



Evaluating the Impact of Haryana's Edible Oil Plant Resources on Human Health

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Oil is odorless compound of herbs and spices and has been used for centuries to flavor and preserve foods, medicines and perfumes. There are many aromatic plant species in the Lamiaceae and Apiaceae plant families. Edible oils are produced in Haryana and is used for its beneficial effects on human health. The most common crops include peanuts, mustard, sunflower seeds, sesame seeds, soyabeans, wheat (rice bran), sunflower, cotton, flaxseeds, etc. Takes place.

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Essential oils have many health benefits. The oil contains antioxidants. Vitamin E, plant sterols and polyunsaturated fatty acids (PUFA), which can lower cholesterol and prevent chronic diseases such as heart disease, diabetes and cancer. Fatty oils are divided into three types: drying and semi-drying oil, non-drying oil, and vegetable oil. The refined grades of drying and semi-drying oils are used to make edible oils, while the poorer grades are used to make soaps, varnishes, paints, candles, and other similar products. Oils contain a variety of bioactive chemicals (e.g., terpenoids), which have most biological effects and qualities in addition to their scent and flavor. Antibacterial, antifungal, antioxidant, insecticide, anthelmintic, acaricidal, larvicidal, anthelmintic, anti-inflammatory, cytotoxic, antibacterial, antiseptic, and local anaesthetic are just few of them. Oil compounds, such as geraniol, have recently demonstrated potential anticancer actions in cancer cells, triggering growth inhibition and death.

Keywords: Edible oil; health benefits; oil seeds; terpenes; production; yield.

1. INTRODUCTION

The oil is found in the flowers, leaves, roots, rhizomes, fruits, seeds, wood, and resins of many plants. The oil is found in glandular trichomes, which are specialized cells on the surface of leaves and calyces. Oils produced by plants act as secondary metabolites, which are bioactive compounds with biological properties. Plants defend against herbivores that make them undesirable; pollinator attraction; protection of the plant from fungal, viral and bacterial diseases; facility communications and signaling; and allopathic is suspected to be involved. According to many studies [1,2,3,4], edible oil plants are often abundant in fatty acids, trace elements and active substances, as a flavouring agents. They also have complex drugs. It is combination of terpenes and terpenoids that make every plant smell, and is the sum of all the substances it contains. Terpenes are low-molecular-weight chemical compounds of isoprenoids units with five carbon units that can bond together to form monoterpenes (10-C), sesquiterpenes (15-C), and diterpene (20-C) units. Examples of oxygenated terpenoids include aldehydes and alcohols. They can be found in trace amounts up to 95 percent of the oil. Fat is made from fatty acids. Organic compounds called fatty acids have long aliphatic hydrocarbon chains with one carboxyl group at one end. Two groups of fatty acids are unsaturated fatty acids and saturated fatty acids [5]. UFAs maintain the fluidity of cell membranes, esterify cholesterol, and reduce triglycerides and also level of cholesterol in the blood to maintain the physical health of the cells [6].

Among agricultural products, oilseeds rank second after grains. For a little while oilseeds' self-sufficiency during the "Yellow Revolution" in

the beginning of 1990s was maintained. India is currently one of the world's top producer of vegetable oils worldwide, despite being world's fifth-largest producer. Vegetable oil has been used for both commercial and culinary applications much more often in recent years [7]. Rapeseed oil and corn oil are the two vegetable oils containing the highest amount of phytosterols [8]. Phytosterols contain many compounds including sitosterol, oleosterol, rapesterol, and soysterol. According to Wang *et al.* [9], states that plant sterols have potent anti-inflammatory properties, reduce the risk of cancer, heart disease and reduce cholesterol absorption.

The imbalance between demand and supply for edible oil is huge, which currently accounts for 60 per cent of the country's demand (2016-17: import 14.01 million tonnes imported; value Rs. 73,048 crore). The domestic oilseed production of the nine-year crop has been good (3.89% compound annual growth rate), it has been due to population growth and increase in per capita consumption (18 kg of oil per year) due to the growing population, income per capita.

