



Grapes Cultivation in India: Status Challenges and Opportunities

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Abstract

Grape cultivation is being intensively done in the tropical regions throughout the globe; countries like Brazil and India are leading the way in the tropical grape production. Grape fruit has nutritional and health benefits. The processing of grapes is being done for numerous goods, including wine, raisins, rapeseed oil, jelly, jam, and juice concentrates. Favourable conditions for grape cultivation are hot, dry, and long summers, with optimum temperatures in the range of 15-40 degrees Celsius, rainfall within 500-600 mm, and soil pH around 6.5-7.5. With context to India, there are over 20 grape varieties, out of which 12 are being commercially grown, primarily in Maharashtra, Karnataka, Tamil Nadu, Andhra Pradesh, Mizoram, Punjab, Haryana, Madhya Pradesh, Jammu and Kashmir, and the Himachal Pradesh regions. Grape cultivators are facing many challenges to make their businesses profitable and sustainable, such as climate change, changing consumer patterns and preferences, labour shortages, increasing input costs, and a lack of required support from the government and other agencies. Technologies like soilless cultivation, digital platforms, smart sensing systems, and DNA-based solutions can help the grape cultivators manage the impact of climate change, disease, fertilizer, pest management, and the development of resistant varieties. The average yield of grapes in India is about 30 tons per hectare. Although the yield of grapes depends on the variety, soil, and climate, if cultivated using scientific techniques, a fully developed orchard can yield about 30 to 35 tonne of grapes. Talking about earning, if its minimum price in the market is Rs. 50/kg and the average yield is 30 tons per hectare, then about Rs. 15 lakh is earned from its production. Even if the cost is taken out of this, the profit is around Rs. 8-10 lakh.

Keywords: Grapes Cultivation; Vineyard; Different Varieties; Status; Challenges; Opportunities in India

Introduction

Grapes, one of the first fruits cultivated by humans, have been consumed since the dawn of civilization through wine, a fermented product. They are highly valued globally, consumed fresh and in processed products like wine, jam, juice, jelly, grape seed extract, dried grapes, vinegar, and grape-seed oil. Commercial grape cultivation in India is 60 years old. The cultivation of grapes is called viticulture and it is considered a strengthening and beauty-enhancing fruit.

Therefore, grapes are considered the best among fruits. Viticulture involves the study and cultivation of grapes for consumption or wine production, encompassing all agricultural practices and studies until the harvest of the grape crop. The grape's origin is in Central Asia (the area between the Black Sea and the Caucasian Sea). In the world, apart from India, grapes are mainly grown in countries like the United States of America, Italy, France, Spain, Argentina, China, Iran, Australia, etc. In India, grapes are cultivated in an area of about 155.3 thousand hectares, and the production

of grapes was about 3357.7 thousand million metric tons in 2021. Grapes grow in large clusters on vines. Grapes are used in three main ways: (1) for direct consumption, (2) for drying raisins, and (3) for making wine. Nashik is known as the grape capital of India and the best exporter of grapes in the country. This area has been continuously increasing for

the last few years. Whereas Maharashtra, Karnataka, Tamil Nadu, Andhra Pradesh, Mizoram, Punjab, Haryana, Madhya Pradesh, Jammu and Kashmir, and Himachal Pradesh are the major producing states. In North India, it is grown in the states of Punjab, Haryana, Western Uttar Pradesh, Rajasthan, and Delhi (Figure 1).

