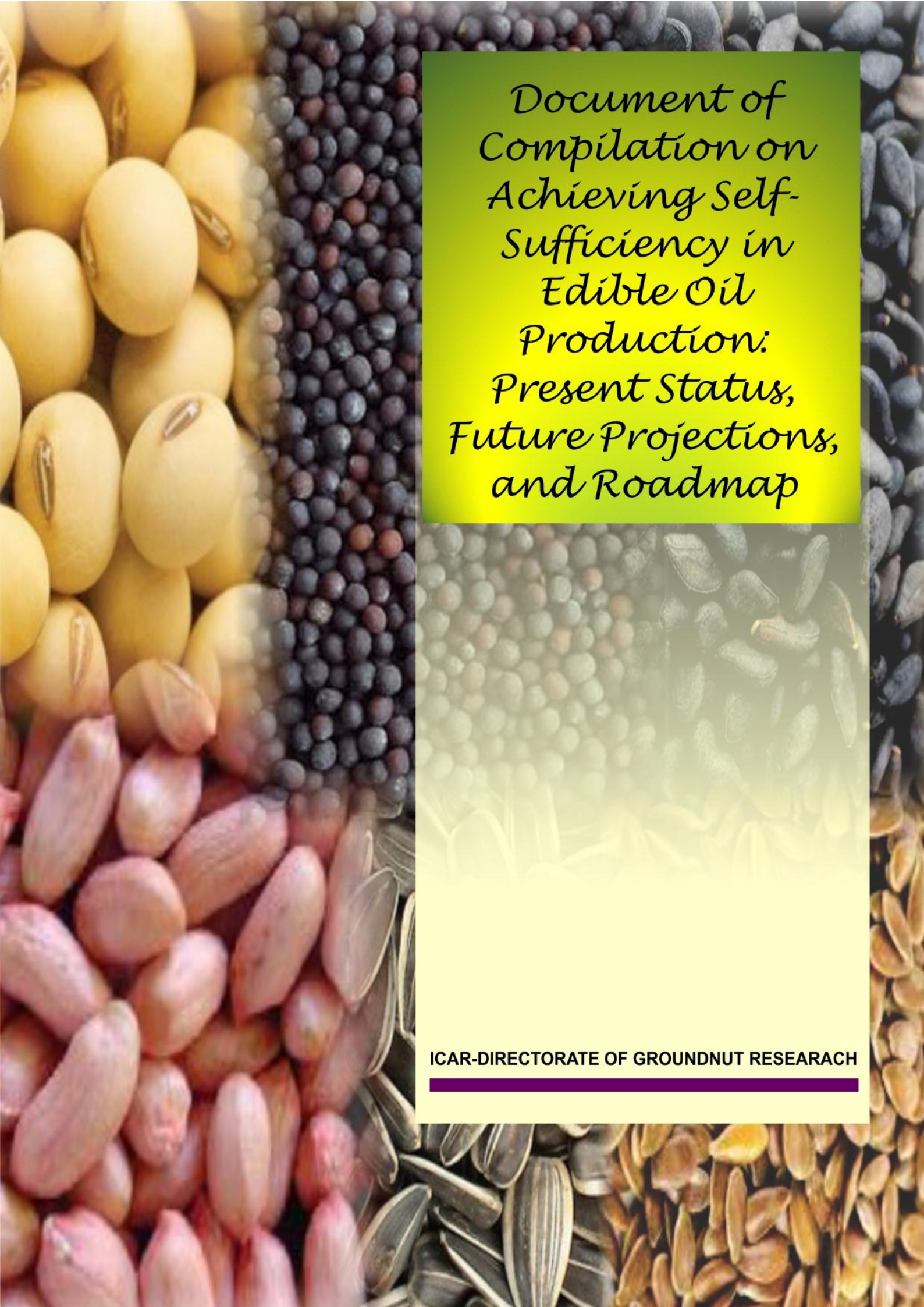

Document of Compilation on Achieving Self-Sufficiency in Edible Oil Production: Present Status, Future Projections, and Roadmap

ICAR-DIRECTORATE OF GROUNDNUT RESEARACH

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Achieving Self-Sufficiency in Edible Oil Production: Present Status, Future Projections, and Roadmap

Introduction

To meet the growing demand, India is importing edible oils nearly 15 MT worth nearly rupees seventy thousand crores at the cost of valuable foreign reserves. The per capita consumption of edible oils has grown @ 2.48% annually with a CAGR of 2.17% from 15.8 kg/capita/year in 2012-13 to 18.76 kg/capita/year in 2019-20. If the trend continues, the per capita consumption in 2034-35, with CAGR of 2.32%, will be 27.08 kg. The growth in consumption is attributed mainly to change in life-style, increase in population, urbanization, growing demand of fast food among younger generations, etc. The demand for edible oil was 25.63 MT in 2019-20 against domestic production of 10.53 MT (7.03 MT from primary sources and 3.50 MT from secondary sources) necessitating the import of 15.10 MT to fill the demand and supply gap.

To lessen the burden on foreign exchequer because of huge import of edible oil and to encourage the domestic production, Government of India has timely intervened and called for 'Atmanirbhar Bharat' in edible oil production.

Considering the low productivity of edible oilseeds (Groundnut, Soybean, Rapeseed-Mustard, Sesame, Sunflower, Safflower and Niger) and being predominantly rainfed cultivation in marginal land by marginal farmers in erratic and deficient rainfalls, the task set is abysmally difficult and ambitious. The situation is compounded further because of the recent declining trend in area of major and minor edible oilseeds, increase in import of cheaper edible oil, non-availability of quality seeds, etc.

During 2019-20, area under edible oilseed crops was 25.81 mha with production and productivity of 31.48 MT and 1220 kg/ha, respectively. However, to boost domestic production towards 'atmanirbhar', the anticipated edible oil production in the year 2024-25 has been set to around 18 MT (13.50 MT from primary sources from seven edible crops and 4.50 million tonnes from secondary sources viz. Coconut, Palm oil, Rice bran, cotton seed, and TBOs). Total demand for edible oil in 2024-25 would be around 28.00 million tonnes with expected import of 10.00 million tonnes assuming that present *per capita* consumption of 19.22 kg/year will remain unchanged. However, at the present rate of increase in consumption of edible oil, the demand would be around 30.4 MT and there will be need for import to the tune of 12.4 MT.

Considering the declining trend in population growth, the demand of edible oil during 2029-30 and 2034-35 is expected to be around 28.7 and 29.7 MT, respectively keeping the present rate of consumption (19.22 kg/capita/year) unchanged. However, at present rate of increase in consumption i.e. 2.48% annually, the demand during the same period would be around 35.76 and 41.83 MT against the anticipated domestic production of 23.04 and 29.48 MT, respectively from primary- and secondary-sources combined.

Therefore, if the *per capita* consumption can be kept unchanged at 2019-20 level through aggressive campaign, gradually the demand and supply gap can be bridged from domestic production substantially.

To fulfil the dream of 'atmanirbhar in edible oil', a new mission i.e. National Mission on Edible Oils (NMEO) has been proposed with the aim to enhance the edible oilseeds production vis-à-vis edible oil availability in the country. The mission aims in enhancing the production of seven edible oilseeds and in boosting edible oil from secondary sources to

reduce the staggering burden of import of edible oils. However, meticulous planning and concerted efforts of all stakeholders are required to achieve the mission. The details of such planning is discussed here in the context of improving productivity of edible oilseeds and area under cultivation.

1. Present Status

In India, both annual and perennial edible oilseeds are in cultivation. Annual edible oilseeds include Groundnut, Rapeseed-Mustard, Soybean, Sunflower, Sesame, Niger, and Safflower and perennials include Oil palm and Coconut. Besides, there are minor oil producing species of forest and tree origin. Moreover, edible oils are also produced domestically from secondary sources like rice bran, cotton seed, corn, and other Tree Borne Oilseeds (TBOs).

Presently, India produces edible oils nearly 40% of its demand and 60% is imported. As *per capita* consumption of edible oils has grown @ 2.48% annually with a CAGR of 2.17% from 15.8 kg/capita/year in 2012-13 to 18.76 kg/capita/year in 2019-20, the demand and supply gap has widened over the years. The demand for edible oil was 25.63 MT in 2019-20 against domestic production of 10.53 MT necessitating the import of around 15.1 MT (palm oil: about 60%; Soybean oil: 25%; Sunflower: 12% and rest others) costing around Rs. 69000 crores to national exchequer.

In 2019-20, India produced 31.48 MT of edible oilseeds from 25.81 mha with productivity of 1220 kg/ha with edible oil production of 7.03 MT. Among the edible oilseed crops, Soybean (35.63%), Groundnut (32.09%), Rapeseed-Mustard (28.96%) contributed 96.68 per cent of the total edible oilseeds production. Sesame, Sunflower, Safflower and Niger contributed 3.32%.

Contrary to production, the major contribution to domestic edible oil kitty comes from Rapeseed-Mustard (3.191 MT: 45.39%), Groundnut (1.769 MT: 25.17%) and Soybean (1.754 MT: 24.95%) amounting to 95.52%. The minor edible oilseeds (Sesame, Sunflower, Safflower and Niger) contributed 4.48% of domestic production of 7.03 MT. Around 3.50 MT of edible oils comes from secondary sources (cotton seed oil, palm oil, corn oil, rice bran oil, coconut oil and other TBOs). The major oilseed producing states are: Madhya Pradesh, Maharashtra and Rajasthan (Soybean); Gujarat, Andhra Pradesh, Rajasthan, Tamil Nadu, and Karnataka (Groundnut); Rajasthan, Madhya Pradesh, Uttar Pradesh, West Bengal and Haryana (Rapeseed-Mustard); Madhya Pradesh, Uttar Pradesh, Rajasthan and Gujarat (Sesame); Karnataka (Sunflower); and Maharashtra and Karnataka (Safflower).

The overall yield gap in oilseed is 65%. The maximum yield gap is in Sunflower (160 per cent) among minor oilseeds and in major oilseeds (Groundnut, Soybean and Rapeseed-Mustard), the yield gap ranged from 37 to 71 per cent. Therefore, production of edible oilseeds in India would enhance substantially by bridging the yield gap by technological interventions, even without the expansion of area under cultivation.

2. SWOT analysis of edible oilseeds

Strength:

- High genetic yield potential of the newly developed varieties of annual edible oilseeds like Groundnut (3500-4000 kg/ha), Mustard (3000-3500 kg/ha), Soybean (2200-2800) and Sunflower (2000-2500 kg/ha) can be realized by optimizing the agro-ecological conditions and adopting available improved production and protection technologies.

- Two major oilseed crops (Groundnut and Soybean) contributing more than 66% of total area under edible oilseeds and production are leguminous and thus require meagre amount of external application of nitrogenous fertilizers.
- Both groundnut (25-30%) and soybean (40-45%) are rich source of proteins.
- Genome sequence of majority of edible oilseeds are available for further exploitation for developing high yielding varieties using molecular breeding, developing SNPs, genome editing, identifying genes responsible for susceptibility/tolerance of traits, etc.
- Network of KVKs and ATARIs are in place in all districts of the country to aid dissemination of improved technologies.
- Oil meals are available in plenty after oil expulsion for animal feed and protein isolates and other commercial ventures.
- Wide adaptability of the edible oilseed crops in tropical, sub-tropical, temperate, and semi-arid tropics.
- Most of the edible oilseed crops fit well in inter- and sequential cropping systems.
- Most of the edible oilseeds are rich in oil (25-55%) except soybean (16-18%).

Weakness:

- Narrow genetic base of most of the edible oilseed crops
- Underutilisation of available germplasms and gene pools for developing pre-breeding materials, resistance breeding, etc.
- Most of edible oilseed crops (except Rapeseed-Mustard) are cultivated in rainfed condition without availability of life saving irrigation facilities affecting productivity.
- Lack of availability of suitable varieties for drought- and salinity- condition as most of them are susceptible to both the conditions.
- Contrary to cereals, hybrids among major edible oilseeds (Groundnut, Soybean), are not available, through hybrids are restricted to sunflower and safflower and Rapeseed-Mustard with very limited area under cultivation.
- Lack of availability of land races among the edible oilseeds as Groundnut, Soybean, Rapeseed-Mustard, Sunflower, and Niger are rather domesticated to India.
- Lack of early maturing varieties in most of the edible oilseeds to fit in different agro-climatic and cropping sequences making it difficult to popularize in newer niches.
- Inadequate supply of quality seeds of improved varieties in both traditional and non-traditional areas.
- Lack of availability and application of low-cost bioagents which can reduce the input cost and enhance production substantially.
- Cultivation of edible oilseeds with inadequate inputs and sub-optimal soil condition affecting productivity.
- Lack of policy support like better incentives to farmers.
- Lack of mechanization and marketing infrastructure in non-traditional areas.
- Lack of R&D support with proper funding for high end research
- Lack of market intelligence.

Opportunity:

- Availability of genomic resources like SNP panels for high throughput multi-trait breeding and allele mining
- Tremendous scope for area expansion and season expansion
- Average yield gap in edible oilseeds is nearly 60% and therefore, production can be enhanced substantially without much efforts on expansion of area under cultivation

- All edible oilseeds respond well to fertilizer application and thus through agronomic management, production can be enhanced further

Threats:

- Most of the edible oilseed crops are susceptible to soil-borne and foliar fungal diseases affecting productivity
- As most of the edible oilseed crops are susceptible to abiotic stresses, impeding climate change and predicted increase in frequency and intensity of abiotic stresses will affect the productivity of a number of crops further rendering their cultivation rather non-remunerative
- Lack of infrastructure for marketing and promotion to non-traditional areas
- Competition from more remunerative crops and has the potential to replace edible oilseeds further
- Import of cheap crude edible oils
- Low SRR and VRR among the edible oilseeds. The situation is further compounded owing to very low seed multiplication ratio of two major oilseeds viz. Groundnut and Soybean

Future Projections

3. Projected Consumption

The per capita consumption is the most critical factor determining the demand of edible oil. Therefore, corrective measures and intervention in maintaining the present rate of consumption or slowing down the growth in consumption will be the determining factor for total demand of edible oil. Since 2012-13, the *per capita* consumption of edible oil is increasing @ 2.48% annually with a CAGR of 2.17%. The per capita consumption in 2012-13 was 15.8 kg, which has increased to 18.76 kg/capita/year in 2019-20. If the trend continues, the projected *per capita* consumption in 2024-25, 2029-30 and 2034-35 will be 21.20 kg, 23.96 kg and 27.08 kg, respectively with a CGAR of 2.32% **(Figure1)**. In the year 2020-21, the consumption is estimated at 19.22 kg/capita/year. To bridge the demand and supply gap, the represent consumption of 19.22 kg/capita/year needs to be maintained by aggressive campaign and creation of mass awareness among the consumers about the health benefits of less consumption of edible oils.

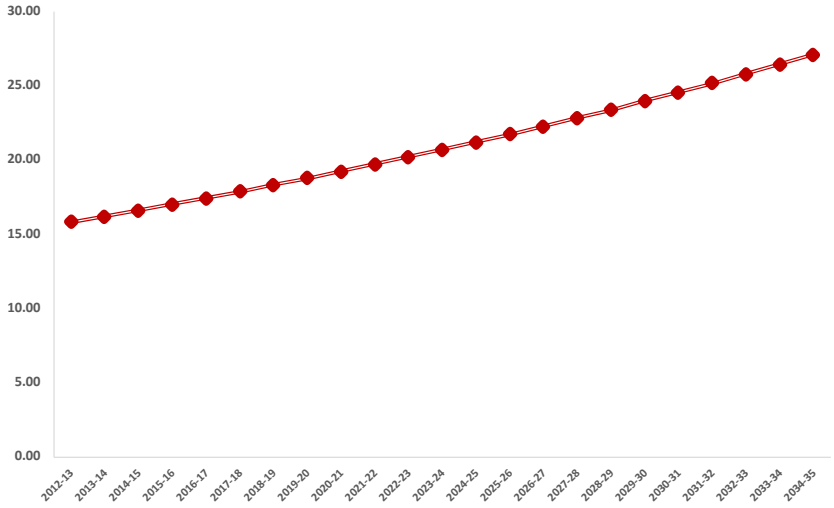


Figure 1 Projected consumption of edible oil

4. Population Growth

The demand of edible oil will increase with the increase in population. As per the long-term estimate of population, there is a declining trend in growth in the last decades. Whereas population of India in 2019 was 136.64 crores with a growth rate of 1.02% as compared to previous year, the projected population of India in 2020 would be 138.00 crores with a growth rate of 0.99% as compared to the population in the year 2019-20. The growth rate will decline further in the next decades and projected to be 0.90%, 0.77% and 0.63% in the year 2024-25. 2029-30 and 2034-35, respectively with projected population of 143.24, 149.25 and 154.45 crores in the corresponding year, respectively.

5. Demand at present rate of consumption (base year 2020-21) to be maintained as static

The two critical factors that decide the total demand of edible oil are population and *per capita* consumption. The *per capita* consumption of edible oil in the pear 2020-21 is estimated to be 19.22 kg and with projected population of 138.00 crores, the total demand of edible oil in India will be 26.52 MT. If the present level of consumption can be maintained by aggressive campaign to create awareness about the health benefit in using less oil, the projected demand of edible oil will be 27.53 MT, 28.69 MT and 29.69 MT in the year 2024-25, 2029-30 and 2034-35, respectively. As per the projection, the population in the corresponding year will be 143.24, 149.25 and 154.45 crores, respectively.

6. Demand at present rate of increase in consumption (base year 2012-13)

Since 2012-13, the per capita consumption has increased from 15.8 kg to 18.76 kg in the year 2019-20 with annual growth rate of 2.48% and with a CAGR of 2.17%. Owing the change in life style, increasing demand for fast foods, urbanization in rapid pace, and growth in population, the trend is likely to be same. Therefore, the demand of edible oils will also continue to grow with the growth in *per capita* consumption. At the present rate of growth in *per capita* consumption, the projected growth in demand of edible oil in 2024-25, 2029-30 and 2034-35 will be 30.37 MT, 35.76 MT and 41.83 MT

with a CAGR of 2.32% considering 2019-20 as base year and also considering the population and *per capita* consumption during that period.

7. Future projection for area, productivity and production of edible oilseeds and oils

The total production of a particular edible oilseeds in India will depend primarily on area under its cultivation and the productivity. In the year 2019-20, India has produced 31.48 MT of seven edible oilseeds (Soybean, Rapeseed-Mustard, Groundnut, Sunflower, Sesame, Niger, and Safflower) from about 25.81 mha with an average productivity of 1220 kg/ha. The major oilseeds (Rapeseeds and Mustard, Soybean and Groundnut) contributed 96.68% of the total production and the rest 3.32% was contributed by four minor oilseeds (Sesame, Sunflower, Safflower, and Niger).

