



Study of Agricultural Commodities Production and Price Movement in Gujarat Region: Demand and Sustainable Livelihoods

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Abstract

Since ancient times, agriculture has been one of the chief factors in the advancement of many nations. Also, it has been a huge contributor to the GDP (Gross Domestic Product). But the farmers and the small-scale retailers are still unaware of the demand and supply of the commodities in mandis. Ultimately, they are compelled to use the repetitive pattern of crops. Through knowledge of the intra-mandi prices for seasonal crops is necessary to gain the desired profit. Price trends in several Gujarat markets were investigated for Ajwain and Isabgol (Psyllium Husk) in order to forecast price volatility and problems that produce mandi-level projections, enhancing its usefulness. Given that medicinal crops have various medical and culinary uses, boosting their productivity could increase farmers' profits in comparison to typical pattern crops. So, the aim of this study is to evaluate the optimum preferred crop conditions for important commodities like Isabgol, Ajwain, Fenugreek, Mint and Raw turmeric with respect to profit. A data from the past decade was screened to observe the variation in prices of the crops along with production analysis. Also, it was validated statistically by various statical measures like Standard Deviation, Mean and Coefficient of Variation. We examined intra-mandi prices and found that prices fluctuate over the whole peak season, with notable fluctuations in modal prices among several mandis. To demonstrate the variations in pricing reported for certain mandis on specific days, we've given a few instances. A low standard deviation implies that the commodities price is clustered around the mean, whereas a large standard deviation shows that the commodities price is more dispersed. Price volatility is the discrepancy between what is anticipated and what occurs.



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Introduction

The art and science of cultivating the soil, growing crops, and raising livestock are known as agriculture. After China and the US, India has the third-largest economy in the world with a \$2.1 trillion economy.⁵ In India, about 80% of the world's population utilizes traditional medicines.² and forest provide 90% of the herbs and medicinal plants.⁴ Our country is a rich repository of medicinal plants. Naturally occurring medicinal plants are very beneficial, either directly or as a component of medications used in our traditional Indian system of medicine (Ayurveda, Siddha Unani, etc.) or a foreign system of medicine (Allopathy, Homeopathy etc.). India is a second-largest producer of rice, wheat, sugarcane, groundnuts, veggies, and other naturally grown goods. History reveals that civilizations have always thrived in areas with excellent agricultural yields that are closer to rivers. A country will always struggle to maintain its economic progress without a solid agricultural foundation.⁵ This is mainly because it won't be able to satisfy the economy's demand for food. It not only meets the state's food needs but also provides a significant amount of jobs. Health-related research in agricultural and food systems covers a wide range of subjects.¹ However, 40 thousand hectares, or 80% of the total area under cultivation in the nation, are used to grow isabagul, a commodity with good export potential in North Gujarat and Kutch.³ Since the previous two to three years, sweet potato (Sonamukhi) plantations have been underway throughout the state. The development and quality of medicinal plants are preserved in some areas of the nation where monsoons occur frequently, rainfall is abundant, and a temperate climate is predominant. Farmers in state do not get desired profit cause of the erratic monsoon, rainfall, arid climate, and high temperatures.⁶ Farmers have used a variety of strategies to get beyond the limitations of traditional

methods. They can increase their revenues by using technology-supported intelligent tactics for marketing their produce and yield planning. The State Forest Development Department and the Department of Indian Medicine and Homeopathy have created arrangements to gather various goods, including wild ones, although Ayurvedic pharmacies are located throughout the state. Nevertheless, the amount is still insufficient for the drug industry. Some therapeutic plants are going extinct or even facing extinction because of the ongoing and excessive gathering of valuable plants and the shrinking forest space. Such plants need to be preserved and protected or restored to their native, natural environments. Additionally, there is a substantial disparity between the supply and demand of medicinal plants, which has an impact on the quality of the plants. It is crucial to make sure that pure and enough raw materials are available. In such cases, systematic cultivation techniques for some species must be established. Some of the state's innovative and forward-thinking farmers are considering growing therapeutic plants. Past years have seen a significant advancement in technology. With the use of contemporary digital devices and Artificial Intelligence (AI) to create solutions for smart agriculture, the explosion of digitized data and developments in Information and Communication Technology (ICT) can play a critical role in achieving digital agriculture.⁸ The National Agriculture Market (eNAM) is a pan-Indian electronic trading site that connects the Agricultural Produce Market Committee (APMC) mandis in order to establish a unified national market for agricultural commodities.⁹ which enable rural businesses to provide value-added services, rural people to realize their full potential, and farmers to boost their profitability by having access to fair markets.¹⁰