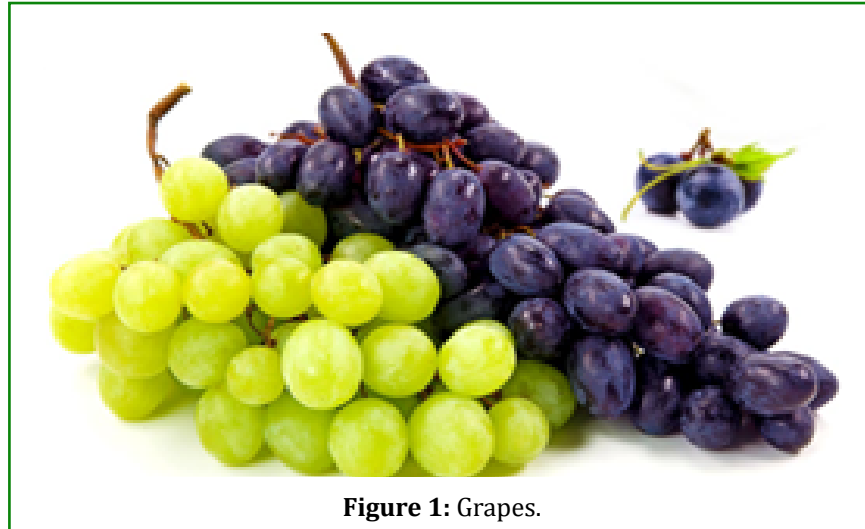


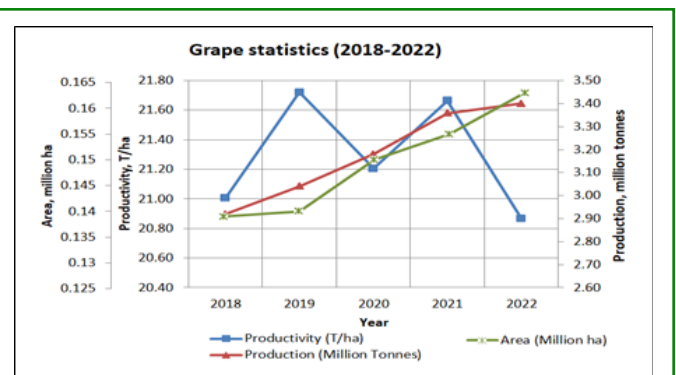
Figure 1: Grapes.

Improved Grape Varieties

India cultivates over 20 grape varieties, with 12 being commercially grown. These include black seeded varieties like Bangalore Blue and Isabella, purple seeded varieties like Gulabi (Muscat), white seeded varieties like Anab-e-Shahi and Dilkhush, black seedless varieties like Sharad Seedless and Beauty Seedless, white seedless varieties like Thompson Seedless, Pusa Seedless, Perlette, Tas-A-Ganesh, Sonaka, Manik Chaman, red seedless varieties like Flame Seedless, purple seeded varieties like Gulabi Syn, Muscat Hamburg, and black seedless varieties like Sharad Seedless. Thompson Seedless currently dominates the production area, with other grape varieties comprising 15%, 5%, and 5%, respectively [1] (Table 1, Figures 2-4).

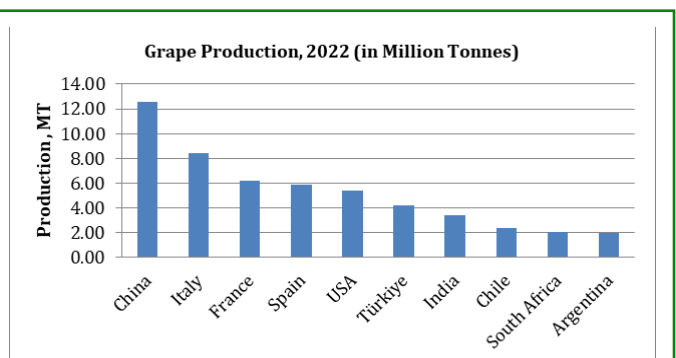
Years	Production (Tonnes)	Area (ha)	Productivity (t/ha)
2018	2920000	139000	21.01
2019	3041000	140000	21.72
2020	3181000	150000	21.21
2021	3358000	155000	21.66
2022	3401000	163000	20.87

Table 1: Area, production and productivity of grapes in India (www.fao.org).