To meet the future target set for projected edible oil production in 2024-25, 2029-30 and 2034-34, the area, productivity and production of edible oilseeds need to grow at CAGR of 2.44%, 6.92% and 4.37%, respectively considering 2019-20 as base year **(Figure 2).**

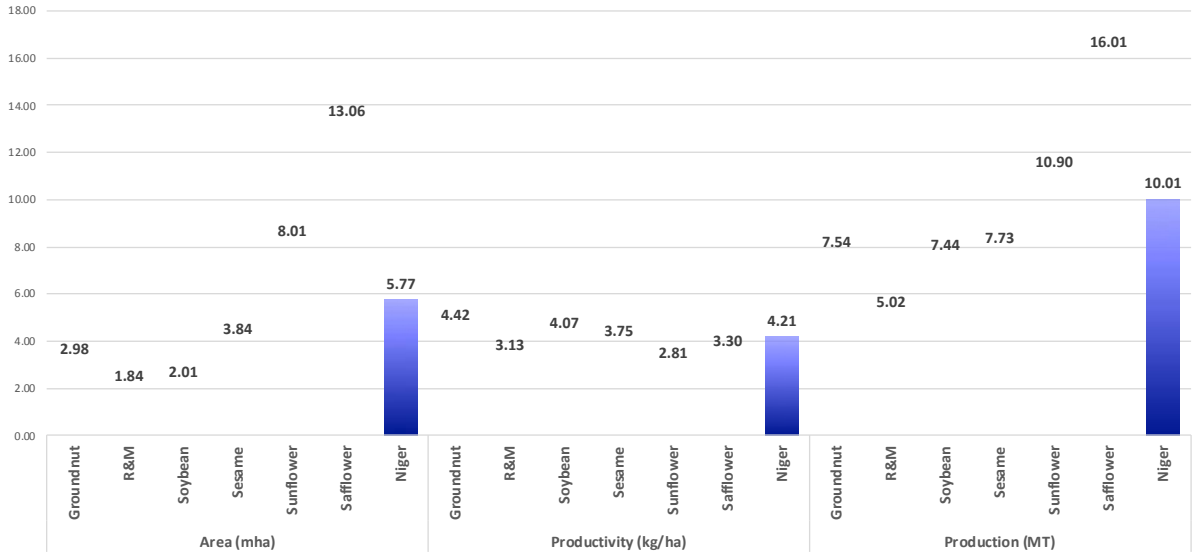


Figure 2. Projected Compound annual growth rate of edible oilseeds over next 15 years

The projected area to be covered under edible oilseeds in 2024-25, 2029-30 and 2034-35 will be 29.87, 33.85 and 37.98 mha, respectively **(Figure 3).**

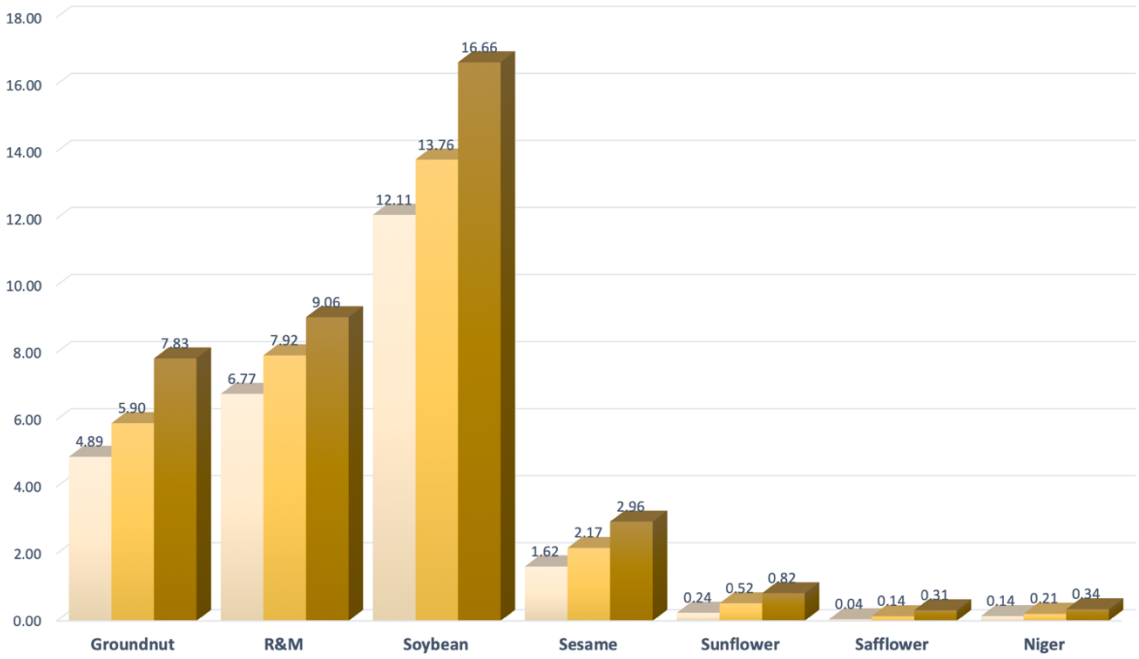


Figure 3. Projected area of edible oilseed crops

The projected productivity during the corresponding years will be 1771 kg/ha, 2123 kg/ha, and 2416 kg/ha. Consequently, because of increase in both area and productivity with technological interventions, the production of edible oilseeds will be 52.91, 71.86, and 91.78 MT during 2024-25, 2029-30 and 2034-35 to meet the target set for domestic production of edible oils from primary sources (Figure 4).

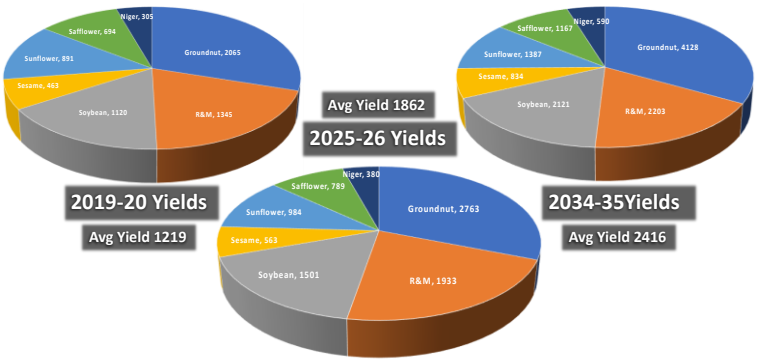


Figure 4. Current and projected yields of edible oilseeds

Whereas area under edible oilseeds cultivation need to grow at 15.71%, 13.33% and 12.21%, respectively in 2024-25, 2029-30 and 2034-35 over 2019-20, 2024-25 and 2029-30 as base year, respectively, productivity has also to grow simultaneously @ 45.26%, 19.84%, and 13.83% correspondingly. Because of double impact of increase in area and productivity, the production of edible oilseeds will be increased by 68.08%, 35.82%, and 27.72%, respectively in 2024-25, 2029-30, and 2034-35 over the base year 2019-20, 2024-25 and 2029-30. As a result, the domestic contribution to edible oil will grow significantly from 7.03 MT in 2019-20 to 13.49 MT in 2024-25, 17.21 MT in 2029-30 and 21.99 MT in 2034-35 with a CAGR of 7.39% over the base year of 2019-20 **(Figure 5)**.

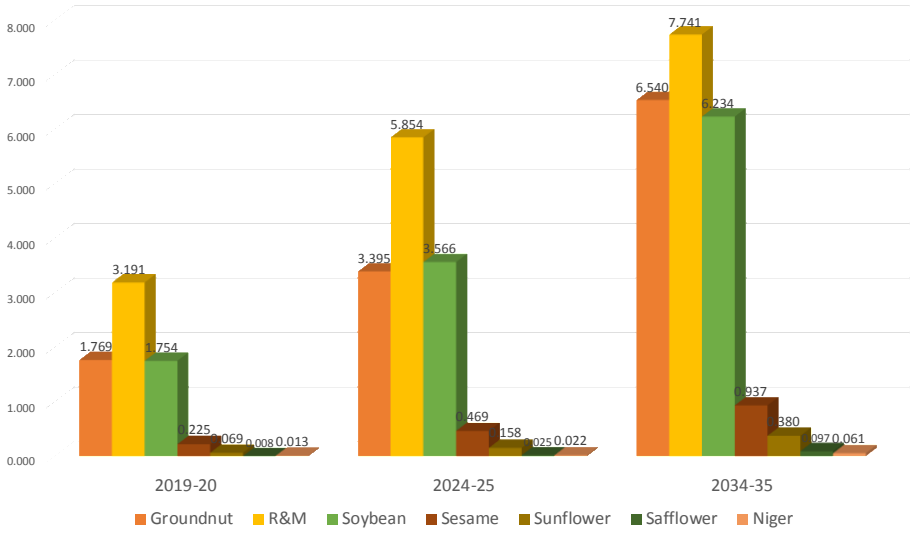


Figure 5. Estimated production of edible oil from edible oilseeds

In this endeavour, major contribution (on an average 90% in area, 96% in edible oilseed production and 95% in edible oil production) will come from three major edible oilseeds viz. Rapeseed-Mustard, Groundnut and Soybean **(Figure 6)**. Relative contribution of rest of the minor oilseeds will remain below 5%. Thus, major thrusts need to be given on expansion of area and improving the productivity of major oilseeds to bridge the future demand and supply gap to lessen the burden on import of edible oil.

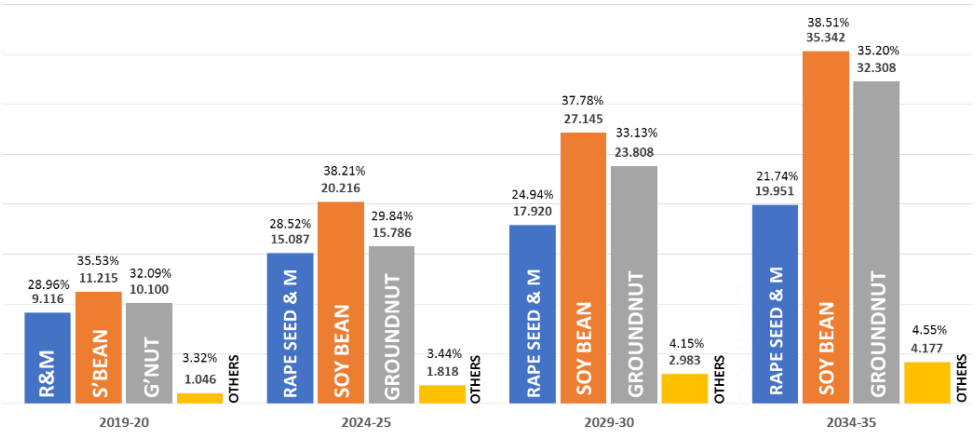


Figure 6. Relative contribution of edible oilseed crops to total production (%)

8. Demand and supply gap vis-à-vis import and dependency depending on projections

Enhancement in area and productivity of seven edible oilseeds alone will not be sufficient to meet the projected edible oil production target. Edible oils from secondary sources will play a significant role in this endeavour. At present, India produces around 3.5 MT of edible oil from secondary sources (Palm Oil, Cotton-seed oil, corn oil, coconut oil, rice bran oil and oil from TBOs). To bridge the demand and supply gap further, production of edible oil from secondary sources need to grow at CAGR of 4.87%. As a result, contribution of edible oils from secondary sources will be 4.51 MT in 2024-25, 5.81 MT in 2029-30 and 7.49 MT in 2034-35. Consequently, total supply of edible oils from primary- and secondary- sources domestically will be 18.0 MT, 23.03 MT and 29.48 MT in the year 2024-25. 2029-30 and 2034-35 **(Figure 7).**

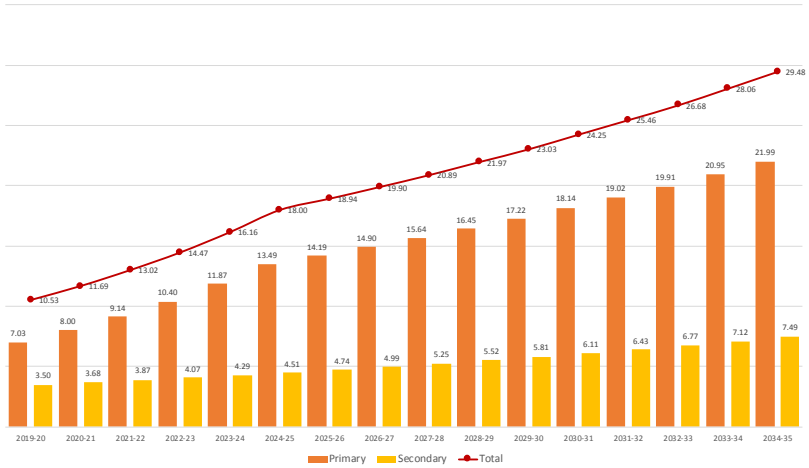


Figure 7. Total edible oil production- projections

Therefore, the projected demand (calculated at present rate of growth in consumption) will be 30.37 MT, 35.76 MT and 41.83 MT in the year 2024-25, 2029-30 and 2034-35, creating gap of 12.37 MT, 12.72 MT and 12.35 MT, respectively. The dependency on import of edible oils will be reduced drastically from around 60% in 2019-20 to 40% in 2024-25, 37% in 2029-30 and 30% in 2034-35 **(Figure 8)** calculated considering the growth in consumption at 2.48% annually. The decrease in dependency will be at CAGR of -4.22%. However, if *per capita* consumption of 19.22 kg in the year 2020-21 is maintained in subsequent years, the demand and supply gap be negligible in the year 2034-35 and India need not to import edible oils as against the demand of 29.69 MT, the domestic production will be 29.48 MT. The dependency on import will be drastically reduced from 60% in 2019-20 to 35% in 2024-25, 20% in 2029-30 and 0.7% in 2034-35 with CAGR of -24.19%.

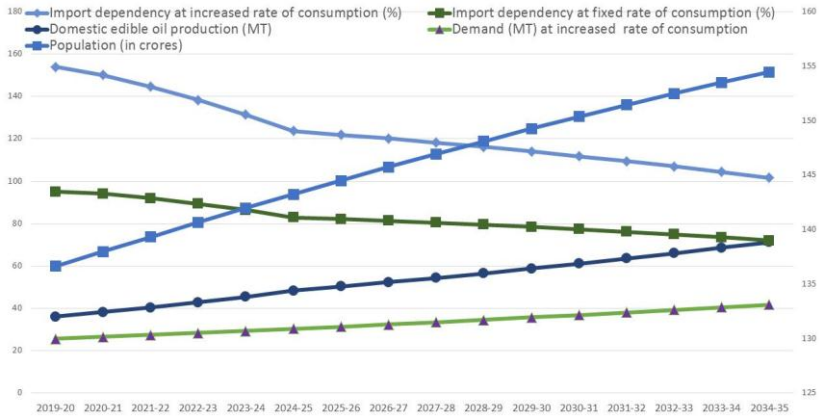


Figure 8. Estimates on the dependency on import of edible oil

9. Yield gaps

The existing yield gap for oilseeds is around 60 per cent. Highest scope exists in case of Sunflower (160 per cent), while for other crops the yield gaps range from 22 per cent (Sesame) to 81 per cent (Safflower). The yield gaps in major oilseeds, namely, Groundnut, Soybean and Rapeseed-Mustard range from 37 to 71 per cent. However, with the availability of high yielding varieties and matching agronomic and plant protection technologies location specifically, the yield gap can be bridged substantially. If the gap is reduced from 60% at present to 20% in next 10 years, yield can be improved substantially and additional production of 25-30 MT in edible oilseeds can be achieved without much difficulties which can contribute around 6-7 MT of edible oil to the kitty. This will further reduce the import dependency.

Roadmap to achieve self-sufficiency in edible oil production

10. Enhancing production of edible oilseeds

Through expansion in area

Projected increase in area under cultivation in next five years (2024-25)

As of now, the edible oilseeds is cultivated in around 25.81 mha during 2019-20 comprising 25.44 mha in traditional and only 0.37 mha in non-traditional areas. However, to enhance the production through expansion of area under cultivation, acreage has to grow both in traditional and non-traditional areas with a CAGR of 1.93% in traditional and 14.99% in non-traditional areas (Table 1, Figure 9). The area is projected to grow from 0.37 mha in 2019-20 to 1.57 mha, a jump of nearly 5 times but net area gain will be 1.20 mha in non-traditional areas. At the same time, area in traditional areas will improve from 25.44 mha in 2019-20 to 28.30 mha in 2024-25, an increase of about 11.25%, net gain of 2.85 mha. Contribution in net gain in area in non-traditional areas will come from Groundnut (0.28 mha: rice- and potato- fallows in West Bengal; Potato-fallows in Deesa-Gujarat and Western UP; rice fallows in Odisha and Jharkhand; NEH region; intercrops with sugarcane in UP, Odisha and Karnataka, etc.), Rapeseed-Mustard (0.11 mha: NEH region, part of Telangana, Andhra Pradesh, and Karnataka under conserved moisture and assured irrigated conditions), Soybean (0.64 mha: Andhra Pradesh, Arunachal Pradesh, HP, Jharkhand, UP, Uttarakhand, West Bengal, Punjab, Haryana and Odisha), Sunflower (0.1 mha: parts of Punjab, Haryana, Bihar, West Bengal, NEH region, Telangana, UP, and

Madhya Pradesh), Sesame (0.065 ha: parts of Bihar, Haryana, Punjab, Assam, and NEH region) and rest by safflower (0.012 mha: parts of Gujarat, Madhya Pradesh and Chhattisgarh) either as sole or as intercrops.

In the traditional areas, the edible oilseed crops are likely to regain some of their lost ground or expanded to new areas and there will be projected net gain of 2.85 mha (Groundnut: 0.54 mha in the states of Gujarat, Andhra Pradesh, Rajasthan, Maharashtra, Karnataka, Tamil Nadu, Madhya Pradesh, Odisha, Telangana and West Bengal; Rapeseed-Mustard: 0.93 mha in the states of Rajasthan, UP, Punjab, West Bengal, Haryana, Gujarat, and Assam; Soybean: 0.72 mha in the states of Madhya Pradesh, Maharashtra, Karnataka, Rajasthan and Gujarat; Sesame: 0.40 mha in the states of Karnataka, UP, West Bengal, Madhya Pradesh, Gujarat, Rajasthan, and Tamil Nadu; Sunflower: 0.14 mha in the states of Andhra Pradesh, Karnataka, Maharashtra, Tamil Nadu and Odisha; Safflower: 0.06 mha in the states of Maharashtra, Karnataka, Telangana and Andhra Pradesh; and Niger: 0.06 mha in the states of Odisha, Chhattisgarh, Assam, Gujarat and Madhya Pradesh).

Projected area under cultivation in next 10 years (2029-30)

During the five-year period of 2025-26 to 2029-30, the area in projected to grow from 1.57 mha in 2024-25 to 2.62 mha, a net area gain of 1.05 mha in non-traditional areas. At the same time, area in traditional areas will improve from 28.30 mha 2024-25 to 31.23 mha in 2029-30, an increase of about 10.36%, net gain of 2.93 mha. Total gain in area from both traditional and non-traditional areas will be 3.99 mha. Contribution in net gain in area in non-traditional areas will come from Groundnut (0.30 mha: rice- and potato- fallows in West Bengal; Potato-fallows in Deesa-Gujarat and Western UP; rice fallows in Odisha and Jharkhand; NEH region; intercrops with sugarcane in UP, Odisha, and Karnataka, etc.), Rapeseed-Mustard (0.08 mha: NEH region, part of Telangana, Andhra Pradesh, and Karnataka under assured irrigated conditions), Soybean (0.56 mha: Andhra Pradesh, Arunachal Pradesh, HP, Jharkhand, UP, Uttarakhand, West Bengal, Punjab, Haryana and Odisha), Sunflower (0.1 mha: parts of Punjab, Haryana, Bihar, West Bengal, NEH region, Telangana, UP, and Madhya Pradesh), Sesame (0.02 ha: parts of Bihar, Haryana, Punjab, Assam, and NEH region) and rest by safflower (0.012 mha: parts of Gujarat, Madhya Pradesh and Chhattisgarh) either as sole or as intercrops.

In the traditional areas, the edible oilseed crops are likely to expand to new areas and there will be project net gain of 2.93 mha (Groundnut: 0.69 mha in the states of Gujarat, Rajasthan, Andhra Pradesh, Maharashtra, Karnataka, Tamil Nadu, Madhya Pradesh, Telangana, Odisha and West Bengal; Rapeseed-Mustard: 0.52 mha in the states of Rajasthan, UP, Punjab, West Bengal, Haryana, Gujarat, and Assam; Soybean: 0.96 mha in the states of Madhya Pradesh, Maharashtra, Karnataka, Rajasthan and Gujarat; Sesame: 0.45 mha in the states of Karnataka, UP, West Bengal, Madhya Pradesh, Gujarat, Rajasthan, and Tamil Nadu; Sunflower: 0.13 mha in the states of Andhra Pradesh, Karnataka, Maharashtra, Tamil Nadu and Odisha; Safflower: 0.12 mha in the states of Maharashtra, Karnataka, Telangana and Andhra Pradesh; and Niger: 0.07 mha in the states of Odisha, Chhattisgarh, Assam, Gujarat and Madhya Pradesh).

Cumulatively, over the base year of 2019-20, there will be increase in area under edible oilseeds cultivation by 8.05 mha (5.79 mha in traditional and 2.26 mha in non-traditional areas).

Projected area under cultivation in next 15 years (2034-35)

During the five-year period of 2030-31 to 2034-35, the area in projected to grow from 2.62 mha in 2029-30 to 3.43 mha, a net area gain of 0.79 mha in non-traditional areas. At the same time, area in traditional areas will improve from 31.23 mha in 2029-30 to 34.56 mha, an increase of about 10.63%, net gain of 3.32 mha. Total grain in area from both traditional and non-traditional areas will be 4.13 mha. Contribution in net gain in area in non-traditional areas will come from Groundnut (0.10 mha: rice- and potato- fallows in West Bengal; Potato-fallows in Deesa-Gujarat and Western UP; rice fallows in Odisha and Jharkhand; NEH region; intercrops with sugarcane in UP, Odisha and Karnataka, etc.), Rapeseed-Mustard (0.10 mha: NEH region, part of Telangana, Andhra Pradesh, and Karnataka under conserved moisture and assured irrigated conditions), Soybean (0.53 mha: Andhra Pradesh, Arunachal Pradesh, HP, Jharkhand, UP, Uttarakhand, West Bengal, Punjab, Haryana and Odisha), Sunflower (0.20 mha: parts of Punjab, Haryana, Bihar, West Bengal, NEH region, Telangana, UP, and Madhya Pradesh), Sesame (0.01 ha: parts of Bihar, Haryana, Punjab, Assam, and NEH region) and rest by safflower (0.02 mha: parts of Gujarat, Madhya Pradesh and Chhattisgarh) either as sole or as intercrops.

In the traditional areas, the edible oilseed crops are likely to expand to new areas and there will be project net gain of 3.32 mha (Groundnut: 1.03 mha in the states of Gujarat, Rajasthan, Andhra Pradesh, Maharashtra, Karnataka, Tamil Nadu, Madhya Pradesh, Telangana, Odisha and West Bengal; Rapeseed-Mustard: 0.55 mha in the states of Rajasthan, UP, Punjab, West Bengal, Haryana, Gujarat, and Assam; Soybean: 1.15 mha in the states of Madhya Pradesh, Maharashtra, Karnataka, Rajasthan and Gujarat; Sesame: 0.39 mha in the states of Karnataka, UP, West Bengal, Madhya Pradesh, Gujarat, Rajasthan, and Tamil Nadu; Sunflower: 0.27 mha in the states of Andhra Pradesh, Karnataka, Maharashtra, Tamil Nadu and Odisha; Safflower: 0.18 mha in the states of Maharashtra, Karnataka, Telangana and Andhra Pradesh; and Niger: 0.13 mha in the states of Odisha, Chhattisgarh, Assam, Gujarat and Madhya Pradesh).