Haryana also contributes to the total edible oilseed production of India. Edible oilseed crops like mustard, groundnut, linseed, sunflower, and several other oilseed crops are grown. Most of the oil seed crops grown in Haryana are kharif crops. Various types of oil seed crops are grown depending on the type of soil and climate of the area. Mustard is grown nearly in all districts of Haryana followed by Groundnut. It is grown in Bhiwani, Faridabad, Fatehabad, Hisar, Jhajjar, Rewari and Rohtak districts. Sesame is sown in nearly all districts except Kurukshetra, Mahendragarh, and Panipat while sunflower is grown in Ambala, Kurukshetra, Panchkula, and Yamuna Nagar districts of Haryana. Castor is

sown in Bhiwani, Hisar, Mewat, and Sirsa regions. Various other oil seed crops although not at the same rate as others are sown like soybean, and safflower in some parts of Haryana. Several other crops are available from which edible oil can be obtained but they are not commercially produced for edible oil including cotton, rice, etc. A multicentre epidemiological study by Rastogi et al. [10] in showed that 71 % lower risk of CHD in comparison to sunflower oil (RR 0.29, 95% CI 0.13–0.64). Another double-blind randomized controlled trial by Singh et al. [11] showed a decrease in cardiac arrhythmias, heart failure, and angina in patients with myocardial infarction using mustard oil.

Various solutions have been used to increase the productivity (and profitability) of the country's oilseeds, both of annual oilseeds and oil palm. The oilseed interventions presented are time-proven and measurable and can therefore be used to increase the profitability of agro-oilseed with appropriate support/ guidance.

Oil seed crops and their health benefits: A brief introduction of various oil seed crops and their health benefits.

Groundnut (*Arachis hypogea*): India is the world's largest peanut producer resulting in total output of 5.64 million tons with a 1140 kg/ha yield (Anonymous, 2010). Codex Alimentarius recommends that the arachidic acid content and greater fatty acid in oils should be below 48 g/kg. According to Cobb and Johnson (1973), peanut contains approximately 20% of fatty acids that are saturated and 80% of fatty acids are unsaturated. While the cultivation area and yield of peanuts, groundnuts, and other crops are decreasing, the requirement of edible oil is increasing day by day. National oilseed production is expanding and stabilizing with greater efforts. Peanuts are the most popular crop during the rainy season. Oleic, linoleic acid and palmitic acid are included in fatty acids present in peanut oil.

Stearic acid, arachidic acid, behenic acid, eicosenoic acid, and tetrocosyl acid are all present in it. According to Jiang et al. [12], peanut have been shown to lower cholesterol and reduce inflammation, which are two major factors in the emergence of chronic illnesses. Peanuts naturally do not contain trans fats, cholesterol, and saturated fat. Eloleic acid (n-6) is a polyunsaturated fatty acid (PUFA) that accounts for 32% of the two main components while oleic acid (n-9) is a monounsaturated fatty acid

(MUFA), accounting for 52%. [13,14]. According to research by Sales et al. [15], several lipids, antioxidants, arginine, dietary fiber, and magnesium can help control inflammation.

Some phytochemicals found in peanuts like resveratrol, sitosterol, campesterol, and stigmasterol, have been shown to help protect against breast, colon, and, most importantly inflammation, prostate cancer [16,17]. Based on the variety of peanut, the PS content of peanuts ranges from 61–114 mg/100 g, of which 78–83% is β -sitosterol. According to Awad et al. [16], crude peanut oil has anti-inflammatory potential as it contains 207 mg PS per 100 grams. In contrast to women who hardly ever or never consumed peanuts, women who ate peanuts at least five times a week had an almost 30 percent reduction in type 2 diabetes, and women who ate peanut butter had a nearly 20 percent less risk. According to Jiang et al. [12], the decrease occurs regardless of established risk factors for type 2 diabetes, including body mass index, family history of the disease, physical activity, body size, smoking, alcohol consumption, and food.

Mustard (*Brassica juncea*): Brassica plants are one of the most important agricultural products with many varieties suitable for oilseed, vegetable, and feed production. Endogenous bioactive phenolic compounds from plants and seeds oil have become the subject of research in the last two decades since phenolic antioxidants serve as vital for human health and nutrition. According to the USDA National Nutrition Standards Reference Library, 26.6% of daily calcium needs, 51.2% of daily iron needs, 92.5% of daily magnesium needs and 20% of daily zinc intake 40.5% and 82.8% of daily phosphorus needs are met by mustard seeds.

