforts and valuable contributions made to strengthen Indian agriculture.

My hearty congratulations once again to the Indian Society of Oilseeds Research for initiating this lecture series.

Recent TAAS Publications

- Public-Private Partnership in Agricultural Biotechnology - Second Foundation Day Lecture, delivered by Dr. Gurdev S. Khush, Adjunct Professor, University of California, Davis, USA, October 17, 2005.
- Farmer-Led Innovations for Increased Productivity, Value Addition and Income Generation - Brainstorming Session, October 17, 2005 - Highlights & Recommendations
- Strategy for Increasing Productivity Growth Rate in Agriculture" - Strategy Paper by Dr. R.S. Paroda, August, 2006.
- Brainstorming Session on "Models of Public-Private Partnership in Agricultural Biotechnology ", April 7, 2007 - Highlights & Recommendations.
- National Symposium on Quality Protein Maize for Human Nutritional Security and Development of Poultry Sector in India and Presentation of the Third Dr. M.S. Swaminathan Award for Leadership in Agriculture, May 3, 2008 – Proceedings and Highlights.
- Overcoming the World Food and Agriculture Crisis through Policy Change, Institutional Innovation and Science– Fourth Foundation Day Lecture, delivered by Dr. Joachim von Braun, Director General, International Food Policy Research Institute, Washington, March 6, 2009
- Brainstorming Workshop on “Emerging Challenges before Indian Agriculture - The Way Forward”, March 6, 2009 - Proceedings & Recommendations.
- Brainstorming Workshop on ’Strategy for Conservation of Farm Animal Genetic Resources’ 10th – 12th April, 2009 – Ranchi Declaration.
- Brainstorming Workshop on “Climate Change, Soil Quality and Food Security”, August 11, 2009 – Proceedings & Recommendations.
- Millions Fed: Proven Successes in Agricultural Development, January 19, 2010 (Translation in Hindi jointly published by IFPRI, APAARI and TAAS)
- National Seminar on “Quality Seed for Food Security through Public-Private Partnership”, April 13-14, 2010 – Proceedings & Recommendations
- TAAS Foundation Day Lecture on “Climate Change and Food Security: From Science to Sustainable Agriculture” by Dr. Mahendra M. Shah, May 7, 2010
- NSAI Foundation Day Lecture on “Revitalizing Indian Seed Sector for Accelerated Agricultural Growth”, October 30, 2010
- Brainstorming Session on Prospects of Producing 100 million tons of Wheat by 2015 and presentation of Fifth Dr. M.S. Swaminathan Award for leadership in Agriculture - Proceeding & Highlights December 18, 2010
- National Dialogue on Building Leadership in Agricultural Research Management, Hyderabad, August 27 - 28, 2010 - Proceedings & Recommendations
- Stakeholders’ Interfae on GM Food Crops, May 19, 2011 - Recommendations
- TAAS Foundation Day Lecture on “Harnessing Knowledge for India’s Agricultural Development” by Dr. Uma Lele, August 12, 2011
- The Sixth Dr. M.S. Swaminathan Award Lecture on "Challenges and Opportunities for Food Legumen Research and Development" by Dr. M.C. Saxena, January 25, 2012
- Proceedings and Recommendations of Farmers’ Led-Innovation. December 23-24, Hisar, Haryana, 2011
- Proceedings and Recommendations of Global Conference on Women in Agriculture. 13-15 March, 2012 New Delhi; India.
- The Seventh Foundation Day Lecture on "Ensuring Food and Nutrition Security in Asia: The Role of Agricultureal Innovation" by Dr. Shenggen Fan, DG, IFPRI. January 11, 2013
- A Brief Report on Seventh Dr. M.S. Swaminathan Award presented to Dr. William D. Dar, DG, ICRISAT, Hyderabad. June 24, 2013