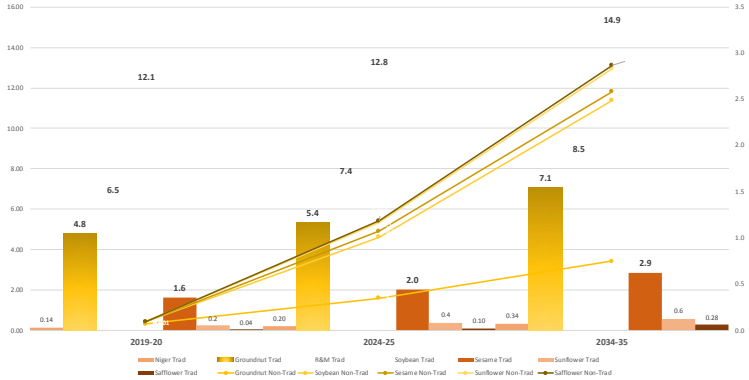


Figure 9. Projection of the expansion of area (mha) in oilseed crops

Table 1. Estimated expansion of area in million ha in oilseed crops

Year	Groundnut			R&M			Soybean			Sesame			Sunflower			Safflower			Niger	Total		
	Trad	Non-Trad	Total	Trad	Non-Trad	Total	Trad	Non-Trad	Total	Trad	Non-Trad	Total	Trad	Non-Trad	Total	Trad	Non-Trad	Total	Total	Trad	Non-Trad	Grand total
2019-20	4.8	0.1	4.9	6.5	0.3	6.8	12.1	0.0	12.1	1.6	0.0	1.6	0.2	0.0	0.24	0.04	0.001	0.04	0.14	25.447	0.367	25.81
2020-21	4.9	0.1	5.0	7.1	0.3	7.4	12.3	0.0	12.4	1.7	0.0	1.7	0.3	0.0	0.33	0.055	0.002	0.06	0.15	26.562	0.439	27.00
2021-22	5.1	0.1	5.2	7.2	0.3	7.5	12.5	0.1	12.6	1.8	0.0	1.8	0.4	0.0	0.36	0.065	0.003	0.07	0.16	27.133	0.547	27.68
2022-23	5.2	0.2	5.4	7.2	0.3	7.6	12.7	0.2	12.9	1.9	0.0	1.9	0.4	0.0	0.40	0.077	0.004	0.08	0.17	27.662	0.723	28.38
2023-24	5.3	0.3	5.5	7.3	0.4	7.7	12.8	0.3	13.2	2.0	0.0	2.0	0.4	0.0	0.44	0.09	0.007	0.10	0.18	28.099	1.023	29.12
2024-25	5.4	0.4	5.7	7.4	0.4	7.8	12.8	0.7	13.5	2.0	0.1	2.1	0.4	0.1	0.48	0.10	0.012	0.12	0.20	28.301	1.565	29.87
2025-26	5.5	0.4	5.9	7.5	0.4	7.9	13.0	0.7	13.8	2.1	0.1	2.2	0.4	0.1	0.52	0.12	0.014	0.14	0.21	28.883	1.732	30.61
2026-27	5.6	0.4	6.1	7.6	0.4	8.0	13.2	0.8	14.1	2.2	0.1	2.3	0.4	0.1	0.56	0.14	0.016	0.16	0.22	29.466	1.919	31.38
2027-28	5.8	0.5	6.3	7.7	0.4	8.2	13.4	1.0	14.4	2.3	0.1	2.4	0.5	0.2	0.61	0.16	0.019	0.18	0.24	30.055	2.129	32.18
2028-29	5.9	0.6	6.5	7.8	0.4	8.3	13.6	1.1	14.7	2.4	0.1	2.5	0.5	0.2	0.66	0.19	0.021	0.21	0.25	30.638	2.364	33.00
2029-30	6.1	0.6	6.7	7.9	0.5	8.4	13.8	1.2	15.0	2.5	0.1	2.6	0.5	0.2	0.71	0.22	0.025	0.25	0.27	31.235	2.625	33.86
2034-35	7.1	0.7	7.8	8.5	0.6	9.1	14.9	1.7	16.7	2.9	0.1	3.0	0.6	0.2	0.82	0.28	0.035	0.31	0.34	34.556	3.428	37.98
CAGR (%)	**2.43**	**15.96**	**2.98**	**1.69**	**4.63**	**1.84**	**1.32**	**30.72**	**2.01**	**3.63**	**32.84**	**3.84**	**5.62**	**41.20**	**8.01**	**12.40**	**24.77**	**13.06**	**5.77**	**1.93**	**14.99**	**2.44**

Cumulatively, over the base year of 2019-20, there will be increase in area under edible oilseeds cultivation by 12.07 mha (9.11 mha in traditional and 3.06 mha in non-traditional areas).

In this endeavour, area under edible oilseeds in non-traditional areas will be: in rice-fallows (about 12.5 mha available)-around 2.1 mha; potato- fallows: 0.3 mha; intercrops: 0.3 mha; NEH: 0.1 mha; others: 0.26 mha in a span of next 15 years. This is without affecting existing cropping systems. However, there is need for discouraging cultivation of crops requiring more inputs and water. Some area under wheat and potato can be converted for cultivation of Rapeseed-Mustard in rabi-season (**Responsibility**: DAC, State Government, SAUs).

Interventions required for expansion of area:

- Providing suitable high yielding short duration varieties (90-100 days duration with yield target of >4000 kg/ha for groundnut with fresh seed dormancy, >2000 kg/ha for Rapeseed-Mustard, >2500 kg/ha for soybean, >1500 kg/ha for sunflower; >1000 kg/ha for sesame; >1000 kg/ha for other oilseeds) equipped with tolerant to biotic and abiotic stresses of all edible oilseeds available for non-traditional areas (potato fallows, rice fallows, NEH region, inter- and sequential cropping systems, hilly terrains, river beds, etc.). **Responsibility**: Crop Institutes, SAUs, ICAR
- Providing medium duration and high yielding varieties (yield target of >3500 kg/ha for groundnut for rainfed, >2500 kg/ha for Rapeseed-Mustard, >3500 kg/ha for soybean, >1000 kg/ha for sesame and other oilseeds for rainfed) tolerant to abiotic stresses like drought- and salinity- stress and biotic stresses like soil-born and foliar fungal diseases for traditional areas: **Responsibility**: Crop Institutes, SAUs, ICAR
- Development of required processing and marketing infrastructure in non-traditional areas. **Responsibility**: State Government, DAC, NGOs
- Popularization of edible oilseeds in non-traditional areas: **Responsibility**: State Government, DAC, NGOs, KVK, SAUs
- Production and making quality seeds available to farmers in traditional and non-traditional areas in PPP mode: **Responsibility**: State Seed Corporations, DAC, NSC, SFCI, NGOs, KVK, FPOs, SAUs, State Department of Agriculture
- Mechanization of farm operation for reducing input cost and contract farming involving KVKs, NGOs, FPOs, SAUs
- Policy support: Higher MSP, incentives for adopting micro-irrigations and assured buyback policy: **Responsibility**: DAC
- R&D support: Liberal funding for development of high yielding varieties of all edible oilseed crops suitable for existing and newer niches: **Responsibility**: DAC, ICAR

Through enhancing productivity

To meet the growing demand of edible oils, production needs to be enhanced to match up the demand and supply gap. That can be achieved through expansion of area and enhancing productivity. To meet the projected target of overall production of edible oilseeds of 52.91 MT, 71.86 MT and 91.78 MT in 2024-25, 2029-30 and 2034-35, respectively, the overall productivity has to be increased by 45.26%, 19.84% and 13.83% during the corresponding period with an overall CAGR of 7.39% during the entire period of next 15 years and estimated at 1771 kg/ha, 2123 kg/ha and 2416

kg/ha, respectively in 2024-25, 2029-30 and 2034-35, respectively. All the edible oilseeds need to contribute in improving the productivity. Thus, productivity of Groundnut, Rapeseed-Mustard, Soybean, Sesame, Sunflower, Safflower and Niger has to be enhanced by 33.82%, 43.74%, 34.01%, 21.67%, 10.41%, and 13.66% individually by the year 2024-25, respectively. Similarly, in the year 2029-30, the productivity will be improved further in Groundnut, Rapeseed-Mustard, Soybean, Sesame, Sunflower, Safflower and Niger by 28.84%, 10.26%, 20.73%, 21.67%, 21.67%. 27.63% and 33.82%, respectively (Table 2).

Table 2. Expected enhancement in the productivity

Year	Groundnut	R&M	Soybean	Sesame	Sunflower	Safflower	Niger	Mean
2019-20	2065	1345	1120	463	891	694	305	1219
2020-21	2189	1520	1235	482	909	708	319	1433
2021-22	2320	1614	1297	501	927	722	333	1511
2022-23	2459	1714	1361	521	946	736	348	1593
2023-24	2607	1820	1429	542	964	751	364	1680
2024-25	2763	1933	1501	563	984	789	380	1771
2025-26	2929	2053	1561	586	1023	828	403	1862
2026-27	3076	2063	1623	609	1064	870	427	1922
2027-28	3229	2110	1688	634	1107	913	453	1994
2028-29	3391	2121	1756	659	1151	959	480	2060
2029-30	3561	2132	1812	685	1197	1007	509	2123
2030-31	3667	2142	1870	713	1233	1037	524	2177
2031-32	3777	2157	1930	741	1270	1068	540	2234
2032-33	3891	2172	1992	771	1308	1100	556	2292
2033-34	4007	2188	2055	802	1347	1133	572	2353
2034-35	4128	2203	2121	834	1387	1167	590	2416
CAGR (%)	**4.42**	**3.13**	**4.07**	**3.75**	**2.81**	**3.30**	**4.21**	**4.37**

Further improvement is predicted for Groundnut, Rapeseed-Mustard, Soybean, Sesame, Sunflower, Safflower and Niger by the year 2034-35 to the tune of 15.93%, 3.34%, 17.06%, 21.67%, 15.93%. 15.93% and 15.93%, respectively.

The herculean task of enhancing productivity in a sustained manner over a span of 15 years with a CAGR of 4.37% can only be achieved with the following interventions:

Development of high yielding varieties: Responsibility: Crop Institutes, SAUs, ICAR

Development of high yielding varieties is of immediate priority adoption of which can improve the productivity by 25-30%. High yielding varieties developed in last 10 years and available for different edible oilseeds for enhancing productivity are listed in Table 3. The average target yield of different edible oilseeds will be as under for overall productivity enhancement from 1220 kg/ha in 2019-20 to 1771 kg/ha in 2024-25, 2123 kg/ha in2029-30 and 2416 kg/ha in 2034-35. The varieties should also be tolerant to drought- and or salinity- stress and tolerant to major soil-borne and foliar diseases and pests.

Table 3. List of available high yielding varieties of edible oilseeds developed in India during last 9-10 years for enhancing productivity

A. Groundnut

S. No.	Name of Variety	State	Year of release	Pod yield (kg/ha)	Oil content (%)	Maturity (days)	Salient features
1	JL 501	Gujarat and southern Rajasthan	2010	1660	48.0	102	Comparatively lowest intensity of LLS was observed in case of JL-501 as against higher in variety JL-24;Suitable for early as well as late sown conditions
2	Vijetha (R 2001-2)	W.B., Orissa, Jharkhand, Assam, Maharashtra, Karnataka, A.P. &, T.N.	2010	1630 (Zone IV); 2522 (Zone V)	46-48	105-110	Resistant to PBND
3	Girnar 3 (PBS 12160)	W.B, Orissa, Manipur	2010	1520	45.0	104-111	Tolerant of leaf miner and thrips
4	Kadiri Harithandhra (K 1319)	Karnataka and Maharashtra	2010	3720	48.0	122	Multiple diseases (rust, ELS, LLs, stem rot, PBND) and insect pests (thrips, *Spodoptera litura,jassid, Helicoverpa)* resistant, Possesses fresh seed dormancy (upto 20days)
5	GPBD-5	Jharkhand and Manipur	2010	1500	46.0	105-110	Resistant toLLS and rust
6	HNG 69	U.P., Punjab and northern Rajasthan	2010	2800	50.0	131	Tolerant to collar rot, stem rot and ELS
7	GJG-HPS-1 (JSP-HPS-44)	Gujarat	2010	2120	49.0	116	Tolerant to PBND
8	RARS-T-1	Andhra Pradesh	2011	2500 (kharif); 4000 (rabi)	44.0	115	Tolerant to leaf spots and rust, sucking pests (thrips and jassids), Bold seeded pods
9	RARS-T-2	Andhra Pradesh	2011	3734 (kharif); 4200 (rabi)	48.0	90-95	Moderate tolerance to Spodoptera litura and leaf hoppers, early maturity
10	Pratap Raj Mungphali	Rajasthan	2011	1432	48.0	97	Tolerant to ELS, LLS, PBND, jassids, thrips and leaf miner and Spodoptera litura, Early maturity

11	Raj Durga (RG 425)	Rajasthan	2011	1788	49.8	128	Moderately resistant to tikka, rust, PBND, collar rot and stem rot
12	Divya (CSMG 2003-19)	UP and Rajasthan	2011	2757	49.0	129	Tolerant to PBND
13	ICGV 00350	Tamil Nadu and Andhra Pradesh	2012	2988	50.0	114	Resistant to LLS and rust, Tolerant to stem rot
14	HNG 123	Rajasthan, UP and Punjab	2012	2648	49.0	124	Tolerant to collar rot, stem rot, LLS, Spodoptera lirura and leaf miner
15	Raj Mungfali-1 (RG 510)	Rajasthan and Punjab	2012	2558	49.0	125-130	Tolerant to collar rot, stem rot, LLS, *peanut stem necrosis diseases, thrips, jassids and grass hopper*
16	CO 6	Tamil Nadu	2012	1914	49.5-51	125-130	Resistant to LLS and rust
17	GJG 31 (J 71)	Gujarat	2012	3483	49.2	117	Tolerant to stem rot
18	GJG 9 (J 69)	Gujarat	2012	1632	48.0	103	Tolerant to stem rot
19	GJG-22 (JSSP 36)	Gujarat	2013	1770	51.6	118	Tolerant to collar rot
20	GJG-17 (JSP-48)	Gujarat	2013	1798	48.0	121	Tolerant to stem rot
21	Dharani (TCGS 1043)	Andhra Pradesh	2013	1887 (Kharif); 2666 (rabi-summer)	48-50	105-110	Tolerant to stem rot, dry root rot, Drought tolerant
22	GJG 18 (JSP 49)	Odisha, West Bengal, Jharkhand and Manipur	2015	1450	48.0	121	Moderately resistant to PBND and PSND
23	Raj Mungfali-2 (RG 578)	Odisha, West Bengal and Manipur	2015	1480	46.0	120	Resistant to LLS, dry root rot,ELS and rust ; tolerant to *S. litura*, thrips, jassids and leaf miner
24	Birsa Groundnut 4 (BAU 25)	Jharkhand	2015	2000-2200	50.8	115-120	Resistant to LLS, Tolerant to occasional dry spell; large seeded
25	Groundnut Co 7	Tamil Nadu	2015	2300 (*kharif*); 2806 (rabi-summer)	50.5-51	100-105	Resistant to rust

26	Phule Bharti (JL 776)	Maharashtra and Madhya Pradesh	2015	2110	50.0	108	Resistant to *S. litura* and rust in field condition
27	G 2-52	Karnataka	2015	2000-2500	48.0	105-110	Foliar disease resistant
28	GJG 19 (JSP 51)	Odisha, West Bengal, Jharkhand and Manipur	2016	1876	47.0	122	Tolerant to stem rot, dry root rot and rust as compared to check (KDG 123)
29	Raj Mungfali 3 (RG 559-3)	Rajasthan, UP and Punjab	2016	3173	49.0	125	Tolerant to *S. litura*, leafminer and thrips, High yielding; large seeded
30	Phule Warna (KDG 128)	Tamil Nadu, Andhra Pradesh, Karnataka, southern Maharashtra Gujarat and Rajasthan	2016	2425	50.9	113	Moderately resistance to rust and leaf spot
31	Phule Morna (KDG 123)	Gujarat, Rajasthan Odisha, West Bengal, Jharkhand, Manipur, Tamil Nadu, Andhra Pradesh, Karnataka and Southern Maharashtra	2016	2212	44.0	114	Moderately resistance to rust and leaf spot
32	KCG 6 (CTMG 6)	Karnataka	2016	3663	51.0	116	Moderately resistance to rust and late leaf spot
33	GKVK 5	Southern Karnataka	2016	2500-2800	50.0	115-120	Moderately resistance to rust and LLS, Drought tolerant
34	ALG -06-320	Tamil Nadu and Andhra Pradesh	2017	2741	50.3	115	Tolerant to rust, LLS and Peanut Bud Necrosis disease (PBND), *S. litura*, leaf miner and thrips
35	Kadiri Amaravathi (K 1535)	Andhra Pradesh	2017	1600-1800	50.0	110-115	Tolerant to leaf spot, sucking pests (thrips and jassids), Tolerant to early and late season drought
36	VRI 8 (VG 09220)	Tamil Nadu	2017	2130 *(Kharif)*; 2700 (Rabi-summer)	49.0	105-110	Moderately resistant to sucking pest (jassids and thrips), moderately resistant to LLS and rust
37	GJG 32 (ICGV 03043)	Tamil Nadu, Andhra Pradesh, Karnataka,	2018	1947	50.0	109	Tolerant to stem rot, color rot and rust

		southern Maharashtra and Telangana, Gujarat (Area extention)					
38	GJG 33 (ICGV 07222)	Tamil Nadu, Andhra Pradesh and Telangana	2018	3064	51.0	113	Tolerant to color rot and rust
39	DH-232	Karnataka	2018	2500-3000	46.9	105-110	Resistance to Foliar diseases, High Shelling (78.7%)
40	DH-245	Karnataka	2018	2500-2900	45.9	105-108	Resistance to Foliar diseases, High oleic acid (>70%)
41	Avtar (ICGV 93468)	Uttar Pradesh	2018	2400	51.1	85-95	Tolerant to BND, Fungal diseases, Jassidand pod borer, Early maturity
42	TMV 14	Tamil Nadu	2019	2124	48.0	95-100	Tolerant to S. *litura*, thrips, leaf minor; moderately resistance to LLS and rust, Early maturity
43	Phule Chaitanya (Central- KDG 160)	Tamil Nadu, Telangana and Andhra Pradesh	2019	2184	51.6	116	Moderately resistant to stem rot and LLS, High Oil content (51.6%)
44	Konkan Bhuratna (RTNG-29)	Maharashtra	2019	2500-3000	50.0	110-115	Resistance to ELS, LLS, rust, PBND, thrips, jassids and leaf miner, High Oil content (50.1%)
45	Gujarat Groundnut HPS 2 (GG HPS 2)	Gujarat	2019	2835	48.8	115-124	Large seeded
46	AK 335 (PDKVG-335)	Maharashtra	2019	2200-2400	48-49	110-113	Moderately resistance to tikka, color rot, stem rot, jassid, thrips and aphids
47	Phule Unnati (RHRG 6083)	Maharashtra	2019	2854 *(Kharif*); 3990 (Rabi-Summer)	52.0	111-128	Resistance to LLS, stem rot, rust, S. litura, and thrips, High Oil content (52%)
48	Phule Dhani (JL 1085)	Tamil Nadu, Andhra Pradesh and Karnataka	2019	3333	50.0	109	Resistance to LLS and rust

49	Gujarat Groundnut-34 (GG 34)	Gujarat	2019	3715	52.8	111-125	High Oil content (52.8%)
50	Dheeraj (TCGS 1073)	Andhra Pradesh	2019	2547 *(Kharif*); 3690 (Rabi)	48-49	105-115	Possesses heat tolerance and high water use efficiency
51	BSR 2 (BSG 0912)	Tamil Nadu	2019	2222 *(Kharif*); 2360 (Rabi-summer)	45.0	105-110	Moderately resistance to rust, LLS, jassid, thrips and aphids
52	Central-Pragati (TCGS 894)	Tamil Nadu, Telangana and Andhra Pradesh	2019	2816	48.0	115	-
53	Dh 256	Tamil Nadu, Andhra Pradesh, Karnataka and Telangana	2019	3258	50.0	110-115	Tolerant to S. litura, thrips and leaf miner and leaf hopper and mid-season drought
54	Girnar 4	Tamil Nadu, Karnataka, Andhra Pradesh, Gujarat, Rajasthan, Telangana	2020	3114	51.0	115	High oleic acid content (78%)
55	Girnar5	Tamil Nadu, Karnataka, Andhra Pradesh, Gujarat, Rajasthan, Telangana	2020	3112	50.0	115	High oleic acid content (78%)
56	Jagtiala Palli (JCG2141)	Telangana	2020	2560	49.0	110	Foliar disease resistant
57	Pratap Mungfali-3 (UG116)	Rajasthan	2020	2750	50.0	110	High yield
58	ICGV06189	Karnataka	2020	2650	50.0	110	High yield
59	GG41 (Padma, JSP 65)	Gujarat	2020	2680	50.0	105	High yield

b. Soybean

	North Hill Zone	North Plain Zone	Central Zone	Southern Zone	Eastern Zone	North Eastern Hill Zone
States	Himachal Pradesh, North hills of Uttarkhand.	Punjab, Haryana, Delhi, North-Eastern plains of U.P., Plains of Uttarkhand, Western Bihar	M.P., Bundelkhand region of U.P., Rajasthan, Gujrat, Northern and western parts of Maharashtra and Orissa	Karnataka, Tamil Nadu, Andhra Pradesh, Kerala, Southern parts of Maharashtra	Chhattisgarh, West Bengal, Bihar, Orissa	Assam, North eastern hill states
Varieties	VL Soya 59, VLS 6363, PS 1556, VLS 89	SL 979, SL 958, SL 955, PS 1477, SL 1079, NRC 128	RVS 2002-4, JS 20-69, NRC 86, JS 20-34, JS 20-29, RVS 2001-4, JS 20-98, JS 20-116, RSC 10-46, AMS-MB-5-18, NRC 130, JS 20-94	KDS 726, DSb 23-2, MACS 1281, KDS 344, DSb 21, MACS 1188, DSb 28, KDS 753, MACS 1460, NRC 132, NRC 147	NRCSL1, NRC 132, NRC 147, RSC 10-46, RSC 10-52, RSC 11-07, NRC 128	RKS 113, MACS 1407, MACS 1460, KDS 753

c. Rapeseed-Mustard

i. Indian Mustard released during 2011-2020

S. No	Name of the Variety	State/Area of Adaptability	Year of Release	Yield (kg/ha)	Oil Content (%)	Maturity (days)	Salient features
1.	Pusa Mustard -26 (NPJ-113)	Zone-II (Delhi, Haryana ,Punjab, J&K and part of Rajasthan)	2011	1481-1895	30-41	115-137	Suitable for late sown (November sowing) irrigated conditions, moderately tolerant to high temperature at seedling and maturity stage