Due to its pungency, mustard oil usage is highly recommended [18]. The healthiest MUFA and PUFA components, as well as SFA at safe amounts, are found in mustard oil. It is thought that mustard oil is safe for human ingestion. Considering its role as a significant MUFA source and its health benefits [19]. Research on diseases conducted in India suggests that eating mustard oil can lower the risk of illness. Since mustard oil lowers cholesterol and strengthens red blood cell (RBC) membranes, it is one of the most important oils that our body needs for many biological functions such as plasma, cellular lipids, and cell membranes [20].

The vitamin E content found in the alpha - tocopherol in this oil helps to reduce the risk associated with diabetes [21,22]. The Department of Chemical Technology at the University of Calcutta, in India is where this research was carried out. A higher α -linolenic acid (ALA) intake reduce the increased risk of cardiovascular disease death [23]. Mustard seeds and oil have long been used to treat rheumatism, arthritic pain and muscle tightness. India uses mustard oil on the scalp to supposedly promote hair growth. The stomach mucosa is stimulated and laxatively affected by its ground seeds, which also cause an increase in intestinal output. Turkish people have utilized mustard to treat a variety of illnesses including peritonitis and neuralgia.

Soyabean (*Glycine max*): The isoflavones daidzein, genistein, and glycitein (1-3 mg/g) as well as their acetyl and malonyl conjugates are present in soybeans in considerable concentrations [24]. Compared to animal protein, fruit juice has cholesterol-lowering effects in animals that have been known for over 90 years [25]. According to Cassidy et al. [26] a daily intake of 45 mg of isoflavones reduced the total and LDL cholesterol level in young women. Honore and colleagues [27] investigated the effects of isoflavones on coronary vascular reactivity in an atherosclerosis. According to Banerjee et al. [28], isoflavones which control proliferation, differentiation, cell cycle, apoptosis and cell signaling are specifically responsible for the anti-inflammatory qualities of soybeans.

Soy products (soy protein and soy isoflavones) were associated with a lower risk of Type 2 diabetes showed by a review and clinical trial on soy and Type 2 diabetes analysis [29]. Intake in pregnancy indicates that beans are rich in proteins, and are an excellent source of omega-3 acids, and are beneficial for lactose intolerant individuals, help control cholesterol levels, prevent obesity, and help in preventing birth disorders and other things (Tian, 2018).

Many studies have reported that soy milk intake reduce inflammation, clotting and oxidative stress in patients with diabetes type-2 and reduce percentage of people with diabetes type-2 [30]. Fat lowers total LDL, polyunsaturated fatty acids (PUFA) and mono-unsaturated fatty acids (MUFA) are considered "good" fats. A good cooking oil should have the right mix of MUFAs

and PUFAs. In addition, since fatty acids omega-3 are especially good for the heart, it is important to choose oil rich in omega-3.

Sunflower (*Helianthus annuus L.*): Sunflower is the third largest crop in the world and the primary source of edible oil. Most sunflowers belong to the *Helianthus* genus of the Asteraceae family and grown every year for oil extraction. Sunflower oil's high nutritional content as a food can aid in the development of products that have a long-term benefit in reducing the risk of contracting ailments among patrons [31].

High-linoleic acid sunflower oil contains linoleic acid (69%), high-oleic acid oil contains oleic acid (82%), medium oleic oil contains oleic acid (65%), and high-stearic acid oil contains stearic acid (18%) and oleic acid (72%). These oils are produced through cultivation and plant breeding [32]. All species of sunflower are allelopathic by nature; when grown properly, sunflower has significant allelopathic potential and prevents the growth of weed seedlings like marigolds, prickly apple, morning glory, wild mustard, and other common types of weeds [33]. Regarding 1-4% of the total amount of chlorogenic acid, sunflowers act as good phenolic antioxidants. Additionally, it contains phytosterols, which aid in changing cholesterol production and lowering blood cholesterol levels by causing the body to excrete more cholesterol [34].

Sunflower oil is a rich source of unsaturated fatty acids, vitamin E, antioxidant substances, tocotrienols and tocopherols, phytosterols, carotenoids, phenols, and chlorophyll. The main nutrients of sunflower seeds and oil are high antibacterial, antidiabetic, anti-inflammatory energy, monounsaturated and polyunsaturated fats, that are antihypertensive, protein, copper, phytosterols, tocopherols, zinc, folic acid, iron, and vitamin B, and its antioxidant properties, are beneficial for health [35]. Phytosterols in sunflower seeds are effective in lowering cholesterol, improving the immune system, and the possibility of developing cancer [36]. The world's need for energy is increasing, while the use of energy resources is expanding quickly. Biodiesel made from sunflower oil. This results in the identification of fresh energy sources that can replace fossil fuels with renewable ones.