DR. R.S. PARODA

Dr. Rajendra S. Paroda is an accomplished plant breeder and geneticist by profession and an able research administrator. He has made significant contributions in the field of crop science research. He is known for modernization and strengthening the national agricultural research system (NARS) in India as well as in Central Asia and the Caucasus. He was instrumental in establishing the Asia-Pacific Association of Agricultural Research Institutions (APAARI) and the Asia-Pacific Seed Association (APSA), while serving with FAO in early ninties. Since, 1992, he is continuing as Executive Secretary of APAARI. He was elected as the first Chairman of the Global Forum on Agricultural Research (GFAR) and served from 1998-2001. Dr. Paroda was also the Director General, Indian Council of Agricultural Research (ICAR) & Secretary, Department of Agricultural Research and Education (DARE), Government of India during 1994-2001. He has the unique distinction of being the main architect of one of the world's largest and most modern National Gene Bank at NBPGR, New Delhi. He is Fellow of almost all the prestigious Science Academies in India and the Agricultural Academies of Russia, Georgia, Armenia and Tajikistan, besides that of Third World Academy of Sciences (TWAS), Italy. He had been the President of the National Academy of Agricultural Sciences (India) from 1996-2001 and was elected as General President of the prestigious Indian Science Congress Association for the year 2000-2001. In addition, he served as President of more than a dozen agricultural scientific societies in India. In recognition of his meritorious contributions to agricultural research, the President of India conferred on him the prestigious PADMA BHUSHAN in 1998. He also received several prestigious awards, namely, ICAR Team Research Award (1983-84), Rafi Ahmed Kidwai Memorial Prize (1982-83), Federation of Indian Chamber of Commerce and Industry (FICCI) Award (1988), Om Prakash Bhasin Award (1992), Asia-Pacific Seed Association Special Award (1995), Dr. Harbhajan Singh Memorial Award (2001), Dr. B.P. Pal Memorial Award (2003), Borlaug Award (2006) and Agriculture Leadership Award (2008), 1st Dr. A.B. Joshi Memorial Award (2012), Prof. Kannaiyan Memorial Award (2012), Medal from Govt. of Vietnam (2012), Krishi Siromani Samman by Mahindra (2013) and Vaigyanik Drishlikon Society (VDS) Samman (2013). In all, 15 Universities including Ohio State University, Indian Agricultural Research Institute, Scientific Council of Agricultural Academy, Agricultural Universities of Pantnagar, Kanpur, Jorhat, Coimbatore, Hyderabad, Udaipur, Varanasi, Srinagar, Meerut, Bhubneshwar, Punjab and Dharwad have conferred honory D.Sc. (Honoris Causa) degrees on him. Dr. Paroda has also served as a member of many international organizations such as Australian Center for International Agricultural Research (ACIAR), Commonwealth Agriculture Bureau International (CABI), Finance Committee of the Consultative Group on International Agricultural Research (CGIAR), Global Biotech Advisory Council of Monsanto, Board of Trustees of IRRI, Chairman of ICRISAT Board of Trustees and Chairman, Program Committee of GFAR. In view of his outstanding achievements, both American Society of Agronomy and the Crop Science Society of America had awarded Dr. Paroda with their prestigious Honorary Membership in 2001. ICRISAT and Kazakhstan have named their Gene Banks after him. He also served as a member of the World Meteorological Organization (WMO) High Level Taskforce for preparing a Global Framework for Climate Services. As Chairman of the Organizing Committee of Global Forum on Agricultural Research for Development (GCARD), he provided leadership at global level to organize successfully GCARD2 in October, 2012 in Uruguay. His passion, as Chairman, Trust for Advancement of Agricultural Sciences (TAAS), is to link science to society through needed policy reorientation and to work for the overall progress of the resource poor farmers. Since 2010, he has been serving as Chairman of the Farmers' Commission of Haryana State and as member of the Rajasthan State Planning Board. Currently, he is a member of the ICAR Society as well as its Governing Body.

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