2.	Pusa Mustard -27 (EJ-17)	Zone III (MP, Uttar Pradesh, Uttarakhand and Rajasthan)	2011	1437-1659	39.6-45.4	108-135	Suitable for early sown (September sowing) irrigated conditions, tolerant to high temperature at seedling and maturity stage
3.	RLC 2	Punjab, Haryana, NCR, parts of Rajasthan	2011	2039-2342	35.2-40.2	132-155	Low (less than 2%) erucic acid ('0') variety of raya
4.	Coral 437 (PAC 437) (Hybrid)	Zone-II (Delhi, Haryana, Punjab, Jammu and parts of Rajasthan)	2012	2032-2772	39.4-41.2	140-150	Hybrid, tolerant to white rust
5.	Pant Rai 18 (PR 2006-1)	Delhi ,Haryana,	2012	1831-3511	39.4-42.4	99-133	Tolerant to high temperature, for late sown irrigated condition
6.	Giriraj (DRMRIJ 31)	Delhi, Haryana, Jammu, Punjab and northern Rajasthan	2013	2246-2767	38.7-42.5	137-153	Large seed, seed yield
7.	RH 0406	Delhi, Haryana, Jammu and Kashmir, Punjab and parts of Rajasthan	2013	2200-2300	38-40	145-150	Suitable for timely sown rainfed conditions, lodging resistant; bold seeded
8.	Divya-33	Rajasthan, Punjab, Haryana and Jammu & Kashmir	2013	1699-3560	36-40.7	136-161	Suitable for timely sown irrigated conditions
9.	Raj Vijay Mustard 2 (JMWR 08-3) (RMV 2)	Delhi, Haryana, Jammu and Kashmir, Punjab and parts of Rajasthan	2013	1674	37.1-41.2	120-141	Moderately resistant to white rust
10.	RH 0749	Delhi, Haryana, Jammu and Kashmir, Punjab and parts of Rajasthan	2013	2600-2800	39-39.8	124-142	Suitable for timely sown irrigated condition; large seed, long siliqua; dominance of primary branches
11.	Pusa Mustard 29 (f)	Delhi, Haryana, Jammu and Kashmir, Punjab and Rajasthan	2013	1927-2568	30.0-39.8	131-155	Low erucic acid; timely sown irrigated, condition
12.	Pusa Mustard 30 (LES 43)	Uttar Pradesh, Uttarakhand,	2013	1564-2238	36-39.4	137	Low erucic acid; timely sown

		Madhya Pradesh. Rajasthan					irrigated condition
13.	RRN 573	Rajasthan	2013	2072	41.58	137	Irrigated, normal sown condition
14.	RGN 229	Delhi, Haryana, Punjab, Jammu and parts of Rajasthan	2013	2162-2568	40.7	146	Tolerant to high temperature and salinity during seedling stage
15.	RGN 236	Delhi, Haryana, Punjab, Jammu and parts of Rajasthan	2013	1636	39.1	127	Tolerant to high temperature and salinity during seedling stage
16.	Gujarat Mustard-3 (GM-3)	Gujarat	2015	1661-2811	38-40.06	103-112	Irrigated conditions, Early, Bold seeded (6.02 g/1000 seed wt.), Tolerant to high temperature
17.	Gujarat Dantiwada Mustard-4 (GDM-4)	Gujarat	2015	1850-3031	38.40-39.02	104-115	Irrigated conditions, High Yield, Bold seeded, High oil content, tolerant to powdery mildew and aphids
18.	Albeli-1	Eastern Rajasthan, Madhya Pradesh, Uttar Pradesh, Uttarakhand	2015	2133	40.8	140-145	Irrigated conditions; tolerant to Alternaria blight, white rust and powdery mildew
19.	Pant Rai-20	Rajasthan, Punjab, Haryana, Delhi, Jammu and Kashmir and	2012/2015	2500-3000	40	122-128	High yielding, medium maturity, bold seeded, suitable for irrigated/rainfed timely sown conditions. High temperature tolerance at maturity.
20.	PBR-357	Punjab, Haryana, NCR, parts of Rajasthan	2015	2039-2342	35.2-40.2	132-155	Bold seeded
21.	RGN-298	Rajasthan, Punjab, Haryana, Delhi, Jammu and Kashmir and Uttar Pradesh	2015	2172	40	143	Suitable for rainfed conditions
22.	Pusa Mustard 28	J & K (Plains), Punjab, Haryana, Rajasthan, Delhi and Western UP.	2016	933-3003	40-42.8	107	Suitable for early (September) sown irrigated conditions and a good substitute to *B. rapa* cv. Toria

23.	Pusa Double Zero Mustard- 31 (PDZ 1)	NCR region of Delhi	2016	2234	40.7	142	Low erucic acid and low glucosinolate
24.	RLC 2 (IC 5 1 1 6 1 5)	Punjab	2016	2039-2342	36.3-38.9	142-150	Low erucic acid
25.	PBR 378	Punjab, Haryana, parts of Rajasthan	2016	1228-3484	37.7-41.9	134-156	Timely sown rainfed conditions
26.	Gujarat Dantiwada Mustard 5 (GDM 5)	Punjab, Haryana, Jammu, Northern Rajasthan and Delhi	2016	2081-2360	38.0-41.4	134-135	High Yield, High oil content (40.50%), Tolerant to lodging and shattering, Suitable for timely sown rainfed conditions
27.	Raj Vijay Mustard 1	Madhya Pradesh	2016	1389-2019	40.2-43.1	98-121	Suitable for rainfed conditions
28.	RLC-3	Irrigated conditions of Punjab	2016	2175 -2435	41.5	138 -150	Double low, yellow seeded, white rust immune variety
29.	CS-58 (CS 1100 - 1-2-2-3)	Haryana, Punjab and Uttar Pradesh	2017	1734-2168	38.5-39.5	128-142	Salinity tolerant
30.	Pant Rai-21	Suitable for irrigated timely sown conditions of Uttarakhand plains	2015/2017	2500-3000	40	122-125	High yielding, medium maturity, bold seeded, long siliqua, long main raceme
31.	RH-725	Jammu, Punjab, Haryana, Delhi and Northern Rajasthan	2018	2500-2600	40.2	136-143	Suitable for timely sowing and rainfed conditions, moderately resistant to Alternaria leaf blight, white rust and aphid Infestation
32.	CS-60 (CS2800-1-2-3-5-1)	Haryana, Punjab, Uttar Pradesh and Rajasthan	2018	1900-2200 Under saline and alkali soil conditions	40-41	125-132	Highly suitable for timely sown, salt-affected soil and water conditions with salinity level (ECe) up to 12.0 dS /m, water salinity up to 15 dS/m and alkali soils up to pH 9.5, resistant

							to Alternaria blight, WR, PM, DM, stag head and SR, tolerant to aphid
33.	Pusa Double Zero Mustard-31 (PDZ-1)	Rajasthan, Punjab, Haryana, U.P., Delhi & Jammu and H.P.	2018	2234	40.7	141-152	Suitable for timely sowing under rainfed conditions
34.	RSPR-69 (MCN-04-35)	Jammu region	2019	1990	39.4	135-145	Suitable for irrigated and rainfed areas, timely sown, resistant to white rust and moderately resistant to Alternaria blight and major pests
35.	TBM-204 (Trobay Bidhan Mustard- 204) TM-204	West Bengal	2019	1500-1800	41	110-115	Timely sown irrigated condition, resistant to white rust and Alternaria blight and negligible to moderate to aphid infestation
36.	RH 761	Jammu, Punjab, Haryana, Delhi and Rajasthan (Northern Region)	2019	2500-2600	40.4	137-143	Suitable for timely sowing and rainfed conditions, long siliqua with bold seeds
37.	Azad Mahak KMR(E) 15-2	Uttar Pradesh	2020	2047	41.60	120-125	Tolerant to high temperature, it escapes from diseases ,*Alternaria blight*, *white rust* and fog.
38.	Pusa Mustard 32 (LES 54)	Zone – II, Rajasthan (Northern and Western parts), Punjab, Haryana, Delhi, Western Uttar Pradesh, Plains of Jammu & Kashmir and Himachal Pradesh	2020	2067	37.5-39.0	143-147	Timely sown irrigated conditions, Low erucic acid variety
39.	DRMR 2017-15 (Radhika)	Zone – II, Rajasthan (Northern and Western parts), Punjab, Haryana, Delhi, Western Uttar Pradesh, Plains of Jammu &	2020	1686-1847	40.7	131	Suitable for late sowing under irrigated conditions, high seed and oil yield

		Kashmir and Himachal Pradesh					
40.	DRMRIC 16-38 (Brijraj)	Zone – II, Rajasthan (Northern and Western parts), Punjab, Haryana, Delhi, Western Uttar Pradesh, Plains of Jammu & Kashmir and Himachal Pradesh	2020	1733	37.6-40.9	120-149	Suitable for late sowing under irrigated conditions high seed and oil yield
41.	DRMR 1165-40	Jammu, Punjab, Haryana, Delhi and Rajasthan (Northern Region)	2020	2200-2600	41.2	142	Rainfed, timely sown
42.	DRMR 150-35	Zone-V (Orissa, WB, Bihar, Jharkhand, Chhattisgarh and Assam)	2020	1200-1800	36.7-42.8	114	Rainfed condition

ii. Yellow Sarson

S. N.	Name of the Variety	State/ Area of Adaptability	Year of Release	Yield (kg/ha)	Oil Content (%)	Maturity (days)	Salient features
1.	Pant Sweta	Uttarakhand plains	2015/2017	1600-2000	45	105-110	High yielding, suitable for sowing in October under irrigated conditions, tetralocular upright bearing and cream colour flowers
2.	Pant Girija	Plains of Uttarakhand	2018/2020	1400-1700	45.30	92-128	Medium maturity, yellow flowered upright, bilocularsiliqua bearing.

iii. Toria

S. N.	Name of the Variety	State/ Area of Adaptability	Year of Release	Yield (kg/ha)	Oil Content (%)	Maturity (days)	Salient features
1.	Sushree	Odisha	2015	1381	42.15	75-83	Suitable for late sown condition and nonlodging type
2.	TWC2 (Composite 2)	Eastern India	-	1000-1200	42	75-80	
3.	TL 17	Toria growing districts of Punjab	2016	*1300*	42	90	Suitable for multiple cropping systems. Escapes major diseases and pests
4.	Sushree	Odisha	2015	1381	42.15%	75 -83	Suitable for late sown condition and non-lodging type
5.	Pant Hill Toria-1	Uttarakhand hills.	2015/2017	900-1200	42	122-134	High yielding, suitable for sowing under rainfed conditions.
6.	Pant Toria-508	Uttarakhand plains	2015/2017	1600-1900	42	91-96	High yielding, suitable for sowing in September under irrigated conditions.
7.	Raj Vijay Toria 1	Madhya Pradesh	2017	1276-1874	41.2	98-105	Tolerant to drought, suitable for rainfed and irrigated condition, tolerant to shattering, sowing lime - first to second week of September
8.	Tapeshwari (TK 06-1)	Uttar Pradesh	2018	13.5-14	41.96	90-95	Suitable for rainfed, irrigated areas and recommended for extra early sowing, i.e. mid September, tolerant to drought and fog, being extra early maturity, it escapes diseases especially Alternaria blight, aphid and white rust.
9.	Tripura Toria 1 (TRC T-1-1-5-1/ IC 615573)	Tripura	2018	800-900		86	Suitable for rainfed upland and lowland after kharif, perform well under residual moisture after kharif rice, also as utera crop, maturity: resistant to lodging, exhibits very low incidence of white rust, Sclerotinia rot, bacterial stem rot and aphid.
10.	RSPT-6 (TCN 13-9)	Jammu Region	2019	1130	42.6	85-90	Moderately resistant to white rust, downy mildew, Alternaria blight, aphid and major pests

11.	Azad Chetna (TKM 14-2)	Uttar Pradesh	2020	1440	42.2	90-95	Being early in maturity it escapes from Alternaria blight, aphid and fog.
12.	TS-38	Zone-V, Assam, Arunachal Pradesh, Nagaland, Manipur, Mizoram, West Bengal and Odisha	2020	1689	42-44	85-95	Suitable for timely sowing, rainfed condition

iv. Brown Sarson

S. N.	Name of the Variety	State/Area of Adaptability	Year of Release	Yield (kg/ha)	Oil Content (%)	Maturity (days)	Salient features
1.	HPBS-1	Himachal Pradesh	2018	1000-1200		147	Suitable for rainfed farming in late September–October in low and mid hills of Himachal Pradesh
2.	Shalimar Sarsaon-2 (KBS-49)	Jammu and Kashmir	2019	1493	42.7	205-215	Tolerance to freezing / cold stress. Moderately Resistant to Alternaria, white rust & Aphids.
3.	Shalimar Sarsaon-3 (KBS-3)	Himachal Pradesh	2019	900-1200	40-45	150-155	Resistant to white rust and cold tolerant

v. Taramira

S. N.	Name of the Variety	State/Area of Adaptability	Year of Release	Yield (kg/ha)	Oil Content (%)	Maturity (days)	Salient features
1	Vallabh Taramira 1(PUT93-11)	Uttar Pradesh	2011	616-1133	38-40	130-135	Suitable for rainfed conditions, moderately resistant to AB and Aphid

2	Jobner Tara (RTM-1351)	Rajasthan, Haryana, Punjab, UP, Gujarat, Delhi, Uttarakhand and Maharashtra	2017	1300-1500	39.70	137-142	Suitable for rainfed situation
3	Jwala Tara (RTM-1355)	Rajasthan, Haryana, Punjab, UP, Madhya Pradesh, Gujarat and Delhi	2017	1300-1400	38.90	133-145	Suitable for rainfed situation

vi. African Sarson / Ethiopian Mustard

S. N.	Name of the Variety	State/Area of Adaptability	Year of Release	Yield (kg/ha)	Oil Content (%)	Maturity (days)	Salient features
1.	BJC 1 (PC 6)	Punjab	2016	1930	40	157	Determinate plant canopy with every shoot terminating into a pod. Free of white rust.

vii. Gobhi Sarson

S. N.	Name of the Variety	State/Area of Adaptability	Year of Release	Yield (kg/ha)	Oil Content (%)	Maturity (days)	Salient features
1.	RSPN-25 (NCN-15)	Jammu region	2015	1595	39.0	145-155	Variety has broad leaves; basal branching, resistance to lodging, responsive to fertilizers, suitable for timely sown conditions
2.	GSC 7 (GSC lol)	Punjab, Haryana, Himachal Pradesh, Jammu and Kashmir and Rajasthan	2015	1911-2190	8.6-42.0	144-163	'00' canola quality variety
3.	ONK 1		2019	693-1789	37.9-42.2	146-172	Low incidence of Alternaria leaf blight and Sclerotinia stem rot, resistance to white rust and moderate resistance to downy and powdery mildew, wider adaptability
4.	Him Palam Gobhi Sarson I (AKMS 8141)	Himachal Pradesh, Srinagar, Jammu, Punjab	2020	1915	37.5-42.8	166	Suitable for timely sowing under irrigated, high fertility

d. Sesame

State/ Variety	Year of release	Seed yield (kg/ha)	Oil content (%)	Days to maturity	Salient characters
GUJARAT					
GJT-6	2016	900-1000	48-50	82-94	White bold seeded, suitable for export purpose
GT-6	2018	900-1000	49-51	80-85	White seed with bolder size, suitable for export
RAJASTHAN					
RT- 346	2009	750-850	49-51	82-86	White seed, short internodal distance, tolerant to leaf curl and *Alternaria*
RT- 351	2010	700-800	48-51	80-85	White seed, tolerant to leaf curl and *Cercospora*
MAHARASHTRA					
PKV-NT-11	2015	800-850	48-49	88-92	White seed, tolerant to bacterial blight,
JLT-408	2012	700-800	51-53	80-85	White bold seed, tolerant to powdery mildew
MADHYA PRADESH/CHHATTISGARH					
Jawahar Til –12 (PKDS-12)	2010	700-750	48-52	82-85	White seed
TKG-308	2010	700-750	46-50	85-90	White seed, tolerant to *Phytophthora*, *Cercospora*, Powdery mildew and *Alternaria*
Jawahar Til -14 (PKDS-8)	2010	700-750	50-53	85-88	Black seed
WEST BENGAL					
Suprava (CUMS-17)	2018	900-1200	48-50	88-92	Light brown coloured, 1000 seed wt-3.3-3.5 g, resistant to root rot, phyllody and powdery mildew; adaptability under high heat and drought situation
HARYANA					
Haryana Til-2	2013	650-750	48-50	85-90	White seed, tolerant to leaf curl
ODISHA					
Shubhra	2015	800-900	48-52	78-84	White seed, delayed shattering , tolerant to Alternaria
Smarak	2015	800-900	48-52	80-85	Golden yellow bold seed, delayed shattering, synchronous maturity, tolerant to

					Macrophomina and Alternaria
TAMIL NADU					
TMV(SV)-7	2009	800-900	48-50	80-85	Brown testa, suitable for confectionery.
VRI 3	2018	850-950	50-52	75-80	Moderately resistant to *Macrophomina* and shoot webber cum capsule borer
KARNATAKA					
DSS-9	2012	550-600	49-50	85-90	White bold seed, tolerant to bacterial blight
DS-5	2015	600-700	50-52	90-95	White bold seed
PUNJAB					
Punjab Til-2	2016	700-800	48-50	85-90	White seeded, bold seeded, tolerance to *Cercospora* leaf blight and phyllody

e. Sunflower

State	H/V	Cultivars
Karnataka	Hybrid	DRSH-1, MDSFH-411, RSFH-1887, RSFH-130, RSFH-1, KBSH-73, PAC-3794, NSFH-1001, LSFH-171, DSFH-3, KBSH-78, KBSH-53
	Variety	DRSF-113, RSFV-901
Maharashtra	Hybrid	DRSH-1, MDSFH-411, LSFH-35, PAC -334, PAC-3794, NSFH-1001, LSFH-171, PDKVSH-952
	Variety	DRSF-113, Phule bhaskar, LSF-8, TAS-82
Tamil Nadu	Hybrid	DRSH-1, MDSFH-411, CO-2, CoH-3, PAC -334, PAC-3794, NSFH-1001, LSFH-171
	Variety	DRSF-113, CO-5
Punjab	Hybrid	DRSH-1, MDSFH-411, PSH-569, PSH-1962, PSH-2080, PSH-996,NSFH-1001, Kaveri champ
	Variety	DRSF-113
Andhra Pradesh	Hybrid	DRSH-1, MDSFH-411, NDSH-1012, PAC -334, PAC-3794, LSFH-171
	Variety	DRSF-113
Telangana	Hybrid	DRSH-1, MDSFH-411, LSFH-171
	Variety	DRSF-113
Haryana	Hybrid	DRSH-1, MDSFH-411, HSFH-848, Kaveri champ
	Variety	DRSF-113

Bihar	Hybrid	DRSH-1, MDSFH-411, Kaveri champ, LSFH-171
	Variety	DRSF-113
Odisha	Hybrid	DRSH-1, MDSFH-411, Kaveri champ, LSFH-171
	Variety	DRSF-113
West Bengal	Hybrid	DRSH-1, MDSFH-411, Kaveri champ, LSFH-171
	Variety	DRSF-113

f. Safflower

State	Cultivar	
Andhra Pradesh & Telangana	Hybrids	DSH-185
	Varieties	Phule Kusuma, NARI-96, SSF-12-40, ISF-1, ISF-764,SSF-13-71
Karnataka	Hybrids	DSH-185
	Varieties	Parbhani Kusum, NARI-57, NARI-96, SSF-12-40, ISF-1, ISF-764,SSF-13-71
Maharashtra	Hybrids	DSH-185
	Varieties	Parbhani Kusum, AKS-207, SSF-708, PKV-Pink, NARI-57, NARI-96, Purna (PBNS-86), SSF-12-40, ISF-1, ISF-764,SSF-13-71
Madhya Pradesh	Hybrids	DSH-185
	Varieties	NARI-57, NARI-96, ISF-1, ISF-764
Chhattisgarh	Hybrids	DSH-185
	Varieties	NARI-96, ISF-1, ISF-764,Chhattisgarh Kusum-1

g. Niger

S. No.	Cultivar Name	Year of Release	Recommended Regions/Areas	Days to maturity	Oil content (%)	Average Yield (kg/ha)	Salient features/ other information