Sesame (*Sesamum indicum*): Oilseed crops can be thought of as both producers of superior cooking oils and effective, low-polluting chemical components that can be turned into high-value

products like an alternative for fossil fuels while also offering a number of health advantages. In order to increase oilseed output through team research, the Indian Central Oilseed Committee (ICOC) started in 1947. AICRPO (All India Oilseeds Research Council) was established in 1967 to conduct research on various oilseed crops. The Sesame, Sunflower, and Castor plants have enhanced seed quality thanks to technology developed by the Improved Seed Quality Research (ICAR), which also shows an improvement in yields and production. Because seeds are so nutrient-dense, they have positive effects on health. The seeds oil content is very high (32.8–62.7%), equals to 52–55% [37]. Sesame oil contains 37-47% linoleic acid, 35-43% oleic acid, and 5-10% stearic acid, the two most important unsaturated fatty acids. The seeds also contain vitamin E, tocopherols, lignans (sesamol and sesamin), and minerals, in addition to (14.1-29.5%) proteins, (4.3-20.5%) dietary fibers, (4.2-6.9%) ash, and (2.7-6.7%) fiber content [38].

The non-glycerol portion of sesame oil contains lignans, which are known to be crucial for antioxidative properties and stability under oxidative stress [39]. Lignan (sesamol and sesamin) are two distinct phytoconstituents extracted from plant part like seeds, have strong effect on decreasing blood pressure and cholesterol in people. They provide plenty of copper, manganese and calcium to reduce pain, osteoporosis and rheumatoid arthritis inflammation [40]. Sesame oil and sesamin have anti-inflammatory and anti-nociceptive properties. Scientists have studied sesame oil and sesamin for their ability to reduce pain and inflammation. Sesame oil, and sesamin reduce diarrhea at 100, 200 or 400 mg/kg doses.

Sesame seeds are rich in lignans, sesamin, and sesolin, all of which are effective in regulating blood lipid and liver function. People can reduce cholesterol by using sesame oil [41].

According to Kamal-Eldin et al. [42] sesame seed oil helps animals' distribution of vitamin E and reduce hypertension. It has been investigated that sesame seed oil can prevent cancer cells from growing in human colon and from developing into malignant melanoma *In vitro* [43,44].

2. RESULTS

Groundnut (*Arachis hypogea*): Table 1 and Fig. 1 provide insights into the trends and variations in agricultural area, production, and yield over 2009-2020. These tables help to analyze changes in agricultural productivity and identify the potential factors influencing these changes during this period.

Mustard (*Brassica juncea*): Table 2 and Fig. 2 represent that mustard shows an increase in area and production with slight fluctuations but yield fluctuated over the years. It dropped in 2011-2012 to its minimum however it gradually increased. Monitoring production helps to assess the impact on the diet of the population and recommendations for incorporating mustard into a healthy diet.

Soybean (*Glycine max*): Fig. 3 shows that after the year 2011-2012, the production of soybeans was negligible. Assessing the health benefits of soybean production of the crop must be encouraged and the reason for lower production should be analyzed for better production and policy development.

Table 1. Area, production, and yield of groundnut (*Arachis hypogea*) during 2009-2020

Year	Area in lakh hectares	Production in lakh tonnes	Yield in kg/ha
2009-10	0.02	0.02	1000
2010-11	0.02	0.02	1000
2011-12	0.03	0.029	967
2012-13	0.028	0.032	1143
2013-14	0.056	0.062	1107
2014-15	0.037	0.042	1135
2015-16	0.046	0.046	1000
2016-17	0.048	0.048	1000
2016-18	0.03	0.036	1202
2018-19	0.037	0.033	900
2019-20	0.028	0.034	1201

Table 2. Area, production, and yield of mustard (*Brassicajuncea*) during 2009-2020