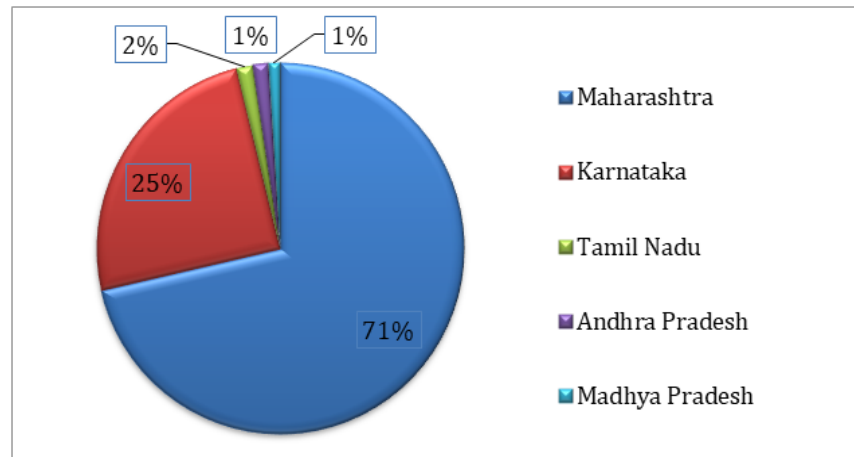
Source: www.fao.org [2].

Figure 2: Area, production and productivity of grapes in India.



Source: www.fao.org [2].

Figure 3: Grape productions of top 10 countries in 2022.



Source: agriexchange.apeda.gov.in [3].

Figure 4: Percentage share of grape production of top 5 states of India in 2022.

Grapes cultivation in India

Adapted Climate For Viticulture

Hot, dry, and long summers are most favourable for profit from grape cultivation. The optimum temperature for grapes should be around 15–40 degrees Celsius, rainfall 500–600 mm, and soil pH around 6.5–7.5. But too much temperature or cold can harm it. Grapes suffer from diseases due to high temperatures and humidity. Weather has a significant impact on fruit development and the texture, flavour, and characteristics of ripe grapes. It is very harmful to have rain or clouds while grapes are ripening; it causes the fruits to

burst and has a very bad effect on the quality of the fruits. Therefore, early-maturing varieties are planted in North India.

Selection of Land For Gardening

There should be at least 4–5 hectares of land for grape cultivation. Grapes can be cultivated in different types of soils. The root structure of grapes is quite strong. Therefore, it can be grown successfully in gravel, sandy, and clay soil, but sandy and loamy soil, which has good drainage, is best for grape cultivation. It cannot be cultivated in very clayey soil (Table 2).

S. No.	Operations	Advanced device
1	Soil levelling	Laser land leveller, scraper, patella, etc.
2	Horticulture ploughing	Mould board plough, disc plough, cultivator, harrow, rotavator, etc.
3	A well-digging	Rake, shovel, hole digger, etc.
4	Intercultural	Gardening fork, power tiller, power weeder, etc.
5	Bund making	Bund maker, shovel, hoe, etc.
6	Medicine spraying equipment	Duster, food sprayer, hand sprayer, power-operated boom sprayer, etc.
7	Fertilizer spreader/sprayer	Sprayer, manure applicator, farmyard manure applicator, etc.
8	Pruning of stems and harvesting of fruit	Pruning saw, trimmer saw, scissors, sickle, pruning knife, etc.
9	Transporting machine	Wheel cart, tractor trolley, etc.

Table 2: Advanced devices and works useful for gardening.

Planting of Vines

It is necessary to get the soil tested before planting. The distance between the vines depends on the particular variety and method of cultivation. Keeping all these things in mind, 3×3×3m. After digging the pits, fill them with 1/2-part soil,

1/2-part rotten manure, and 30 g of chloropyriphos (1 kg). Superphosphate and 500 g of potassium sulphate, etc. are mixed well and filled. Plant one-year-old rooted cuttings in these pits in the month of January. Water the vine immediately after planting (Figure 5).