Maharashtra							
1	IGPN-8004	2016	*Kharif,* Rainfed, Maharashtra	100-105	39-41	500-550	Bold seeded with shiny black colour, high oil quality and protein content Resistant to the leaf spot and Powdery mildew
Karnataka							
2	DNS-4	2012	*Kharif*, Zone 3 and 8 Karnataka	90-95	39-41	500-600	Shining black bold seed
Orissa							
3	Utkal Niger-150	2009	Orissa	105-110	38-40	650-700	Black seed, tolerant to Alternaria and Cercospora
Gujarat							
4	GNNIG-3	2016	Gujarat	100-105	46-48	400-450	Bold seeded with shining black colour, Resistant to *Cercospora* and *Alternaria* leaf spot

Year 2024-25 (at least two high yielding varieties as per target set for each crop developed):
Groundnut: 2763 kg/ha (rainfed: 2600 kg/ha; irrigated: 3600 kg/ha)
Rapeseed-Mustard: 1933 kg/ha
Soybean: 1501 kg/ha
Sesame: 563 kg/ha
Sunflower: 984 kg/ha
Safflower: 789 kg/ha
Niger: 380 kg/ha

Year 2029-30 (at least two high yielding varieties at par target set for each crop developed):
Groundnut: 3561 kg/ha (rainfed: 3500 kg/ha; irrigated: 4000 kg/ha)
Rapeseed-Mustard: 2132 kg/ha
Soybean: 1812 kg/ha
Sesame: 685 kg/ha
Sunflower: 1197 kg/ha
Safflower: 1007 kg/ha
Niger: 509 kg/ha

Year 2034-35 (at least two high yielding varieties at par target set for each crop developed):
Groundnut: 4128 kg/ha (rainfed: 4000 kg/ha; irrigated: 4500 kg/ha)
Rapeseed-Mustard: 2203 kg/ha
Soybean: 2121 kg/ha
Sesame: 834 kg/ha
Sunflower: 1387 kg/ha
Safflower: 1167 kg/ha
Niger: 590 kg/ha

Improvement in SRR

The seed replacement rate of most of the edible oilseeds is very low. The seed replacement rate will require to be improved substantially in most of the crops by the year 2034-35 to achieve the targeted productivity. Whereas, in groundnut it has to be improved from 20% to 30%, it will be 38% to 68% in soybean, 55-90% in Rapeseed-Mustard, 18-29% in Sesame, 18% to 36% in Sunflower, 22-27% in Safflower and 8% to 36% in case of Niger (Table 4). With aggressive policy intervention, production of quality seeds of recently released improved varieties in the entire seed chain of nucleus-breeder-foundation-certified seed-supply to farmers is to be ensured to improve SRR. Overall improvement in SRR will be from about 23% at present to about 40% in 2034-35.
Responsibility: DAC, State Department of Agriculture, SAUs, KVKs

Improvement in VRR

Concomitant with the improvement of SRR, VRR also need to be improved from present level of 5% to 50% in next 5 years and 100% in the next 10 years. Cultivation of old varieties should be discouraged both at policy and procurement level with giving inceptive to farmers for cultivation of new varieties with assured buy back policies. **Responsibility: DAC, State Department of Agriculture, SAUs, KVKs**

Table 4. Projected Seed Replacement Rate (SRR) in oilseed crops

Year	Soybean	R&M	Gnut	Sesame	Sunflower	Safflower	Niger	Mean
2020-21	38	55	20	18	18	22	8	23.43
2021-22	41	60	21	20	18	22	9	25.00
2022-23	43	65	22	21	26	22	25	29.57
2023-24	45	70	24	22	27	22	25	31.14
2024-25	48	74	24	22	29	24	25	32.57
2025-26	52	77	25	24	30	27	29	35.14
2026-27	54	80	25	25	31	27	30	36.00
2027-28	56	81	25	25	32	27	30	36.57
2028-29	58	83	26	26	33	27	31	37.57
2029-30	59	84	27	26	34	27	31	38.14
2030-31	60	86	28	27	34	27	32	38.86
2031-32	61	87	28	27	34	27	33	39.29
2032-33	62	89	29	28	35	27	34	40.14
2033-34	63	90	29	28	35	27	35	40.57
2034-35	64	90	30	29	36	27	36	41.43

Ensured sufficient quantity of seeds of improved varieties

Unless required quantity of quality seeds in each stage of seed production is ensured, improved varieties will not reach to the farmers. To meet the target production, breeder, foundation and certified seeds of each edible oilseed crops need to be produced to ensure the adequate supply in time. The combined requirement of breeder seeds of seven edible oilseeds in 2021-22, 2024-25, 2029-30 and 2034-35 will be to the tune of 46766 q, 58645 q, 75938 q and 101898q, respectively to cover the projected area of 27.68 mha, 29.87 mha, 33.85 mha, and 37.98 mha, respectively in the corresponding years (Table 5). The requirement of foundation and certified seed of each crops has also be projected till 2034-35. Among the edible oilseeds more than 98% indent of breeder seed is for Groundnut and Soybean owing to high seed rate and low seed multiplication rates. As most of the time, there is insufficient production of breeder seed (particularly soybean) because of erratic rainfall, the policy decision is required to grant permission for production of breeder seed in farmers field with the help of breeder concerned involving FPOs, KVKs, NGOs, and private parties in PPP mode. Quality seed should be emphasized to be produced location specifically in seed village, community level, seed hubs, etc. involving FPOs, NGOs, KVKs, etc. Seed storage facilities are to be created in each village involving private parties. More seed hubs (50 each) should be allotted for quality seed production of especially groundnut and soybean varieties. **Responsibility: DAC, State Department of Agriculture, SAUs, KVKs, NGOs, ICAR, NSC, SFCI, State Seed Corporations, FPOs**

Table 5. Estimates of breeder seed production (q) of edible oilseeds

Year	Groundnut	R&M	Soybean	Sesame	Sunflower	Safflower	Niger	Total
2020-21	31476	3.24	11476	1.53	4.75	0.41	0.094	42962
2021-22	34107	3.58	12649	1.79	5.23	0.50	0.113	46767
2022-23	36875	3.94	13551	1.98	5.75	0.60	0.335	50438
2023-24	41515	4.31	14486	2.18	9.14	0.71	0.358	56017

2024-25	42843	4.62	15784	2.30	10.44	0.94	0.384	58646
2025-26	46056	4.88	17467	2.61	12.11	1.22	0.474	63544
2026-27	47530	5.15	18529	2.83	13.53	1.42	0.522	66082
2027-28	49051	5.29	19628	2.94	15.09	1.64	0.556	68705
2028-29	50621	5.50	20766	3.19	16.83	1.91	0.612	71415
2029-30	54330	5.65	21578	3.32	18.74	2.21	0.652	75939
2030-31	58225	5.87	22416	3.55	19.89	2.32	0.706	80673
2031-32	62314	6.03	23280	3.65	20.49	2.44	0.765	85627
2032-33	66605	6.26	24170	3.90	21.72	2.56	0.827	90810
2033-34	71106	6.42	25088	4.02	22.37	2.69	0.894	96230
2034-35	75828	6.52	26034	4.29	23.70	2.82	0.966	101900

Development of matching production and protection technologies

Genetic yield potential of a particular variety can only be realized with adequate supply of nutrients, suitable soil and environmental conditions and adequate disease and pest control measures are adopted simultaneously. Thus, to enhance productivity matching agronomic practices are required to be developed. At present such location specific agronomic (Table 6) and plant protection (Table 7) measure for each crop are in place and the location specific technologies will be further refined as per emerging disease and pest situation and in line with the projected climate change. **Responsibility: Crop Institutes, DAC, State Department of Agriculture, SAUs, KVKs, NGOs, ICAR, FPOs, Line Departments**

Table 6. Improved crop production technologies of seven edible oilseeds

a. Soybean

Input/ practices	North Hill Zone	North Plain Zone	Central Zone	Southern Zone	Eastern Zone	North Eastern Hill Zone
State/Zone	Himachal Pradesh, North hills of Uttarkhand	Punjab, Haryana, Delhi, North-Eastern plains of U.P., Plains of Uttarkhand, Western Bihar	M.P., Bundelkhand region of U.P., Rajasthan, Gujrat, Northern and western parts of Maharashtra and Orissa	Karnataka, Tamil Nadu, Andhra Pradesh, Kerala, Southern parts of Maharashtra	Chhattisgarh, West Bengal, Bihar, Orissa	Assam, North eastern hill states
1. Planting time	Last week of May to June end	Mid of June to First week of July	Middle of June to Middle of July	(i) For Kharif-Mid June to July end (ii) For Rabi- I week of October to Dec. (iii) For Summer- II fortnight of	Middle of June to middle of July	Middle of June to middle of July

				January		
2. Planting geometry	45 x 5 cm	45 x 5 cm	45 x 5–8 cm	30 x 5 cm	45 x 5 cm	45 x 5 cm
3. Plant population	0.4 million /ha	0.4 million /ha	0.4-0.6 million /ha	0.4-0.6 million /ha	0.4-0.6 million /ha	0.4-0.6 million /ha
4. Depth of sowing	3 to 5 cm	3 to 5 cm	3 to 5 cm	3 to 5 cm	3 to 5 cm	3 to 5 cm
5. Manure and Fertilizer (Kg/ha)	10 t FYM/ha +20:80: 20: 20 $N:P_2O_5:K_2O$:S kg/ha	10 t FYM/ha +20:60: 20: 20 $N:P_2O_5$: K_2O:S kg/ha, 1 kg B/ha	10 t FYM/ha + 20:60: 20: 20 $N:P_2O_5$: K_2O:S kg/ha, 1 kg B/ha	10 t FYM/ha +20: 80: 20: 20 $N:P_2O_5$: K_2O:S kg/ha, 0.5 kg B/ha	10 t FYM/ha + 20:80: 40: 20 $N:P_2O_5$: K_2O:S kg/ha, 2 kg B/ha	10 t FYM/ha + 20:80: 40: 20 $N:P_2O_5$: K_2O:S kg/ha, 2 kg B/ha
6. Seed rate	65 kg/ha	65 kg/ha	65 kg/ha	65 kg/ha	55 kg/ha	55 kg/ha
s7. Bio-regulator	-	Cycocel @ 500 ppm at flowering	Cycocel @ 500 ppm at flowering	Ether @ 200 ppm or Slicylic acid @ 50 ppm at pod initiation	Ethrel @ 200 ppm at flower and pod initiation	Ethrel @ 200 ppm at flower and pod initiation
8. Foliar nutrition at pod initiation stage	-	RDF + Urea @ 2%	RDF + DAP 2%	RDF + DAP 2%	RDF + 19:19:19 (NPK) 2% - EZ, RDF + MOP 0.5% - NEHZ	RDF + 19:19:19 (NPK) 2% - EZ, RDF + MOP 0.5% - NEHZ
9. Fertigation / irrigation	-	-	Fertigation / irrigation at flowering, pod initiation and seed filling stage	-	Fertigation / irrigation at flowering, pod initiation and seed filling stage - EZ	Fertigation / irrigation at flowering, pod initiation and seed filling stage - EZ
10. Soil acidity amelioration	-	-	-	-	FYM @ 2.5 t/ha + lime @ 600 kg/ha	FYM @ 2.5 t/ha + lime @ 600 kg/ha
11. Seed treatment	Thiram 75 WP + Cabendazim 50 WP (2:1) @ 3 g/kg seed / Carboxin + Thiram (3g/kg) / carbendazim + mancozeb (2g /kg)					
12. Seed inoculation	About 500 g/65 kg seed Bradyrhizobium japonicum culture + PSB 500 g/ 65 kg seed					
13. Land configuration	Planting of soybean on Broad Bed Furrow (BBF) or Furrow Irrigation Raised Bed Systems (FIRBS) or opening of conservation furrow after every 3 or 6 rows of soybean.					
14. Drought management	1. Straw mulch @ 5 t/ha after emergence of soybean. 2. Spray of anti-transpirant i.e. KNO_3 @ 1% or $MgCO_3$ or Glycerol @ 5% during dry spell period.					

15. Weed control	**Type of weedicide**	**Chemical Name**	**Dose**
	PPI	Fluchloralin 45EC	2.22 l/ha
		Trifluralin 48 EC	2.00 l/ha
		Pyroxasulfone 85 WG	150 g/ha
	PE	Metalochlor 50 EC	2.00 l/ha
		Chlomozone 50 EC	2.00 l/ha
		Pendimethalin 30 EC	3.25 l/ha
		Diclosulum 84 WDG	26 g/ha
		Sulfentrazone + Clomazone 58 % WP (F 8072) premix	1.25 l/ha
	POE (10-12 DAS)	Chlorimuron ethyl	36 g/ha
	POE (15-20 DAS)	Imazethapyr 10 EC	1.00 l/ha
		Quizalofop-ethyl 50 EC	1.00 l/ha
		Quizalofop -p-tefuryl 4.41 EC	1.00 l/ha
		Fenoxaprop-p- ethyl 9 EC	1.00 l/ha

b. Rapeseed-Mustard

Land preparation	Under irrigated condition, first ploughing should be done with soil turning plough followed by 3 to 4 harrowing or ploughing and planking after every ploughing. Under rain-feed condition, disc harrowing should be carried out after every effective shower in monsoon to conserve soil moisture. Planking should always follow the harrowing or ploughing to avoid clod formation and moisture loss. Pulverize the soil, using cultivator before sowing.
Sowing time	October 10- 25th is the most appropriate time of sowing. The maximum temperature during sowing should not be more than 32^{o} C. For yellow sarson, time of sowing is the first fortnight of October. Toria should be shown during the first fortnight of September.
Seed Rate and spacing	Optimum seed rate is 3.5-4 kg/ha. Line sowing at 45 cm x 10-15 gives optimum plant population. In late sown crops a closer inter row 30 cm spacing adopted. For Toria and Yellow sarson the row to row spacing should be kept at 30 cm.
Nutrient management	Application of N:P:K @ 80:40:40 kg/ha under timely sown condition and @ 100:50:50 under late sown condition along with sulphur @ 40 kg/ha. Half of the nitrogen to applied as basal dose and half at 30-45 DAS at the time of first irrigation. For rain-feed crop apply the full-recommended dosages of nutrients at the time of sowing. Replacing of DAP with Single Super Phosphate (250kg/ha) resulting in availability of sulphur. It is recommended that gypsum @ 200 kg/ha should be applied as basal dressing if Single Super Phosphate is not used as the source of P. Use of Azotobacter can reduce the nitrogen requirement up to 25-30 kg/ha provided bacterial strain is efficient and soil is rich in organic matter.
Weed management	Pendimethalin pre-plant incorporation @ 1kg/ha also found effective.
Thinning	Thinning operation by removing the extra plants should be done at 15 to 25 days after sowing.
Irrigation management	Two irrigations, one at pre-flowering stage (35-45 DAS) and at siliqua formation stage. The mustard crop seed yield increases by 24% using micro sprinkler (irrigation efficiency 60-70%) and by 18 % using drip irrigation (irrigation efficiency 80-90%) over check basin (irrigation efficiency 30-40%).
Harvesting and threshing	The crop should be harvested when 75 per cent of pods turn to golden yellow in colour. The crop should preferably be harvested in the morning when the pods are damps with night dew, which minimizes the shattering losses. Threshing should be done preferably by using threshers. Seeds should be sun dried for at-least one week to reduce the moisture content.

Location specific technology

- Cultivation of short duration crop of cluster bean as green manure instead of keeping the land fallow during kharif (Rajasthan).
- Intercropping of mustard with chickpea (1:4) and with lentil (1:6) (Rajasthan).
- Taking the advantage of rains in the first fortnight of September, sowing of toria should be done followed by wheat or sugarcane (Uttar Pradesh).
- For the management of diara land: Follow rice-mustard cropping system in Gomti Diara and Wheat + mustard and maize-toria-wheat cropping systems in SaryuDiara
- Adopt the remunerative intercropping systems. In irrigated condition Toria + Sugarcane (1:1 / 2:1), Mustard + wheat (1:9), Mustard + Potato (1:3) and in rainfed condition, Mustard + Gram (1:5) combination be adopted (Uttar Pradesh).
- Intercropping: chickpea+ mustard (4:1), wheat + mustard (9:1) and Lentil + mustard (5:1) (Haryana).
- In case the monsoon is delayed and the kharif crops like maize, pearl millet and paddy suffer severely, toria may be sown (Haryana).
- Use of white rust resistant Indian mustard variety-Jawahar Mustard 1 in the affected areas (MP).
- Paira cropping of yellow sarson- broadcasting yellow sarson early in the standing aman rice three days before its harvest (West Bengal).
- **Grow short duration varieties such as "PusaMahak and Sej-2" of Indian mustard on residual soil moisture (West Bengal).**
- **Grow Jhumka, Ragini and Subinoy varieties of Yellow Sarson (West Bengal).**

Other Technologies

- Basal application of 40 kg S/ha + thiourea (0.1%) sprayed at pre-flowering stage increased mustard seed yield.
- Application of 0.09-0.15 kg/ha oxadiargyl 80WP (PE) or 0.75 kg/ha trifluralin 48EC (PPI) or 0.15 kg oxyfluorfen 23.5EC (PE) or 1.0 kg isoproturon 50WP (PE) or 0.75-1.0 kg/ha pendimethalin 30 EC (PE) effectively manages weeds in rapeseed-mustard.
- Soil incorporation of 2.5 t/ha mustard straw along with *Sesbania* green manuring increased seed yield of Indian mustard by 45%.
- Application of 40 kg sulphur along with 1 kg boron per hectare increased the seed and oil yield of mustard in the deficient soils.
- The variety NRCHB 101 gave maximum seed yield when sown on 10 November at 30x10 cm spacing and with 150% RDF (N:P:K:S:B:Zn:FYM @ 60:32:30:24:1:15 kg/ha: 5t/ha) at Imphal.
- Maize- mustard (short duration) - green gram system was found more remunerative than the traditional maize-wheat system and recommended for Pantnagar and Kangra conditions.
- Pearl millet + Cluster bean (fodder) mustard sequence was most remunerable under Rainfed conditions of Rajasthan.
- Application of hydrogel 5.0 kg/ha + foliar spray of salicylic acid 200 ppm at flowering and siliqua formation stage recorded 5.3, 9.6, 20.4, 31.3 and 6.9% 18.6, 42.6, 37.7, 72.6 and 133% higher seed yield.
- Application of irrigation at 0.4-0.8 IW/CPE ratio along with 2.5/5 Kg hydrogel/ha recorded maximum seed yield across the locations.
- Intercropping of mustard + maize (1:1 or 1:2) at Bhubaneswar and Dholi; wheat + mustard (9:1) at Varanasi, Kanke and Nagpur and mixed cropping of wheat + mustard (90:10%) at Chatha proved more remunerative than their sole crops at their respective centers. However, sole mustard at Kanke and sole wheat at Kanpur and Morena were more rewarding than their intercropping.
- Seed treatment with *Azotobactor* + PSB along with 100%NP resulted in 2.0 to 14.7% higher seed yield in comparison to 100%NP.
- Weeds caused 8.8-63.0% loss in seed yield of rapeseed-mustard. Depending upon the weed flora at respective centers the herbicides 1 kg a.i/ha isoporteuron 75WP at 30 DAS, 0.15 kg a.i./ha oxyfluorfen 23.5EC (PE), 1 kg a.i./ha pendimethalin 30EC (PE), 0.75 kg a.i./ha pendimethalin 38.7CS (PE), 0.75 kg/ha trifluralin 48EC (PPI), 0.06 kg a.i./ha quizalofop 5EC (PE), 0.06 kg a.i./ha clodinafop 15WP (25-30 DAS) and 0.09 kg a.i./ha oxadiargyl 80WP (PE) were effective against weeds and significantly reduced yield losses.
- Foliar spray of brassinolide @20ppm and salicylic acid @100ppm improved seed yield under

rainfed conditions.