Year	Area in lakh hectares	Production in lakh tonnes	Yield in Kg/ ha
2009-10	5.13	8.49	1655
2010-11	5.04	9.42	1869
2011-12	5.35	7.47	1396
2012-13	5.59	9.62	1721
2013-14	5.37	8.8	1639
2014-15	4.93	7.06	1432
2015-16	5.05	8.05	1594
2016-17	5.1	9.45	1853
2016-18	5.49	11.079	2018
2018-19	6.092	12.537	2058
2019-20	6.413	11.499	1793

Table 3. Area, production, and yield of sunflower (*Helianthusannus*) during 2009-2020

Year	Area in lakh hecatres	Production in lakh tonnes	Yield in kg/ha
2009-10	0.15	0.25	1667
2010-11	0.1	0.18	1800
2011-12	0.1	0.18	1800
2012-13	0.15	0.26	1733
2013-14	0.05	0.12	2400
2014-15	0.116	0.321	2767
2015-16	0.09	0.185	2056
2016-17	0.089	0.124	1393
2017-18	0.05	0.094	1886
2018-19	0.095	0.181	1905
2019-20	0.091	0.168	1846

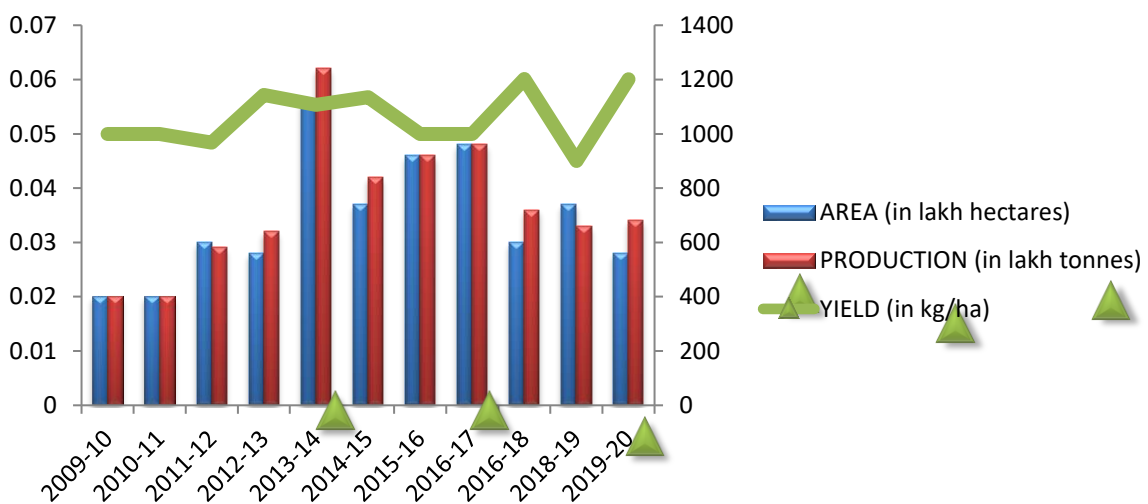


Fig. 1. Area, production, and yield of groundnut (*Arachis hypogea*) during 2009-2020

Table 4. Area, production and yield of sesame (*Sesamum indicum*) during 2009-2020

Year	Area in lakh hectares	Production in lakh tonnes	Yield in kg/ha
2009-10	0.03	0.01	333
2010-11	0.03	0.012	400
2011-12	0.035	0.016	457
2012-13	0.028	0.01	357
2013-14	0.013	0.007	538
2014-15	0.021	0.008	381
2015-16	0.034	0.013	382
2016-17	0.016	0.006	400
2017-18	0.013	0.008	615
2018-19	0.015	0.009	615
2019-20	0.016	0.009	565

Table 5. The district-wise yield of different oilseeds crops in Haryana during the year 2018-19

District	Groundnut	Mustard	Sesame	Sunflower
Ambala	0	2.05	0.25	2.04
Bhiwani	1	1.82	0.44	0
Charki Dadri	0	2.1	0.54	0
Faridabad	1	1.83	0.5	0
Fatehabad	1.1	2.12	0.67	0
Gurugram	0	2.24	0.5	0
Hisar	1.08	2.14	0.6	0
Jhajjar	1.06	2.05	0.5	0
Jind	0	2.25	0.4	0
Kaithal	0	1.85	0.5	0
Karnal	0	2.05	0.5	0
Kurukshetra	0	1.76	0	1.81
Mahendragarh	0.5	2.05	0	0
Mewat	0	2.29	0.5	0
Palwal	0	2.12	0.32	0
Panchkula	0.6	0.8	0.31	2.52
Panipat	0	2.33	0	0
Rewari	1.21	2.3	0.39	0
Rohtak	0	1.84	0.51	0
Sirsa	1.2	2.12	0.8	0
Sonapat	0	1.72	1	0
Yamuna Nagar	0	1.33	1.53	2