Figure 5: Grape Vines.

Fertilizer Application

Grapes absorb a lot of nutrients. Therefore, to maintain the fertility of the soil and to get a good-quality crop continuously, it is necessary that immediately after pruning the grape vines, 200 g of water be applied to each plant. Potassium sulphate, 250 g, Single super phosphate and 250g, Ammonium sulphate is used 200g after the fruits start appearing. A second dose of potassium sulphate is also given. To overcome the deficiency of micronutrients like iron and zinc, they are sprayed at a rate of 0.2 percent.

Nutrients should be supplied by organic fertilizers. 3×3 m. 5-7 year-old grape seedlings planted at a distance of about 55–65 kg. Cow dung manure is required. After spreading the organic fertilizer with a fertilizer spreading machine, mix it well in the soil and irrigate it immediately [4].

Pruning of Vines

To get a continuous and good harvest from the vines, it is very important to harvest and prune them at the right time. Pruning can be done when the vine is dormant, but the process must be completed before buds appear. Generally, harvesting and pruning are done in the months of January and February. In the process of pruning, the part of the vine where fruits have grown is cut off to some extent. It depends on the particular variety of grape. According to the grape variety, some spurs should be cut, leaving only one or two eyes and the rest. These are called renewal spurs. Generally, only those branches that have borne fruit are kept as renewal spurs. While pruning, remove diseased and withered branches and spray Blytox 0.2 percent on the vines (Figure 6).

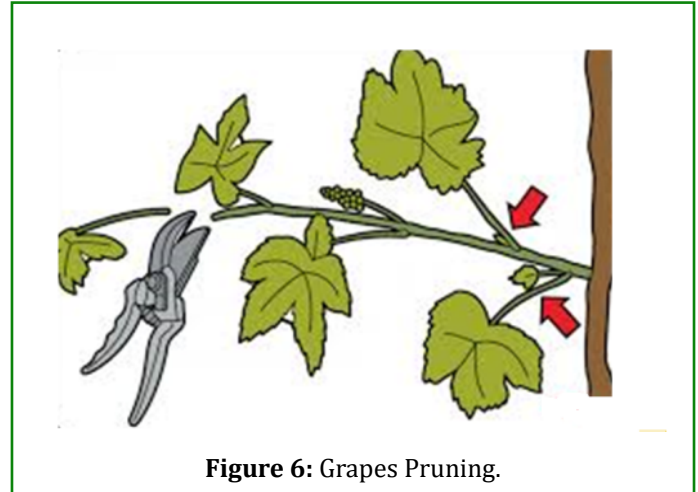


Figure 6: Grapes Pruning.

Irrigation and Fertigation

The water needed depends on factors like annual precipitation, evapotranspiration, plant age, development stage, growing period, soil type, environmental conditions, variety, and growing techniques. The total water requirements of a grapevine during a growing season range from 500-1200mm, with winemaking varieties generally requiring fewer irrigation sessions than table varieties. There is no special need for irrigation from November to December because the vine is in a dormant state, but irrigation is necessary after pruning. Water is required until flowering and full fruit formation. During this period, a lack of water has a negative impact on both production and quality. During this period, irrigation should be done at an interval of 7–10 days, keeping in mind the temperature and environmental conditions. Watering should be stopped as soon as the fruit-ripening process begins; otherwise, the fruits may burst and rot. Even after the harvesting of fruits, irrigation must be done. Precision agriculture utilizes advanced technology to accurately measure vine water needs, with producers typically applying one weekly irrigation session using drip irrigation with 50 cm valves.

Spraying in Grapes

Grapes grow in a tropical, dry atmosphere and must be treated every 10 to 14 days since they are susceptible to diseases such as mildews and rots. Spraying keeps the crops from becoming diseased. Farmers can tell what disease the crop is infested with as soon as the leaves begin to show signs. As a farmer, you will be extra cautious about crop spraying since you do not want your crops to be ruined. Choosing a spraying machine is a difficult task, but it will help prevent fungal diseases from affecting your crop. Farmers face unanticipated crop difficulties. The correct equipment and spray, together with technology, can help to lower pressure.