c. Groundnut

Name of Technology	Technology description	States
Water soluble foliar grade fertilizers (WSGF) for improved growth and yield of summer groundnut	Use of FYM @ 7.5 t/ha and 100% RDF as basal and foliar spray of WSGF @ 2% of starter dose 11:36:24 kg NPK/ha at 30 DAS and booster dose of 8:16:39 kg NPK/ha at 45 and 60 DAS improved pod yield (9.8%) and net returns by Rs.18838/ha	Maharashtra Gujarat, Odisha, West Bengal
Optimum ratios and levels of nitrogen and phosphorus for kharif groundnut	Application of NP @ 30:75 kg/ha in the ratio of 0.40 along with recommended dose of potassium improved pod yield (17.1%) and net returns by Rs.15275/ha	Maharashtra Gujarat, Karnataka, Andhra Pradesh, Rajasthan, Tamil Nadu
Optimum fertilizer doses and plant population under check basin method of irrigation for summer groundnut	Sowing at 20 x 10 cm spacing (5.00 lakh plants/ha) with application of 31:62:31 kg/ha of NPK (125 percent RDF) increased pod yield and net returns by 15 and 22 percent, respectively	Maharashtra Gujarat, Karnataka,
Nutrient management practices for production maximization of summer groundnut	Application of 150% of RDF (25:50:00 kg NPK/ha) as basal+ FYM @ 7.5 t ha^{-1} is recommended for higher yield and net returns of summer groundnut	All states
Management of sulphur and calcium through application of gypsum in rainfed groundnut	Application of gypsum @ 400 kg/ha, split as 50% (200kg/ha) at the time of sowing and remaining 50 % (200 kg/ha) at 45 DAS gave higher yield and net returns	Maharashtra Gujarat, Karnataka, Andhra Pradesh, Rajasthan, Tamil Nadu
Nutrient management practices for yield maximization in kharif groundnut	Application of FYM @ 7.5 t ha + RDF (25: 50:00 kg NPK/ha) along with soil application of $FeSO_4$ and $ZnSO_4$ @ 20 kg/ha and foliar application of urea @ 2% at 30 and 60 DAS is recommended for higher yield and net returns	Maharashtra Gujarat, Karnataka, Andhra Pradesh, Rajasthan, Tamil Nadu
Management of sulphur and hydrogel in kharif groundnut	Application of irrigation water at 0.8 IW/CPE and hydrogel @ 2.5 kg/ha is recommended for higher yield and net returns and higher water use efficiency	Maharashtra Gujarat, Karnataka, Andhra Pradesh, Rajasthan, Tamil Nadu
Fertilizer doses and plant population under drip fertigation for summer groundnut	Groundnut sowing at plant spacing at 25 x 10cm (4.00 lakh plants/ha) with 100% RDF (25:50:00 kg NPK/ha) as fertigation using drip irrigation at alternate day with 9 equal splits along with basal application of 5t/ha FYM is recommended.	Maharashtra Gujarat, Karnataka
DAPG-producing fluorescent Pseudomonades for enhancing nutrient, use efficiency, bio-control of soil-borne diseases and higher yield of kharif groundnut	Application of DAPG-4 bio inoculants as seed treatment is recommended for higher kharif groundnut yield, economic return and control of soil borne disease incidence of stem rot and collar rot.	All states

DAPG- producing fluorescent pseudomonades for enhancing nutrient use efficiency, bio-control of soil-borne diseases and higher yield of rabi/ summer groundnut	Application of FP-98/ FP-86 bio- inoculants as seed treatment is recommended for increased summer groundnut yield. It gives about 61% higher pod yield with higher net returns and BCR over existing practice, reduces diseases incidence for stem rot (40%) and collar rot (52%)	All states
Water soluble foliar grade fertilizers in summer groundnut	Application of FYM @ 7.5 t ha^{-1} with 100% recommended fertilizer dose (25:50:00 NPK kg ha^{-1}) and foliar application of 2% water soluble grade fertilizers with starter dose of 11:36:24 at 30 DAS and booster dose of 8:16:39 at 45 DAS is recommended for higher yield and economic returns.	Maharashtra Gujarat,
Tillage and sowing options for rabi-summer groundnut	The tillage operations carried out by rotavator reduced the soil compaction which further increased infiltration rate and soil moisture conservation leading to higher yield (43.9%) and net returns (113.5%), maintenance of higher soil moisture content	Maharashtra Odisha, West Bengal
Micronutrient management in kharif groundnut	In order to overcome micro-nutrient deficiency, basal application of zinc through zinc sulphate @ 20kg/ha and boron through boric acid @ 6 kg/ha along with recommended dose of fertilizer i.e. 25:50:00 kg NPK ha^{-1} is recommended for higher yield (18.9%) and net returns (71.2%)	Maharashtra Gujarat, Karnataka, Andhra Pradesh, Rajasthan, Tamil Nadu
Effective weed control in rabi groundnut	Application of pre-emergence application of pendimethalin @ 1.0 kg a.i./ha + one hand weeding at 30 DAS proved practically more convenient and economically best feasible integrated weed management practice for groundnut considering the present condition of scarcity and high cost of labours, quality of weed control, yield and B:C ratio of cultivation of groundnut	Maharashtra Odisha, West Bengal
Nutrient management practices for production maximization of rabi groundnut	The optimization of the mineral nutrition plays key role in production maximization of groundnut. Hence in order to address this issue, application of 100% RDF (25:50:00 NPK kg ha^{-1}) as basal dose + 50% RDF (12.5:25:00 NPK kg ha^{-1}) as top dressing at 30 DAS was found superior for not only higher pod, kernel and haulm yield but also for net returns over 100% RDF as basal. It gave higher yield (24%) and net returns (145%)	Maharashtra Odisha, West Bengal, Jharkhand
Water soluble foliar grade fertilizers in rabi groundnut	Application of FYM @7.5 t/ha with 100 % recommended fertilizer dose (25:50:00 NPK kg ha^{-1}) and foliar application of 2 % water soluble grade fertilizers with starter dose of 11:36:24 NPK kg ha^{-1} at 30 DAS and booster dose of 8:16:39 NPK kg ha at 45 DAS is recommended for higher yield and economic returns.	Maharashtra Odisha, West Bengal, Jharkhand
Nutrient management in groundnut-rice cropping system	Application of 100 % N + 150 % PK (25 kg N + 75 kg P_2O_5 + 0 kg K_2O/ha) to groundnut and 75 % RDF i.e. 75 kg N + 37.5 P_2O_5 + 37.5 kg K_2O ha to rice under South Konkan coastal conditions for higher yields and economic returns from rabi groundnut- kharif rice system	Odisha, West Bengal, South Gujarat, Tamil Nadu
Mulching, hydrogel and nutrient management for summer groundnut	Application of white polythene mulch of 7 micron thickness @ 55 kg/ha with soil application of hydrogel @ 5.0 kg/ha with INM (FYM @ 7.5t/ha+ RDF; 25:50:00 kg/ha) is recommended for higher production, profit and WUE in summer groundnut. There was a Saving 25% water	Maharashtra, Gujarat, Karnataka, Andhra Pradesh

	with higher WUE (3.31 kg/ha mm), pod yield (16-21%) and net returns (24-32%) over existing practice	
Integrated phosphorus management in kharif groundnut	In lateritic soil of Konkan, for exploiting native soil phosphorus for groundnut production during kharif season, seed treatment with DGRC-1/DGRC2 @ 1250 gm/ha is recommended with 100 percent of recommended dose of fertilizers (25:50:00 NPK kg ha^{-1}) gave higher pod yield (16%) with an additional net returns of Rs 10,387/ha over existing practice (50 % P and 5 ton FYM/ha)	All states
Economizing phosphorus use in rabi-summer groundnut production by exploiting phosphorus build up in soil	Application of FYM 5 t/ha + 25% P + DGRC-1/2 recorded 7.12 per cent increase in dry pod yield over existing practice and net income to the tune of 13.13 per cent.	All states
Effect of paclobutrazol on growth and productivity on rainfed groundnut	Application of paclobutrazol @100 ppm at 30 and 50 days after sowing	Maharashtra West Bengal, Odisha
Alleviation of moisture-deficit stress in kharif groundnut by application of endophytic bacteria	As a low cost technology, seed treatment with any DGREB Culture with normal inter-culturing especially DGREB-4 for increased dry pod yield in the range of 16.0 to 52.1 %	Maharashtra Andhra Pradesh, Karnataka
Standardization of potash levels and apportioning time in summer groundnut under drip irrigation	Application of 30 kg potash per ha uniformly in 8 equal splits at weekly interval up to 60 DAS through Drip irrigation for summer Groundnut increased dry pod yield up to 28.01 % over existing practice with highest net return (Rs.68451 ha^{-1}) and BCR (1.88)	Maharashtra

d. Sesame

Sr. No.	Name of technology	States
1.	One hand weeding at 15 DAS + vegetative mulching (4 t/ha organic waste) was the best *in-situ* moisture conservation technique for maximum seed and oil yield of sesame.	All states
2.	Application of zinc (20 kg $ZnSO_4$ /ha) and iron (25 kg $FeSO_4$ / ha) and with RDF and 2.5 t FYM gave the maximum seed yield and economic returns.	All states
3.	In organic production of sesame application of 75% RDF + *Azotobacter* + PSB resulted in maximum seed yield, oil content and oil yield.	All states
4.	Terminal nipping at 30 DAS followed by spraying of Salicylic acid (SA) @ 100 ppm/ha andDAP 2% enhances the plant growth and gave higher seed yield.	All states - *kharif* season
5.	Sowing of sesame after harvest of rice under till condition with combined nutrient spray of 1% urea and 2% DAP increase the leaf area index, number of branches/plant, number of capsules per plant and number of seeds per capsules resulting higher sesame seed yield.	Tamil Nadu
6.	Seed pelleting with neem leaf powder @ 760 g + 120 g *Azotobacter* + 120 g phosphobacteria for 1 kg seed with 1.5 % combined nutrient spray at 30 & 45 DAS for early pest control and nutrient management	Tamil Nadu and Madhya Pradesh
7.	Application of FYM @ 12.5 t/ha + seed treatment (*Azospirillum* + Phosphobacteria + PGPR each @ 600 g ha^{-1} of seed) + soil application of biofertilizer (*Azospirillum* + Phosphobacteria + PGPR each @ 2 kg ha^{-1}) and foliar application of panchagavya 3% spray at 30 and 45 DAS for organic sesame production.	All states

e. Sunflower

Technology	States
Management of sunflower-chickpea cropping system Apply 100% NPK, Sulphur @ 20 kg/ha through gypsum + boron @ 1 kg/ha as borax in alternate years + Zn @ 10 kg/ha to the *kharif* sunflower and 100% NPK to *rabi*chickpea for realizing higher profitability and maintaining soil fertility for sunflower-chickpea cropping system at Raichur, Karnataka. Apply 5t FYM/ha in *kharif* followed by 100% NPK each for *kharif*Sunflower and *rabi* groundnut for higher productivity and profitability for sunflower-Groundnut cropping system in Alfisols at Coimbatore	Karnataka, Tamil Nadu
Management of *kharif* sunflower Apply 100% recommended NPK + Sulphur @ 40 kg/ha as single super phosphate for *kharif* sunflower for higher sunflower productivity and economics in Vertisols of western Maharashtra region (Savalvihir)	Maharashtra
Management of sunflower/groundnut A basal application of 5t FYM/ha in *kharif* followed by 100% RDF for sunflower/groundnut in *kharif* and 100% RDF for succeeding *rabi* sunflower/groundnut in Alfisols is profitable for Alfisols in cropping systems involving sunflower in Karnataka.	Karnataka
General fertilizer recommendation for sunflower A general fertilizer dose of 90:90:40kg N:P_2O_5:K_2O/ha is recommended for sunflower under clay loam soils of West Bengal	West Bengal
Weed management for Sunflower in Vertisols Application of Pendimethalin @ 1.0 kg a.i/ha (Pre-emergence) + Quizalofop Ethyl 10 EC @ 37.5 g a.i./ha at 15 – 20 DAS (Post emergence) is recommended for higher sunflower yields in Vertisols of Latur.	Maharashtra (Latur region)
Weed management in Vertisols Apply Pendimethalin @ 1.0 kg a.i./ha (PE) + Propaquizofop @ 62 g a.i/ha at 15-20 DAS (PoE) followed by one inter-cultivation at 30 DAS	Karnataka (Raichur)
Weed management in Vertisols Application of Pendimethalin @1.0 kg a.i./ha (PE)+ Fenoxypropethyl (whip super) @ 37.5 g a.i./ha at 15-20 DAS as directed PoE is recommended for sunflower in Vertisols	Andhra Pradesh
Integrated nutrient management packages for Groundnut-sunflower, soybean-sunflower, sunflower-groundnut and legume-sunflower cropping systems for higher crop productivity and BC ratios at Tamil Nadu, Karnataka and Maharashtra.	Maharashtra
Technology to reduce phosphorus dose	Maharashtra
Soil test based fertilizer recommendation for sunflower for Karnataka	All states
Nutrient recommendation for sunflower for the state of West Bengal	West Bengal
Pre and post emergence herbicide recommendation for the states of	Karnataka, Andhra Pradesh and Maharashtra
Suitable land configuration for rainfed sunflower	Maharashtra
Soil amendments for moisture storage for high sunflower productivity	Maharashtra

f. Safflower

	Technologies for Traditional states	States
1	• Soil moisture conservation measures • Integrated Nutrient Management (INM) on cropping system basis involving biofertilizers • Integrated Nutrient Management (INM) on cropping system basis involving crop residues • Nutrient management for inter-cropping systems	Maharashtra, Karnataka, Telangana, Andhra Pradesh
2	**Technologies for Non-Traditional states**	
	• Integrated weed management for rice-safflower system for Chhattisgarh • Plant spacing and plant population • Irrigation scheduling	Madhya Pradesh, Chhattisgarh

h. Niger

Sr. No.	Name of technology	States
1.	Application of FYM 2 t/ha + neem cake 400 kg/ha + PSB 5 kg/ha + *Azotobactor* 5 kg/ha + ELS 15 kg/ha S + *Trichoderma viride* 2.5 kg/ha seed treatment recorded higher organic niger production and improved soil fertility.	All states
2.	Among the new crop combinations, intercropping of niger + ricebean (2:4), niger + frenchbean (4:2) and niger+ castor (2:2) recorded the maximum NEY, NMR and B:C ratio	All states

Table 7. Improved crop protection technologies of seven edible oilseeds

a. Soybean

	Insect	Insecticide	Dose
a. Insect management	Defoliators (Semilooper, Tobacco Caterpillar, *Heliothis armigera)*	Chlorentramiliprol 18.5 SC	0.1 lit/ha
		Quinolphos 25 EC	1.5 lit/ha
		Triazophos 40 EC	0.8 lit/ha
		Indoxacarb 14.5 SC	0.3 lit/ha
		Bacillus thuringensis or Beauveria bassiana	1.0 lit/ha
	White Fly	Seed treatment with Thiamethoxam 30 FS	10ml/kg seed
		Imidachloprid 48 FS	1.25 g/kg seed
		Beta-cyfluthrin + Imadichloprid	0.350 lit/ha
	Stem Fly	Seed treatment with Thiamethoxam 30 FS	10ml/kg seed
	Pod Borer (*Helicoverpa armigera*, *Cidiaptychora*)	Indoxacarb 14.5 SC	0.3 lit/ha
	Girdle Beetle	Triazophos 40 EC	0.8 lit/ha
		Thichloprid 21.7 SC	0.65 lit/ha
	Blue Beetle	Quinolphos 25 EC	1.5 lit/ha

b. Disease management	**Disease**	**Mode/Time**	**Control Measure**	**Dose**
	Rust	First spray during initiation of the disease and second after 15 days	Hexaconazol	800 ml/ha
			Propiconazol	800 ml/ha
			Tridimefon/ Oxycarboxin	800 g/ha
	YMV	Seed treatment	Thiamethoxam 30 FS	10 ml/kg seed
			Imidachloprid 48 FS	1.25 ml/kg seed
		Spray 20-25 days after sowing	Thiamethoxam 25WG	100g/ha
			Imidachloprid 17.8 SL	650 ml/kg seed
	Charcoal Rot	Soil Application	Zinc sulphate	25 kg/ha
			Borex	0.5 kg/ha
		Seed treatment	Thiram + Carbendazim (2:1)	3 g/kg seed
			Trichoderma viridi	8-10 g/kg seed
	Anthracnose and Pod Blight	Seed Treatment during sowing	Thiram + Carbendazim (2:1)	3 g/kg seed
		First spray 18-20 days after sowing and second spray after 10-15 days	Thiophenate Methyl	1 kg/ha
			Benlet	1 kg/ha
			Seed treatment with Carboxin + Thiram (3g/kg) or carbendazim + mancozeb (2g /kg) fb two sprays of Thiophanate methyl @ 0.1% at 55 and 75 DAS	
	Bacterial Pustule	Immediately after symptoms are visible	Kasugamycin	100 g/ha
	Collor rot	Seed Treatment	Thiram + Carbendazim (2:1)	3 g/kg seed
			Trichoderma viride	8-10 g/kg seed
			Chloroneb	3 g/kg seed
18. Irrigation	Pre- sowing and at flowering and pod filling stage, in case of drought			
19. Harvesting	When pods turn black, brown or golden, seed has 17% moisture			
20. Threshing	Operate thresher at low cylinder speed of 400 to 500 rpm at 14% seed moisture			
21. Seed drying and storage	At seed moisture of about 10 %, store in moisture proof bags			
22.Intercropping	Corn, Pigeonpea	Corn, Pigeonpea, Sorghum	Sorghum, Pigeonpea, Cotton, Pearl millet, Groundnut	Cotton, Corn, Sugarcane, Finger millet, Pigeonpea, Groundnut, Wheat	Finger millet, Paddy, Pigeonpea

b. Rapeseed-Mustard

Insect management	
Insect	**Management Practices**
Mustard aphid	Foliar spray of 2% neem oil or 5% Neem Seed Kernel Extract (NSKE). Use predators such as coccinellids, syrphid and lacewing Oxydemeton methyl 25 EC @ 1.0 litre dissolved in 700-800 litres of water/ha
Painted bug	Seed treatment with imidacloprid 70WS @ 5g/kg seed. Conserve bio-control agents *Alophora* spp. (tachinid fly) parasitizing eggs of painted bugs.
Pea leaf miner	Predators : Lacewings, ladybug beetle, spiders, fire ants Foliar spray of systemic insecticide such as Oxydemeton methyl 25 EC @ 1.0 litre

Mustard saw fly	Conserve *Perilissus cingulator* (parasitoids of the larvae), and the bacterium *Serratia marcescens* which infect the larvae of sawfly. Spray the crop with malathion 50 EC @ 500 ml in 500 litre of water in one hectare. Repeat the spray if population builds up again.
Bihar hairy caterpillar	Dust the crop with Malathion 5% dust @ 25-30 kg/ ha against young caterpillars. Spray the crop with malathion 50 EC @ 1.0 litre in 500 litre of water in one ha.
Cabbage butterfly	Collect and destroy the gregarious form of larvae in 5% kerosenized water. Spray the crop with malathion 50 EC 1 litre in 600-800 litre of water per hectare under severe infestation.
Flea beetle	Spray the crop with malathion 50 EC @ 1 litre / ha in 600-800 litre of water under severe infestation.
Leaf webber	Pluck the infested shoots and inflorescence with larvae and destroy them. Spray the crop with malathion 50 EC @ 1.0 litre / ha in 600-800 litre of water in severe infestation.
Diamond Back Moth	*Diadegma insulare* is the most important parasitoid of the diamondback moth. Application of 4% NSKE Spray the crop with malathion 50 EC @ 1.0 litre / ha in 600-800 litre of water.
Termites	Entomopathogenic fungi like *Beauveria bassiana* 1kg multiplied in 50 kg FYM/compost can effectively control the termites. Application of chlorpyriphos 20 EC @ 4 litre/ ha during last ploughing and properly mixing in soil minimize the termite infestation.
Diseases management	
Disease	**Management Practices**
Damping-off and seedling blight	Seed treatment with Apron 35 SD 6 g/kg + Carbendazim 2 g/ kg @ 0.2%
Alternaria blight	Iprodione @ 2 g per litres of water or mancozeb (dithane M-45) @ 2.5 kg/ha at 15 days interval normally at 45, 60 and 75 days after sowing or Tebuconazole 50%+ Trifloxystrobin 25% 1 g /lit of water at 45 and 75 DAS.
Downy mildew and White rust	Treat the seed with Metalaxyl (Apron 35 SD) @ 6 g/ kg seed. Spray Ridomil MZ 72 WP @ 2 kg/ha dissolved in 800 litres of water soon after the disease appearance at 15 days interval. Avoid irrigation at pod formation stage.
Sclerotinia stem rot	Irrigation management (no irrigation during 25 Dec-15 Jan) Seed treatment (ST) carbendazim 50WP 2g/kg seed or with *Trichoderma* 10g/kg seed Foliar Spray of carbendazim 2g or tebuconazole @ 1 ml/lt of water or Tebuconazole 1 ml /lit of water at 60-70 DAS.
Powdery mildew	Spray of 1 kg dinocap or 2 kg wettable sulphur/ha dissolved in 800 litres of water
Club root	Apply chemical amendment lime @ 3 ton/ha along with compost before sowing in the infested soil so as to increase the soil pH to 7.2 and save the crop
Root rot	Seed treatment with carbendazim @2 g/ kg followed by spray on ground level with 0.1% carbendazim could be effective in managing the disease.
Other Technologies	

- Foliar spray of mancozeb 0.2% 45 DAS followed by hexaconazole 25 EC @ 0.05% 60 DAS proved effective in controlling the Alternaria leaf blight.
- Foliar spray of propiconazole 25 EC @ 0.05% was proved effective against powdery mildew and Sclerotinia rot.
- Seed treatment with *Trichoderma harzianum* @ 10 g/kg seed followed by foliar spray of *Pseudomonas fluorescence* (oil-based) @ 10ml/1 at flower initiation stage for reducing the disease (white rust, Sclerotinia stem rot, downy mildew and Alternaria blight).
- Soil application of $ZnSO_4$ @ 15 kg /ha + S (dose location specific) followed by 2 foliar sprays of carbendazim + mancozeb @ 0.2% at 45 and 60 DAS was most economical and effectively reduced all foliar diseases.
- Dimethoate 30 EC@ 300g a.i./ha or imidacloprid 17.8 SL @ 20g a.i./ha was found effective

against mustard aphid and recommended for its management.