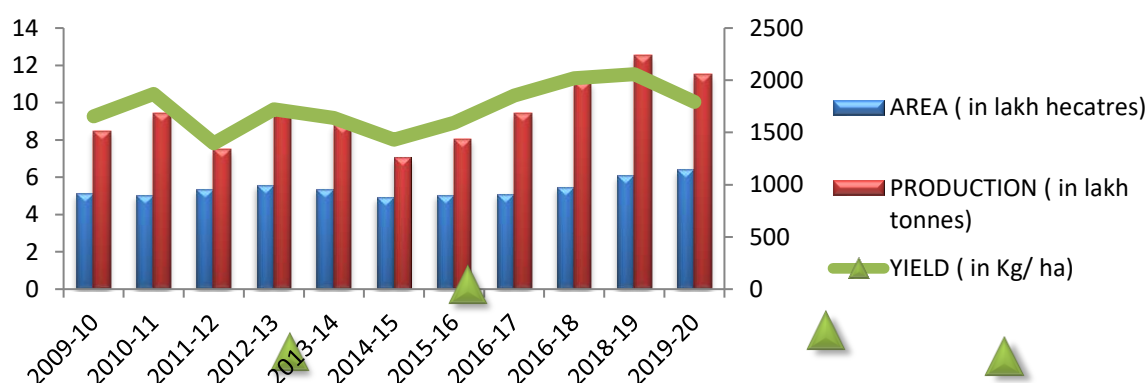


Fig. 2. Area, production, and yield of mustard (*Brassica juncea*) during 2009-2020