Grape Harvesting

Grapes do not ripen after being plucked; hence, they should be plucked at the same time when they become edible or have to be sold in the market. An increase in sugar and a decrease in acid are symptoms of fruit ripening. Fruits should be harvested in the morning or evening. Sort the bunches to get a fair price. Before packing, remove broken and rotten grains from the bunches. Well-maintained vineyards start yielding fruits after three years and can be harvested for 20–30 years. 30–35 tons of fruit per hectare can be obtained from a 14–15-year-old orchard of the Parlet variety. Grapes are harvested in April in Maharashtra, April-June and September-October in Karnataka, March-April in Madhya Pradesh, February in Gujarat, and May and November in Rajasthan (Figure 7).



Figure 7: Grapes Picking.

Grapes Storage

For storing grapes, the temperature is kept at about 2–3°C to 18°C, and the relative humidity should be about 65–70 percent. Grapes can be easily stored for 3–5 months.

Grapes Processed Products

Fresh grapes are consumed in large quantities. Numerous goods, including as raisins, wine, grape seed oil, jam, jelly, and juice concentrates, are made from it through processing. 77% of grapes grown in India are used for table, 20% are used to make raisins, 2% are used to make juice, and 1% is used to make wine [5].

Raisins: Semi-processed grape product, produced by drying Thompson Seedless grapes and their clones.

- Green raisins are more expensive than dark brown ones.
- Raisins with 12-15% moisture content are suitable for storage.

Wine: Major processed product of grapes, produced through fermentation.

- Lighter wines have a shorter fermentation process, while stronger wines have a longer lifespan.
- White wines have lower tannin content, lighter body, higher acidity, and shorter aging time.

Grape Juice: Refreshing and healthy product requiring expertise to achieve the right flavour, taste, and colour.

- Extracted using hot-press or cold-press techniques.
- Chilled, ready-to-serve juices require special packaging.

Vinegar: Derived from sour wine, can be produced from various raw materials.

High-quality vinegars are preferred over wines.

Sweet Preserves: Made by cooking grapes and their juice with sweeteners and pectin's.

- Made from whole or crushed fruits.
- Fruit butter is made by cooking cleaned fruits to a smooth consistency.
- Jelly is made from fruit juice for a clear, firm product.

Challenges for Grape Cultivation

In India, grape is cultivated in the tropical belt and faces many challenges at various fronts.

Climate Change

The grape crop is highly sensitive to changes in climatic conditions. As the majority of grape production is concentrated in the semi-arid tropics, challenges like water availability for irrigation and salinity are present, and these challenges are anticipated to aggregate in the future due to changing climatic conditions. Elevated levels of temperature due to climate change might have an effect on the ripening of berries and the composition of the fruit, thereby having the potential to affect the quality of production [6]. Another threat due to climate change is an increase in the attack of new or virulent pathogens and an increase disease severity. Changing climates can alter the pattern and incidence of pest attacks like mites, mealybugs, and trips [7].

Change in Consumer Behavior and Consumption Patterns

Factors like market availability, awareness, economic status, and health issues affect consumer behaviour and consumption patterns. It is a misconception in the minds of consumers that the grapes receive large amounts of chemical sprays, and the residual components of these chemicals sprayed over the crop are packed berries. Consumers are becoming more aware of the content of food and production quality; economically strong consumers prefer organic food and processed products [8].

Labour Shortages and High Crop Inputs

Cultivation of grapes requires skilled labourers, and the availability of sufficient and skilled labour during the crucial phases of grape production is becoming a worrying issue for the cultivators. Delay in the execution of viticulture processes due to a labour shortage has a negative impact on the grape quality, thus leading to low revenue in the market. On the other hand, maintenance and harvesting of grape crops require skilled labour, specialized trellis systems, and advanced crop protection measures, which add to the high costs associated with vineyard establishments compared to other fruit crop cultivation [9].