- Foliar spray of mancozeb 0.2% 45 DAS followed by metalaxyl 8% + mancozeb 0.2% 60 DAS proved effective in controlling the white rust.
- Spray of dimethoate @ 1 ml/litre followed by release of *Coccinella septempunctata* @ 5000 beetles/ha is recommended for the eco-friendly integrated pest management of mustard aphid.
- *Verticillium lacanni. Chrysoperla carnea* and *Chilonemus sexmaculatus* were evaluated as bio-agents of mustard aphid.

c. Groundnut

- For managing sucking pests like, thrips and leafhoppers: a single spray of Imidacloprid 200SL @ 150 mL /ha or Thiacloprid 480SC @ 125 mL /ha or Thiomethoxam 25WG @ 100g/ha or Acetamiprid 20SP @ 100g /ha between 25 and 30 DAS or on need basis.
- For managing the defoliator pests like, *Spodoptera litura* and *Helicoverpa armigera*: a single spray of Rynaxypyr 20 SC @ 125 mL /ha or Flubendiamide 480 SC @ 100 mL /ha or Novaluron 10 EC @ 500 mL /ha on need basis.
- For managing *Aproarema modicella*: a single spray of Profenophos @ 50 EC @ 1000 mL /ha or Spinosad 45 SC @ 150 mL/ha or Flubendiamide 480 SC @ 75-100 mL /ha or Quinalphos @ 1000 mL/ha on need basis.
- The farmers cultivating groundnut are advised to 'treat the seed with mancozeb (2 g/kg seed) followed by two sprays of hexaconazole @ 0.1% at 45 & 60 DAS'
- Seed treatment with tebuconazole 1.5 g/kg seed followed by two sprays of tebuconazole @ 0.1% at 45 & 60 DAS' for effective management of Late leaf spot and rust diseases.
- Foliar spray of Karanj (*Pongamia*) oil @ 3 mL/L or Azadirachtin 3% @ 3 mL/L or Neem oil @ 3 mL/L or tank mixing of Karanj oil and Neem oil each @ 1.5 mL/L for management of defoliators using botanicals
- Seed treatment with Chlorpyriphos 20EC @ 12 mL/kg or Imidacloprid 48FS @ 2 mL/kg for management of white grubs
- Deep summer ploughing with mould board plough, then soil application of *Trichoderma* sp. @ 4 kg/ha enriched in 250 kg FYM/ha as basal (furrow) application, then seed treatment with Tebuconazole 2 DS @ 1.5 g/kg seed followed by PGPR @ 625 g/ha of seed, then again soil application (broad casting) of *Trichoderma* sp. @ 4 kg/ha enriched in 250 kg FYM/ha at 35 and 70 days after sowing for integrated management of soil-borne diseases
- Seed treatment with Tebuconazole 2DS @ 1.5 g/kg seeds followed by two foliar sprays of Tebuconazole 50% + Trifloxystobin 25% 75WG @ 1.32 g/L at 40 and 65 days after sowing for management of foliar diseases
- Seed treatment with Tebuconazole 2DS @ 1.5 g/kg seed + Border crop with bajra (3 or 4 rows) + Need based foliar spray of Thiodicarb 75WP @ 1 g/L between 50-70 days after sowing for defoliator pests + Need based foliar spray of Hexaconazole 5EC @ 1 mL/L between 50-70 days after sowing for foliar diseases: IPDM Module

d. Sesame

Sr. No.	Name of technology	States
1.	Management of sesame phyllody vectors through newer molecules indicated that the minimum vector incidence (leaf hopper), higher seed yield and BC ratio was recorded from seed treated with Imidacloprid 70 WS (7.5 g/kg seed) and two foliar sprayings of thiamethoxam 0.25 g/l or Imidacloprid 17.8 SL at 30 and 45 DAS.	All states
2.	For the management of *Tribolium castaneum* in stored sesame spinosad 45 SC (0.5 ml/kg seed) was found most effective and gave 100% mortality of beetles at 5 days after release. However, among plant products, NSK powder (5g/kg seed) was found	All states

	most effective and gave 90 per cent mortality at 25 days after treatment.	
3.	Application of IPM module comprising seed treatment with imidacloprid 600 FS @ 5ml/kg seed + inter cropping with green gram (3:3) along with yellow sticky traps then one foliar spray of profenofos 0.1% (2 ml/litre) at 30 days after sowing, if needed second foliar spray of NSKE 5% was effective to manage insect pests of sesame.	All states
4.	For the management of rice moth (*Corcyra cephalonica*) in stored sesame, seed treated with neem seed kernel powder (5g/kg of seed) and neem leaf powder (5g/kg of seed) were found most effective treatment.	Odisha
5.	Integrated management of stem and root rot of sesame, seed treatment with *T. viride* @ 10 g/kg, furrow application of enriched *T. viride* (2.5 kg in 100 kg of FYM) @ 250 kg/ha followed by foliar spray of combi-product (Tebuconazole 50% + Trifloxystrobin 25%) @ 0.5 g/l.	All states
6.	Integrated management of foliar disease of sesame: seed treatment with *T. viride* @ 10 g/kg, furrow application of enriched *T. viride* (2.5 kg in 100 kg of FYM) @ 250 kg/ha followed by foliar spray of combi-product (Tebuconazole 50% + Trifloxystrobin 25%) @ 0.5 g/l was found effective	All states
7.	Integrated management of stem and root rot of sesame: Seed treatment with *Trichoderma viride*+ *Pseudomonas florescence* @ 10g/kg +soil application of *T. viride*+*P. florescence* before sowing @2.5 kg/ha (enriched with 100kg of FYM + neem cake)@ 250kg/ha was found effective for the management of stem and root rot of sesame.	All states

e. Sunflower

Insect Pests

S. No.	Name of technology / Strategy	States
1.	**Integrated Pest Management (IPM) module** IPM modules including Seed treatment with imidacloprid 70WS @5g/kg, hand picking and destruction of egg masses and early larvae of *Spodoptera* and *Spilosoma* and foliar spray of Spinosad 45SC @ 150 ml/ha	Karnataka, Maharashtra
2.	**Management of Head borer** Application of chlorantraniliprole 18.5 SC @ 0.3ml/l (150ml/ha) or Bt-127 SC formulation @ 3.0ml/l (1500ml/ha) for effective management of headborer	Karnataka, Maharashtra

Diseases

S. No.	Name of technology / Strategy	States

1.	**Management of Alternariaster Leaf Spot/Blight** • Seed treatment with Iprodine + Carbendazim (QuintalTM)@ 0.2% (2 g/kg) and two sprays of Iprodine @ 0.2% (2 g/kg) at 30 and 45 DAS • Seed treatment with Iprodine + Carbendazim (QuintalTM) @ 0.2% (2 g/kg) and two sprays of Propiconazole (Tilt TM) @ 0.1% (1 ml/litre of water) at 30 and 45 DAS • Seed priming (Carbendazim 2 g/kg + Thiamethoxam @ 0.04% (0.4 ml/litre of water) + spraing of Propiconazole @ 0.1% (1 ml/litre of water) + Azadirachtin @ 0.15% (1.5 ml/litre of water) as soon as disease appears and the second spray may be taken up after 15 days • Seed treatment with *Pseudomonas fluorescens*@ 10 g/kg followed by spraying of Propiconazole @ 0.1% (1 ml/litre of water) at 45 DAS and *P. fluorescens*@ 1.0% (1 ml/litre of water) at 60 DAS	Karnataka, Maharashtra Tamil Nadu Andhra Pradesh
2.	**Management of Charcoal Rot** • Seed treatment with Carbendazim 12% + Mancozeb 63% @ 2 g/kg and weekly proper irrigation	Punjab
3.	**Management of Sunflower Necrosis** • Seed priming (Carbendazim 2 g/kg + Thiamethoxam @ 0.04% (0.4 ml/litre of water) + spraing of Propiconazole @ 0.1% (1 ml/litre of water) + Azadirachtin @ 0.15% (1.5 ml/litre of water) as soon as disease appears and the second spray may be taken up after 15 days • Seed treatment with Thiamethoxam (CruiserTM) @ 4 g/kg and sprays of Thiamethoxam @ 0.05% (0.5 ml/litre of water) at 30 and 45 DAS	Karnataka, Maharashtra Tamil Nadu Andhra Pradesh
4.	**Management of Powdery Mildew** • Foliar spray of Propiconazole @ 0.1% or Difenoconazole @ 0.05% or Triadimefon @ 0.1% at 30 and 45 DAS	Karnataka, Tamil Nadu, Andhra Pradesh

f. Safflower

Sr. No.	Name of technology / Strategy	States
1.	**Management of Aphid** • Aphid management low cost technologies like Seed treatment with thiamethoxam 30 FS@10ml/kg seed or imidacloprid 600FS@ 8ml/kg • Foliar sprays with more effective new insecticides like pymetrozine 50WG @ 300g/ha; thiamethoxam 25 WG @ 125g/ha or imidacloprid 17.8 SL @ 200ml/ha and twice at 15 days interval.	Maharashtra, Karnataka and Telangana
2.	**Management of Gujhia weevil** • Gujhia weevil management through soil application of Phorate 10G granules @ 10kg/ha at the time of sowing and foliar spray with Chlorpyriphos 20EC @ 2.5ml/l	Maharashtra

g. Niger

Sr. No.	Name of technology	States
1.	Management of Niger foliar diseases through seed treatment with spray of 0.1**%** Carbendazim + 0.2% Mancozeb (3g/l of water) recorded minimum incidence of *Alternaria* and *Cercospora leaf spot* with the maximum seed yield.	All states

Quantifiable Targets with time scale for edible oilseeds set by the ICAR in the next five years (2021-22 to 2025-26) for enhancing productivity

To achieve the targets of enhancing edible oil production in India, the following quantifiable targets have been fixed for each crop in the EFC of oilseed crops for the period 2021-22 to 2025-26.

Crop-wise Activities	Targets					
	2021-22	2022-23	2023-24	2024-25	2025-26	Total
Rapeseed-Mustard						
Plant germplasm evaluated (no.)	300	300	300	400	500	1800
Genotypes identified and registered for unique traits (no.)	4	4	5	5	5	23
No. of CMS and restorer lines developed for hybrid development	CMS-2 R-2	CMS-2 R-2	CMS-2 R-2	CMS-2 R-2	CMS-2 R-2	CMS-10 R-10
Elite advance breeding lines/hybrids evaluated in common and station trials (no.)	100	115	125	125	125	590
Varieties/hybrids identified (no.)	1	1	1	2	2	7
Varietal Identification Committees (no.)	1	1	1	2	2	7
Varieties/hybrids released and notified (State and central releases)	1	1	1	2	2	7
Varieties/hybrids commercialized (no.)	1	1	1	1	1	5
Genes cloned and characterized (no.)	0	2	0	2	0	4
Marker assisted selection/backcrossed derived lines developed (no.)	5	5	2	2	2	16
New protection and production technologies developed and tested (no.)	4	4	4	4	4	20
Front line demonstration conducted (no.)	250	250	250	250	250	1250
Soybean						
Plant germplasm evaluated (no.)	1000	1200	1400	1600	1800	7000
Conservation of microbial genetic resources (no.)	4	4	4	4	4	20
Genotypes identified and registered for unique traits (no.)	4	6	6	7	7	30
Elite advance breeding lines/hybrids evaluated in common and station trials (no.)	50	50	50	50	50	250
Varieties/hybrids identified by AICRP (no.)	5	5	5	5	5	25
Varietal Identification Committees (no.)	1	1	1	1	1	5
Varieties/hybrids released and notified (State and central releases)	5	5	5	5	5	25
Varieties/hybrids registered with PPV&FRA	3	3	3	3	3	15
Varieties/ hybrids commercialized (no.)	0	0	0	0	0	0
Genes cloned and characterized (no.)	1	1	1	1	1	5
Marker assisted selection/backcrossed derived lines developed (no.)	10	15	20	25	30	100

Genome edited/Transgenic products varieties/hybrids/lines) (no.)	0	0	0	0	0	0
New protection and production technologies developed and tested (no.)	02	02	02	02	02	10
Front line demonstration conducted (no.)	25	25	25	25	25	125
Groundnut						
Plant germplasm evaluated (no.)	1200	1400	1600	1800	2000	8000
Conservation of microbial genetic resources (no.)	450	500	600	700	800	800
Genotypes identified and registered for unique traits (no.)	5	7	10	12	15	49
Elite advance breeding lines/hybrids evaluated in common and station trials (no.)	50	60	65	70	75	320
Varieties/hybrids identified by AICRP (no.)	2	2	2	2	2	10
Varietal Identification Committees (no.)	2	2	2	2	2	10
Varieties/hybrids released and notified (State and central releases)	2	2	2	2	2	10
Varieties/hybrids registered with PPV&FRA	2	2	2	2	2	10
Varieties/ hybrids commercialized (no.)	0	0	0	0	0	0
Genes cloned and characterized (no.)	0	0	1	1	1	3
Marker assisted selection/backcrossed derived lines developed (no.)	10	15	20	25	30	100
Genome edited/Transgenic products varieties/hybrids/lines) (no.)	0	1	1	1	1	4
New protection and production technologies developed and tested (no.)	4	6	7	8	10	35
Front line demonstration conducted (no.)	250	300	350	400	450	1750
Minor oilseeds (Sesame, Sunflower, Safflower, Niger)						
Plant germplasm evaluated (no.)	1780	2080	1530	1300	1200	7890
Genotypes identified and registered for unique traits (no.)	3	3	3	3	3	15
No. of CMS and restorer lines developed for hybrid development	2	2	3	4	4	15
Elite advance breeding lines/hybrids evaluated in common and station trials (no.)	196	208	135	135	175	909
Varieties/hybrids identified by AICRP (no.)	8	8	8	8	8	40
Varieties/hybrids released and notified (State and central releases)	3	3	3	3	3	15
Varieties and hybrids commercialized (no.)	0	0	0	1	1	2
Marker assisted selection/backcross derived lines developed (no.)	1	2	2	2	3	10
Genome edited/transgenic products (varieties/hybrids/lines) No.	0	0	2	0	0	2
New protection and production technologies developed and tested (no.)	4	4	4	4	4	20
Front line demonstration conducted (no.)	400	500	600	600	600	2700

11. Sustainability

Marketing and Infrastructure

To boost cultivation of edible oilseeds and making it remunerative particularly in non-traditional areas, required infrastructure will required to be created for post-harvest processing, value addition and marketing, easy availability of farm machineries, etc. The following support will be required: **(Responsibility: DAC, Ministry of Commerce, State Department of Agriculture, Ministry of Industries, etc.)**

- Establishment of oil mills, solvent extraction units, *ghanies,* etc. in non-traditional areas in PPP mode. Government should provide all support for declaring tax holidays for 10 years to all processing units, and minimum freight charges for transportation of components of processing units, oil mills and farm implements. Soft loan to entrepreneurs for establishment of factories for manufacture of farm implements and easy access to lands for establishment of manufacturing units.
- Catch up grants for establishment of community seed bank, seed hubs, etc.
- Capacity building to farm women and shelf-help groups and FPOs to encourage production of value added products from oilseed crops and marketing them
- Establishment of seed hubs for production of quality seeds

Policy support

To make cultivation of each crop remunerative, positive policy support from GOI will be required to encourage the farmers to take up cultivation of edible oilseeds. The following policy supports will be required from GOI from time to time:

- Ensuring availability of quality seeds of each crops to the farmers and efforts to be made for establishment of more number of seed hubs, seed village, and seed bank **(Responsibility: DAC, NSC, ICAR, State Department of Agriculture)**
- All required machineries would be developed in PPP mode to ensure availability at affordable price. Tax holiday for small implements, tractors of more than 30 HP, other implements **(Responsibility: DAC, State Government)**
- Encourage 'Make in India' by discouraging import if cheap oil by imposing maximum possible bound duty **(Responsibility: DAC, Ministry of Commerce)**
- Ensure high MSP and remunerative price to farmers to take up more oilseed crops **(Responsibility: DAC)**
- Policy decision on releasing indigenously developed GM oilseeds may be hastened **(Responsibility: DAC; Ministry of Environment and Forest)**
- Shifting acreage from grain crops to oilseed crops **(Responsibility: DAC)**
- Ensure subsidies to transportation of edible oilseeds and oils to reduce cost of marketing of edible oil **(Responsibility: DAC)**
- Favourable internal transport and freight charges on edible oil and machinery **(Responsibility: DAC; Ministry of Railways and Surface Transport)**
- Incentives for adoption of new varieties with assured buyback **(Responsibility: DAC)**
- Extend subsidy to all machineries for adoption of micro-irrigation **(Responsibility: DAC)**
- Extend MSP buyback from 25% to 100% to assure return to the farmers **(Responsibility: DAC)**

Extension

Unless improved package of practices are reaching to the farmers, adoption will not take place. Benefits of all the crop production, crop protection and improved varieties of all edible oilseed crops need to be demonstrated in large scale to the farmer's field either as individual package or whole package as FLDs or CFLDs location specifically. It is proposed to have in place at least 1500 FLDs and 250 CFLDs for each crop in each season. Monitoring of the FLDs is to be ensured. Farmers are also required to be trained about the improved technologies through trainings, organizing goshthis, kisan mela, and dissemination of information using print, electronic and social media platforms. **(Responsibility: DAC, State Department of Agriculture, Line Departments, KVKs, SAUs, NGOs, etc.)**

12. Special emphasis on development of drought tolerant varieties

As majority of edible oilseeds (except Rapeseed-Mustard) is cultivated under rainfed conditions, yield is affected significantly and in worst scenario, the entire crop may fail. In the changed climatic scenario and with predicted increase in frequency and intensity of climate extremes, the incidence of drought will be more pronounced. Moreover, because of climate change, there will be ingression of saline water in coastal belt rendering vast area unfit for cultivation. Therefore, urgent attention will be required for developing suitable varieties and or management practices to impart either drought- and salinity- tolerance or developing mitigation strategies. The following actions are envisaged:

- Introgression of abiotic stress tolerant traits from germplasm or wild accessions into cultivated background using molecular tools
- Engineering drought- and salinity- tolerant genes into cultivated background from other known sources
- Alleviation of drought- and or salinity- stress by water management practices and application of endophytic microorganisms

(Responsibilities: All Crop Institutes, SAUs)

Self-Sufficiency in Edible Oil Production

With all the above technical and policy interventions in place, the projected production of edible oil will be to the tune of 13.49 MT, 17.21 MT and 21.99 MT in the year 2024-25, 2029-30 and 2034-35, respectively from present level of 7.03 MT. During this period of 2019-20 to 2034-35, the growth in production of edible oil will be at CAGR of 7.39%. Major contribution in edible oil kitty will come from Rapeseed-Mustard, Soybean and Groundnut with overall contribution of 43.40% (5.85 MT), 26.44% (3.57 MT) and 25.17% (3.39 MT) in the year 2024-25, respectively. In 2029-30, the relative contribution of these edible oils will be 40.55% (6.85 MT), 26.74% (4.51 MT) and 26.90% (4.80 MT), respectively for Rapeseed-Mustard, Soybean and Groundnut. By the year 2034-35, relative contribution of edible oil from Rapeseed-Mustard will go down to 35.20%, however, it will remain be top producer with 7.74 MT. On the contrary, the contribution from groundnut will be 29.74% with production of 6.54 MT and that from soybean, it will be 6.23 MT (28.35%). The overall contribution from all other minor oilseeds will be in the range of 4-6% (Figure 10).