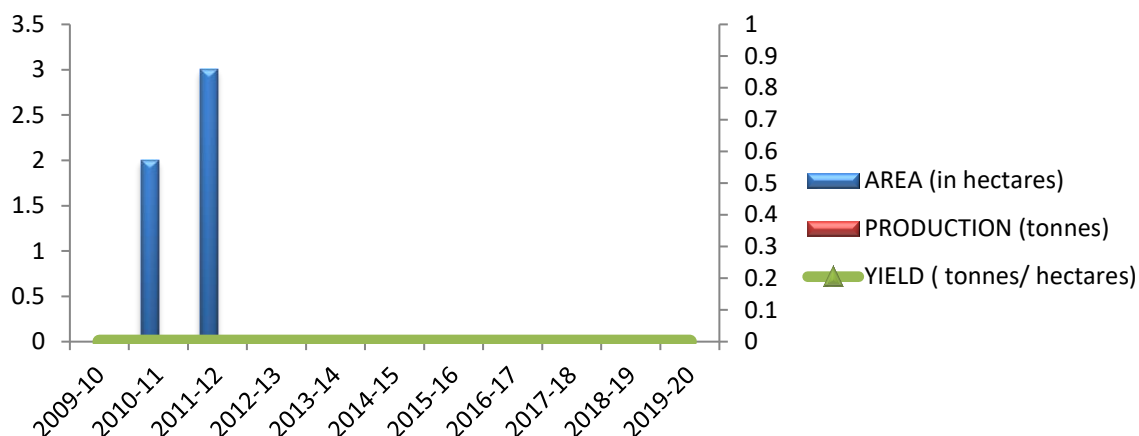


Fig. 3. Area, production, and yield of soybean (*Glycine max*) during 2009-2020

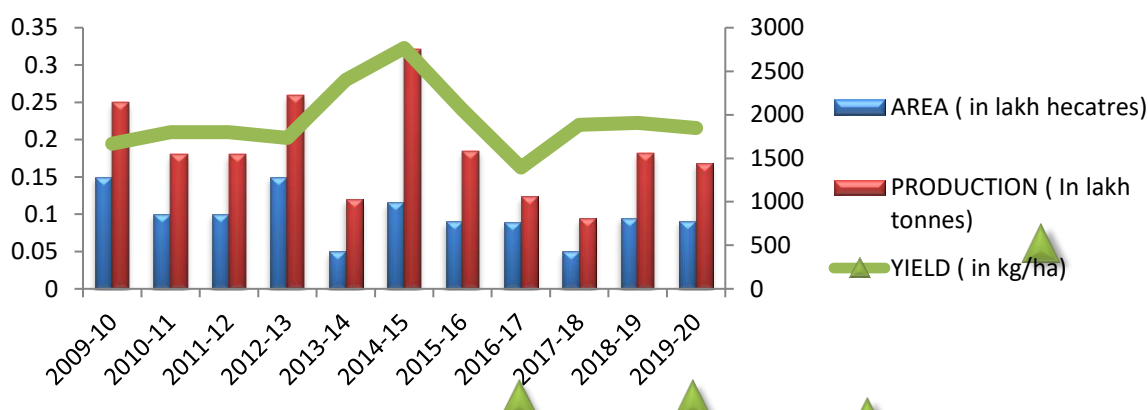


Fig. 4. Area, production, and yield of sunflower (*Helianthus annus*) during 2009-2020

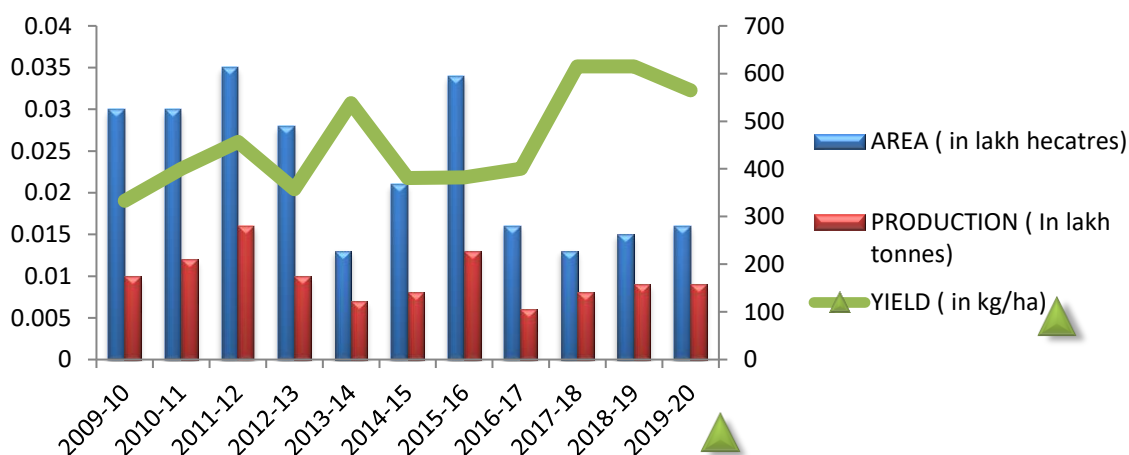


Fig. 5. Area, production, and yield of sesame (*Sesamum indicum*) during 2009-2020

Sunflower (*Helianthus annus*): Table 3 and Fig. 4 show great fluctuations in area, production, and yield from 2009 to 2020. The stability in the year 2016-20 suggests a more

predictable supply of sunflower-based products in these years and helps to understand the dietary patterns and health outcomes associated with sunflower consumption.

Sesame (*Sesamum indicum*): Table 4 and Fig. 5 represent that yield per hectare shows variations, ranging from 333kg/ha (2009-10) to 615kg/ha (2017-18 and 2018-19). Higher yield suggests efficient cultivation practices and informs about the availability and accessibility of sesame-based products in the context of a healthy diet.

Table 5 shows the district-wise production of crops in Haryana. Policymakers can utilize the data to encourage sustainable and efficient policies that ensure a steady supply of oils for the nutritional well-being of the population.

3. CONCLUSION

Oilseed crops can be considered as both producers of high-quality culinary oils and efficient low-polluting chemical components that can be transformed into value-added goods, such as a fossil-fuel substitute while providing various health benefits as well. The traditional skills and environmentally friendly methods used in growing these plants have not only boosted the regional economy but also strengthened ties between Haryana's residents and the surrounding environment. It is crucial to protect and promote the production of these edible oil plants as we continue to discover their potential, guaranteeing a healthier and more sustainable future for both the people of Haryana and the larger global population. Consuming these oils encourages a healthy lifestyle while also celebrating Haryana's rich agricultural legacy and strengthening the link between food, culture, and well-being.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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