Irregular Information from Government Agencies and Consultancies

A case study on grape cultivators in Nashik, Maharashtra, highlighted that the farmers are facing major constraints due to ineffective advice specific to weather, market, etc. and delayed information by consultancies and government agencies [10].

Opportunities in Grape Cultivation

Soil less Cultivation Technique

Recent developments in the Table-Grape Soil Less Cultivation (TGSC) system are paving the way for advanced cultivation. The TGSC technique provides many advantages, including easier manipulation of the crop production cycle, flexibility over various varieties, control over high quality and yield in extra-seasonal production, control over efficient use of water and fertilizer, reduction in pesticides, and pesticide residual components. TGSC also offers solutions to soil and rootstock-related issues [11].

DNA-Based Technologies

DNA-based technologies such as cytogenetic techniques, PCR-based techniques, array-based technologies, reduced representation sequencing (RRS), whole genome resequencing approaches, and RNA sequencing offer great opportunities to explore the grapevine biodiversity for efficient exploitation and conservation of germplasm, along with overcoming the shortfalls of phenotype-based diversity analysis [12].

Use of Smart Digital Technologies and Applications in Viticulture

Digital sensing technologies have their own viticulture applications: soil property and soil quality assessment, nutritional status, canopy architecture, pest and disease detection, as well as management, fruit composition and

attributes, and crop forecasting. Non-invasive sensor technologies like thermography, X-ray spectroscopy, chlorophyll fluorescence, multispectral, and hyperspectral imaging have great application potential in disease and pest detection as well as smart viticulture applications [13].

Nutrients Content and Health Benefits

Grapes are considered the best among fruits. Grapes are a power-enhancing and beauty-enhancing fruit. Grapes are a good source of potassium, a mineral that helps balance fluids in your body. Potassium can help reduce high blood pressure and reduce the risk of heart disease and stroke. Most people do not get enough of this nutrient, so eating grapes can help make up for this deficiency. Nutrients like calories, fat, sodium, carbohydrates, fibre, sugar, protein, etc. are found in grapes (Table 3). One cup (92g) of grapes contains 62 calories, 0.6g protein, 16g carbs, and 0.3g fat. Grapes are a great source of vitamins C and K. The USDA provides the following nutritional information.

S. No.	Particulars	Values
1	Energy, Calories	62
2	Fat, g	0.3
3	Sodium, mg	2
4	Carbohydrates, g	16
5	Fiber, g	1
6	Sugars, g	15
7	Protein, g	0.6
8	Vitamin C, mg	3.68
9	Vitamin K, mcg	13.4
10	Vitamin A, mcg	4.6

Source: USDA, National Nutrient Database [14].

Table 3: Nutrient value in 92 g of grapes.

The Major Health Benefits are

- Grapes contain antioxidants like polyphenols, including resveratrol, which can prevent tumour growth and leukaemia.
- The presence of fibre and potassium in grapes aids in cardiovascular health and blood pressure.
- Resveratrol can decrease atherosclerosis risk and protect the heart.
- Fibber and water content in grapes aid in good bowel movement and constipation treatment.
- Contrary to popular belief, grapes are suitable for diabetics, provided they are consumed in moderation.

Conclusion

For viticulture, more production can be achieved by using improved varieties, advanced machines, and new technology. By using modern smart machines, along with improved variety, the cultivators can enhance production and productivity, and their profit margins can be increased by reducing the dependence on labour in viticulture, completing agricultural work with less time and less labour. The use of advanced digital sensing equipment and applications has potential for the management of soil, fertilizer, pests, diseases, and crop forecasting. DNA-based technologies can be used to develop varieties resistant to climate change to manage the impact of climate change on grape production.

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