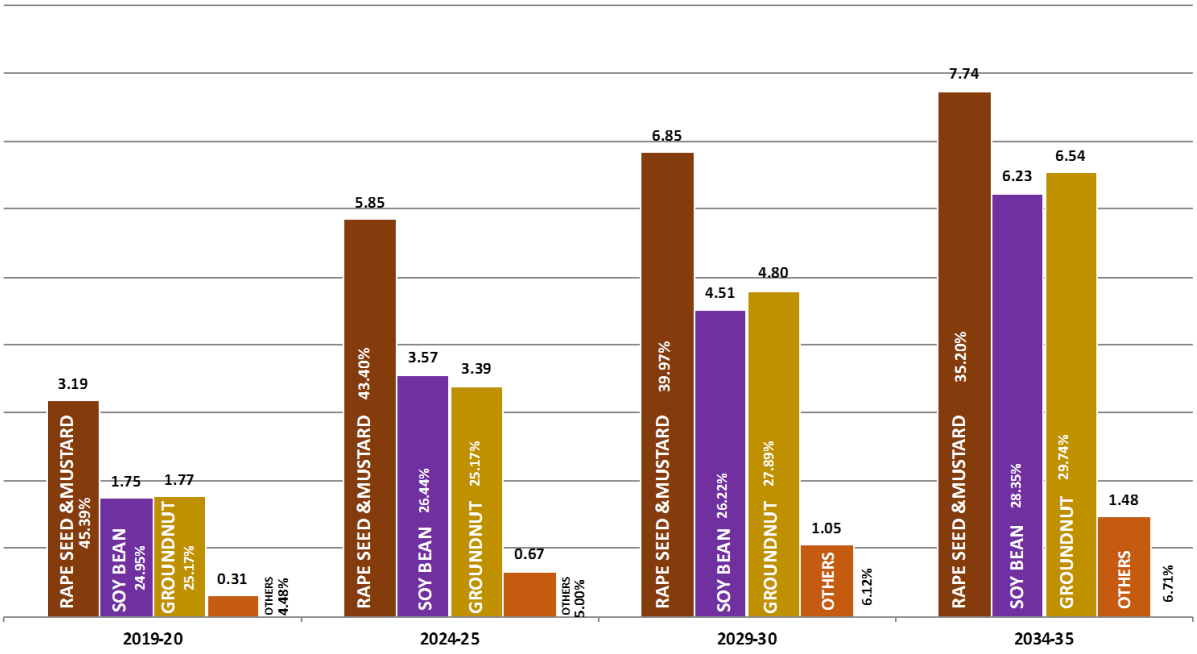


Figure 10. Relative contribution (%) on edible oil production by oil seed crops

13. Campaign for reducing edible oil consumption

In achieving self-sufficiency in production of edible oils in India, *per capita* consumption has to be maintained at present level i.e. 19.22 kg/capita/year as on 2019-20. Even 19.22 kg/capita/year consumption is much higher than WHO recommended consumption (13.00 kg/capita/year). However, it will be difficult owing to pressure from population growth, rapid urbanization, change in life style, and increase demand of fast food from younger generation. Therefore, aggressive campaign is to be launched in print, electronic and soil media platforms involving prominent personalities and citizen appealing for reducing the consumption of edible oil by creating awareness among the population about the health benefits of using less oil. If we can reduce the consumption through the campaign and pledge for 10% reduction/capita/year in consumption, there will be reduction in demand by 10% in respective years, calculated at fixed rate of consumption of (19.22-1.92=17.3 kg/capita/year). Projected demand, after deduction of 10% will be 24.78 MT, 25.82 MT and 26.72 MT against original demand of 27.53 MT, 28.69MT and 29.69MT, respectively during 2024-25, 2029-30 and 2034-35, respectively. Accordingly, India will achieve 'atmanirbhar' in edible oil production by the beginning of 2031-32 and no more export will be required (Table 8). Accordingly, if increase rate of consumption is considered, and 10% reduction in consumption is pledged per person per year, there will be demand of 27.33MT, 32.19MT and 37.65MT of edible oil against original demand of 30.37MT, 35.76MT and 41.83MT, respectively during 2024-25, 2029-30 and 2034-35, respectively. Consequently, dependency in edible oil import will be reduced further to 34.10%, 28.42% and 21.70%, respectively (Table 8).

Table 8. Likely impact of campaign to reduce edible oil consumption on demand and dependency on import of edible oil

Year	Edible oil consumption (kg/capita/yr)		Demand (MT)		Import dependency (%)		Saving after pledge of reduction in consumption (MT)		Demand after pledge of 10% reduction in consumptions (MT)		Import dependency (%) after reduction in consumption by 10%	
	At present rate	At increased rate *	At present rate	At increased rate *	At present rate	At increased rate *	At present rate	At increased rate *	At present rate	At increased rate*	At present rate	At increased rate*
2019-20	18.76	18.75	25.63	25.63	58.92	58.92	0	0	25.63	25.63	58.98	58.98
2020-21	19.22	19.22	26.52	26.52	55.91	55.92	2.65	2.65	23.87	23.87	51.02	51.02
2021-22	19.22	19.70	26.78	27.45	51.46	52.63	2.68	2.74	24.10	24.70	46.06	47.37
2022-23	19.22	20.19	27.03	28.39	46.46	49.02	2.70	2.84	24.33	25.55	40.51	43.36
2023-24	19.22	20.69	27.29	29.37	40.87	45.06	2.73	2.93	24.56	26.43	34.28	38.96
2024-25	19.22	21.20	27.53	30.36	34.58	40.69	2.75	3.04	24.78	27.33	27.31	34.10
2025-26	19.22	21.73	27.77	31.39	31.88	39.73	2.78	3.14	24.99	28.25	24.31	33.04
2026-27	19.22	22.26	28.01	32.45	29.05	38.75	2.80	3.24	25.21	29.20	21.16	31.94
2027-28	19.22	22.82	28.24	33.52	26.07	37.72	2.82	3.35	25.42	30.17	17.85	30.80
2028-29	19.22	23.38	28.47	34.63	22.95	36.67	2.84	3.46	25.62	31.17	14.39	29.63
2029-30	19.22	23.96	28.68	35.76	19.68	35.57	2.87	3.58	25.82	32.19	10.75	28.41
2030-31	19.22	24.55	28.90	36.92	16.24	34.45	2.89	3.69	26.00	33.23	6.94	27.16
2031-32	19.22	25.165	29.11	38.11	12.64	33.28	2.91	3.81	26.19	34.30	2.94	25.87
2032-33	19.22	25.79	29.31	39.32	8.86	32.08	2.93	3.93	26.38	35.40	-1.27	24.53
2033-34	19.22	26.43	29.50	40.57	4.88	30.82	2.95	4.06	26.55	36.50	-5.68	23.14
2034-35	19.22	27.08	29.69	41.83	0.70	29.53	2.97	4.18	26.72	37.64	-10.33	21.70

*Increase rate of demand @2.48% annually

14. R&D support and establishment of centre of excellence

For development of required improved technologies for enhancing productivity of the edible oilseeds, R&D support will be required for take up the following issues:

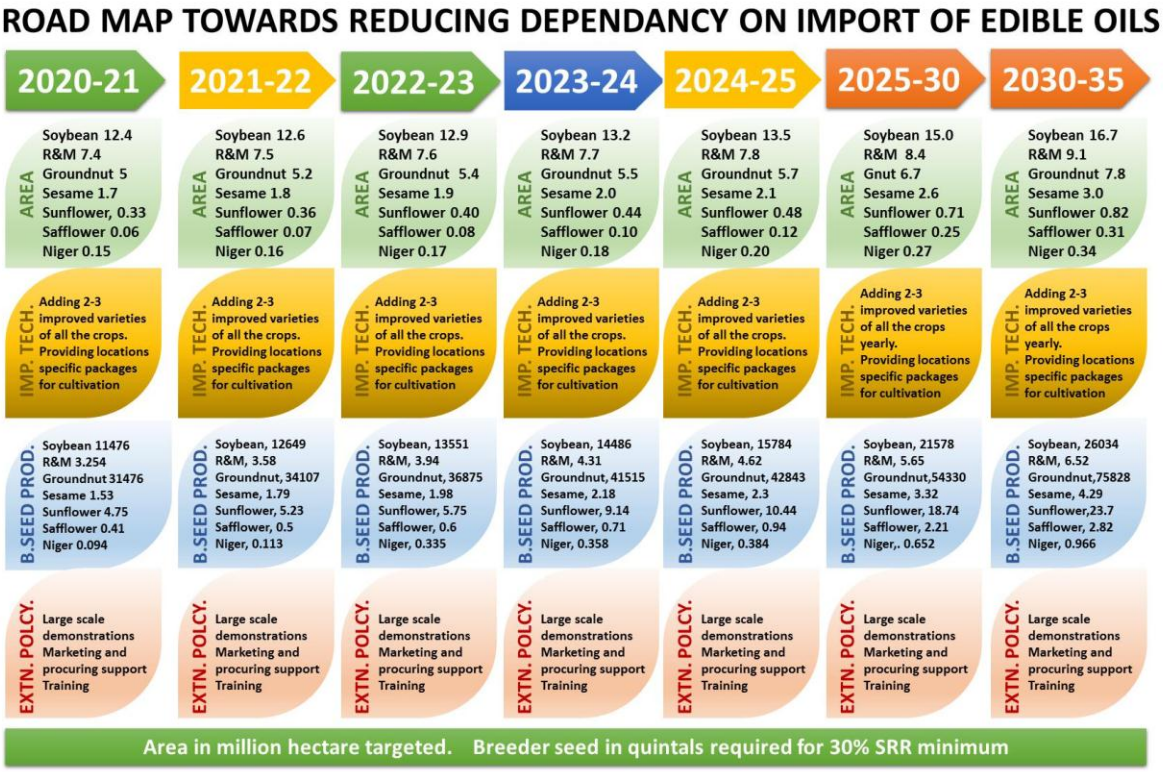
- Development of high yielding varieties tolerant to abiotic and biotic stresses using molecular tools
- Development of matching agronomic and crop protection measures for enchanting production of edible oilseeds further
- Diversification and value addition of oilseed products and byproducts
- High throughput genotyping and phenotyping facilities Investment in developing high-end infrastructure facilities for developing required high yielding varieties by broadening the genetic base and introgressing stress tolerant genes into agronomic background from germplasm and germplasm accessions and for using MAS as much as possible for selection of superior desired genotypes
- Use in gene editing and genetic engineering tools for improvement of targeted traits w.r.t yield improvement
- Investment for making low cost bioagents to farmers in time on no-profit-no-loss basis in 'Bioagent-hub' concept as envisaged for certified seed production of improved varieties

Establishment of centre of excellence by proving one-time grants for establishment of modern infrastructure facilities for R&D (Responsibilities: ICAR, DAC)

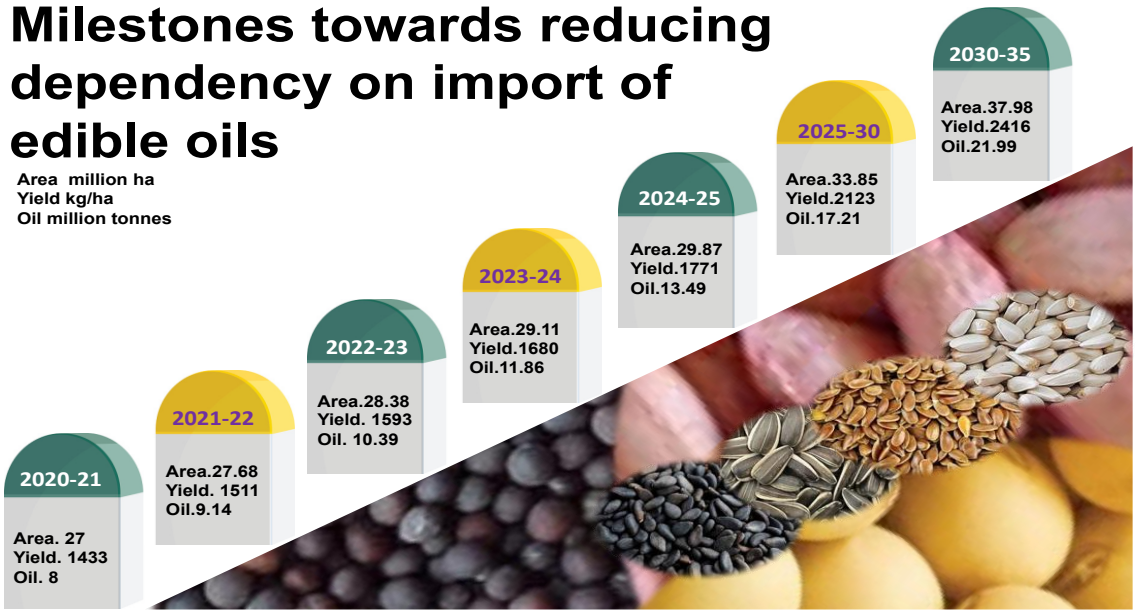
The proposed Centre of Excellence (CoEs) will be set up through ICAR for each oilseeds (Groundnut, Rapeseed-Mustard, Soybean and other oilseeds) with the following objectives:

- Development of high yielding varieties tolerant to abiotic and biotic stresses using molecular tools
- Development of matching agronomic and crop protection measures for enchanting production of edible oilseeds further
- Diversification and value addition of oilseed products and byproducts
- Enhancing shelf-life of each oilseed crops
- Value added products and technologies and recipe development.
- Refinement of technology, retrofitting machineries and their demonstration
- Providing entrepreneurship development and training by incubating them
- Facilitate market linkages between processors and producers
- Up scaling of developed technologies
- Creating awareness on nutritional wellness of edible oils

Road map



Milestones



Conclusion

India needs to be 'Atmanirbhar' in edible oil production in future to save valuable foreign exchange to the tune of nearly seventy-thousand crores and so that the amount saved can be utilized for other developmental work. The action plan proposed here is to be followed in letter and spirit to achieve the goal. Though the target looks highly ambitious, it will be achievable with the coordinated effort and support of all stakeholders.

ROAD MAP TOWARDS REDUCING DEPENDENCY ON IMPORT OF EDIBLE OILS (Tabular)

CROP		2020-21	2021-22	2022-23	2023-24	2024-25	2025-30	2030-35
Soybean	Area (mha)	12.4	12.6	12.9	13.2	13.5	15.0	16.7
	IMPROVED TECHNOLOGIES	Adding 2-3 improved varieties. Providing locations specific packages for cultivation	Adding 2-3 improved varieties. Providing locations specific packages for cultivation	Adding 2-3 improved varieties. Providing locations specific packages for cultivation	Adding 2-3 improved varieties. Providing locations specific packages for cultivation	Adding 2-3 improved varieties. Providing locations specific packages for cultivation	Adding 2-3 improved varieties. Providing locations specific packages for cultivation	Adding 2-3 improved varieties. Providing locations specific packages for cultivation
	BREEDER SEED PRODUCTION (q)	11476	12649	13551	14486	15784	21578	26034
	EXTENSION & POLICY	Large scale demonstrations Marketing and procuring support Training	Large scale demonstrations Marketing and procuring support Training	Large scale demonstrations Marketing and procuring support Training	Large scale demonstrations Marketing and procuring support Training	Large scale demonstrations Marketing and procuring support Training	Large scale demonstrations Marketing and procuring support Training	Large scale demonstrations Marketing and procuring support Training
CROP		2020-21	2021-22	2022-23	2023-24	2024-25	2025-30	2030-35
Rapeseed-Mustard	Area (mha)	7.4	7.5	7.6	7.7	7.8	8.4	9.1
	IMPROVED TECHNOLOGIES	Adding 2-3 improved varieties. Providing locations specific packages for cultivation	Adding 2-3 improved varieties. Providing locations specific packages for cultivation	Adding 2-3 improved varieties. Providing locations specific packages for cultivation	Adding 2-3 improved varieties. Providing locations specific packages for cultivation	Adding 2-3 improved varieties. Providing locations specific packages for cultivation	Adding 2-3 improved varieties. Providing locations specific packages for cultivation	Adding 2-3 improved varieties. Providing locations specific packages for cultivation
	BREEDER SEED PRODUCTION (q)	3.24	3.58	3.94	4.31	4.62	5.65	6.52

	EXTENSION & POLICY	Large scale demonstrations Marketing and procuring support Training	Large scale demonstrations Marketing and procuring support Training	Large scale demonstrations Marketing and procuring support Training	Large scale demonstrations Marketing and procuring support Training	Large scale demonstrations Marketing and procuring support Training	Large scale demonstrations Marketing and procuring support Training	Large scale demonstrations Marketing and procuring support Training
CROP		**2020-21**	**2021-22**	**2022-23**	**2023-24**	**2024-25**	**2025-30**	**2030-35**
Groundnut	**Area (mha)**	**5.0**	**5.2**	**5.4**	**5.5**	**5.7**	**6.7**	**7.8**
	IMPROVED TECHNOLOGIES	Adding 2-3 improved varieties. Providing locations specific packages for cultivation	Adding 2-3 improved varieties. Providing locations specific packages for cultivation	Adding 2-3 improved varieties. Providing locations specific packages for cultivation	Adding 2-3 improved varieties. Providing locations specific packages for cultivation	Adding 2-3 improved varieties. Providing locations specific packages for cultivation	Adding 2-3 improved varieties. Providing locations specific packages for cultivation	Adding 2-3 improved varieties. Providing locations specific packages for cultivation
	BREEDER SEED PRODUCTION (q)	**31476**	**34107**	**36875**	**41515**	**42843**	**54430**	**75828**
	EXTENSION & POLICY	Large scale demonstrations Marketing and procuring support Training	Large scale demonstrations Marketing and procuring support Training	Large scale demonstrations Marketing and procuring support Training	Large scale demonstrations Marketing and procuring support Training	Large scale demonstrations Marketing and procuring support Training	Large scale demonstrations Marketing and procuring support Training	Large scale demonstrations Marketing and procuring support Training
CROP		**2020-21**	**2021-22**	**2022-23**	**2023-24**	**2024-25**	**2025-30**	**2030-35**
Sesame	**Area (mha)**	**1.7**	**1.8**	**1.9**	**2.0**	**2.1**	**2.6**	**3.0**
	IMPROVED TECHNOLOGIES	Adding 2-3 improved varieties. Providing locations specific packages for cultivation	Adding 2-3 improved varieties. Providing locations specific packages for cultivation	Adding 2-3 improved varieties. Providing locations specific packages for cultivation	Adding 2-3 improved varieties. Providing locations specific packages for cultivation	Adding 2-3 improved varieties. Providing locations specific packages for cultivation	Adding 2-3 improved varieties. Providing locations specific packages for cultivation	Adding 2-3 improved varieties. Providing locations specific packages for cultivation
	BREEDER SEED PRODUCTION (q)	**1.53**	**1.79**	**1.98**	**2.18**	**2.3**	**3.32**	**4.29**

	EXTENSION & POLICY	Large scale demonstrations Marketing and procuring support Training	Large scale demonstrations Marketing and procuring support Training	Large scale demonstrations Marketing and procuring support Training	Large scale demonstrations Marketing and procuring support Training	Large scale demonstrations Marketing and procuring support Training	Large scale demonstrations Marketing and procuring support Training	Large scale demonstrations Marketing and procuring support Training
CROP		**2020-21**	**2021-22**	**2022-23**	**2023-24**	**2024-25**	**2025-30**	**2030-35**
Sunflower	**Area (mha)**	**0.33**	**0.36**	**0.40**	**0.44**	**0.48**	**0.71**	**0.82**
	IMPROVED TECHNOLOGIES	Adding 2-3 improved varieties. Providing locations specific packages for cultivation	Adding 2-3 improved varieties. Providing locations specific packages for cultivation	Adding 2-3 improved varieties. Providing locations specific packages for cultivation	Adding 2-3 improved varieties. Providing locations specific packages for cultivation	Adding 2-3 improved varieties. Providing locations specific packages for cultivation	Adding 2-3 improved varieties. Providing locations specific packages for cultivation	Adding 2-3 improved varieties. Providing locations specific packages for cultivation
	BREEDER SEED PRODUCTION (q)	**4.75**	**5.23**	**5.75**	**9.14**	**10.44**	**18.74**	**23.70**
	EXTENSION & POLICY	Large scale demonstrations Marketing and procuring support Training	Large scale demonstrations Marketing and procuring support Training	Large scale demonstrations Marketing and procuring support Training	Large scale demonstrations Marketing and procuring support Training	Large scale demonstrations Marketing and procuring support Training	Large scale demonstrations Marketing and procuring support Training	Large scale demonstrations Marketing and procuring support Training
CROP		**2020-21**	**2021-22**	**2022-23**	**2023-24**	**2024-25**	**2025-30**	**2030-35**
Safflower	**Area (mha)**	**0.06**	**0.07**	**0.08**	**0.10**	**0.12**	**0.25**	**0.31**
	IMPROVED TECHNOLOGIES	Adding 2-3 improved varieties. Providing locations specific packages for cultivation	Adding 2-3 improved varieties. Providing locations specific packages for cultivation	Adding 2-3 improved varieties. Providing locations specific packages for cultivation	Adding 2-3 improved varieties. Providing locations specific packages for cultivation	Adding 2-3 improved varieties. Providing locations specific packages for cultivation	Adding 2-3 improved varieties. Providing locations specific packages for cultivation	Adding 2-3 improved varieties. Providing locations specific packages for cultivation
	BREEDER SEED PRODUCTION (q)	**0.41**	**0.50**	**0.60**	**0.71**	**0.94**	**2.21**	**2.82**

	EXTENSION & POLICY	Large scale demonstrations Marketing and procuring support Training	Large scale demonstrations Marketing and procuring support Training	Large scale demonstrations Marketing and procuring support Training	Large scale demonstrations Marketing and procuring support Training	Large scale demonstrations Marketing and procuring support Training	Large scale demonstrations Marketing and procuring support Training	Large scale demonstrations Marketing and procuring support Training
CROP		**2020-21**	**2021-22**	**2022-23**	**2023-24**	**2024-25**	**2025-30**	**2030-35**
Niger	**Area (mha)**	**0.15**	**0.16**	**0.17**	**0.18**	**0.20**	**0.27**	**0.34**
	IMPROVED TECHNOLOGIES	Adding 2-3 improved varieties. Providing locations specific packages for cultivation	Adding 2-3 improved varieties. Providing locations specific packages for cultivation	Adding 2-3 improved varieties. Providing locations specific packages for cultivation	Adding 2-3 improved varieties. Providing locations specific packages for cultivation	Adding 2-3 improved varieties. Providing locations specific packages for cultivation	Adding 2-3 improved varieties. Providing locations specific packages for cultivation	Adding 2-3 improved varieties. Providing locations specific packages for cultivation
	BREEDER SEED PRODUCTION (q)	**0.094**	**0.113**	**0.335**	**0.358**	**0.384**	**0.652**	**0.966**
	EXTENSION & POLICY	Large scale demonstrations Marketing and procuring support Training	Large scale demonstrations Marketing and procuring support Training	Large scale demonstrations Marketing and procuring support Training	Large scale demonstrations Marketing and procuring support Training	Large scale demonstrations Marketing and procuring support Training	Large scale demonstrations Marketing and procuring support Training	Large scale demonstrations Marketing and procuring support Training