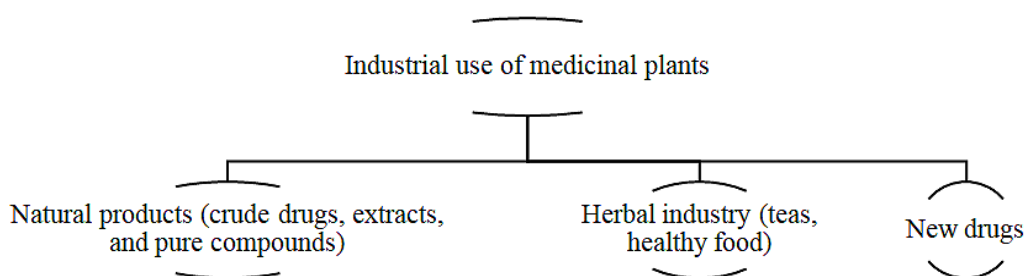


Fig. 1: Industrial use of medicinal plants.¹¹

Major Cultivation: Districts of Gujarat

Many medical professionals have recommended increasing the body's immune system in the current situation where the entire world is trying to find a solution for the Covid-19 pandemic. This can assist to lessen the effects and speed recovery from the illness. The use of medicinal herbs has proven to be a lifesaver in this awful situation. Industrial use of medicinal crop is depicted in figure 1.

In Gujarat, 17.75 thousand hectares of Isabgol (*Psyllium Husk*) are cultivated. 12.85 MT was produced the previous year, which is greater throughout India. In terms of this average, Kutch farmers have shown to be the highest in all of India. In Gujarat, Banaskantha has the greatest productivity. 826 kg are grown there each acre which is the highest in all over India. The plantation has a 4276-hectare footprint, and it produces 3532 MT.³ It was planted on 25,000 hectares throughout the state in 2017–18. The amount produced was 18,000 metric tonnes. 95 percent of isabgol is grown in Gujarat, Kutch, Banaskantha, and Patanam, according to the director of agriculture. 16.75 thousand hectares are typically under cultivation.

An area of 25,000 hectares has been planted as of 2021. For experimental analysis data was obtained from Ag mark net website which is managed by Indian government.²² Figure 2-5 represents major cultivation producing districts of Gujarat region for Raw Turmeric, Methi Seeds, Meethi Leaves, Isabgol (*Psyllium Husk*) respectively.²¹

Issues that Impact Small Scale Farmer's Income.²²

- Unfair market price
- Lack of supply chain between Producer and consumer
- Lack of linkage between producer and Consumer
- Lack of standardization of Medicinal plants
- Lack of awareness for medicinal crop and their production profit
- Limited resources for research (Research is limited to certain medicinal crops only)
- Lack of support from the government towards the production of medicinal plants
- Lack of availability of marketplace for their produce

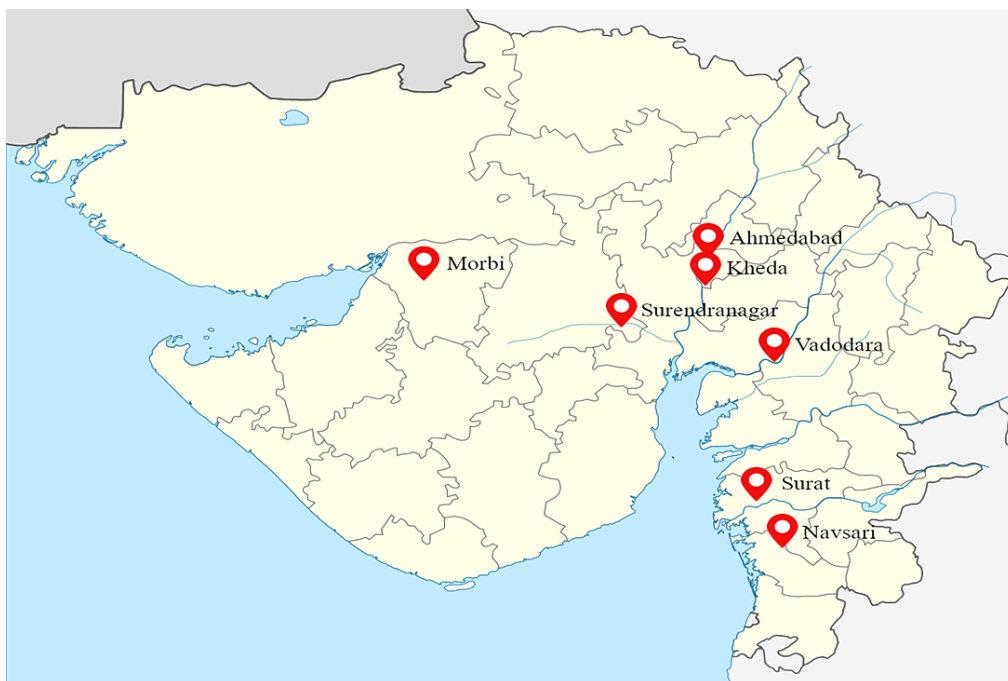


Fig. 2: Highest RawTurmeric Producing region of Gujarat. ²¹

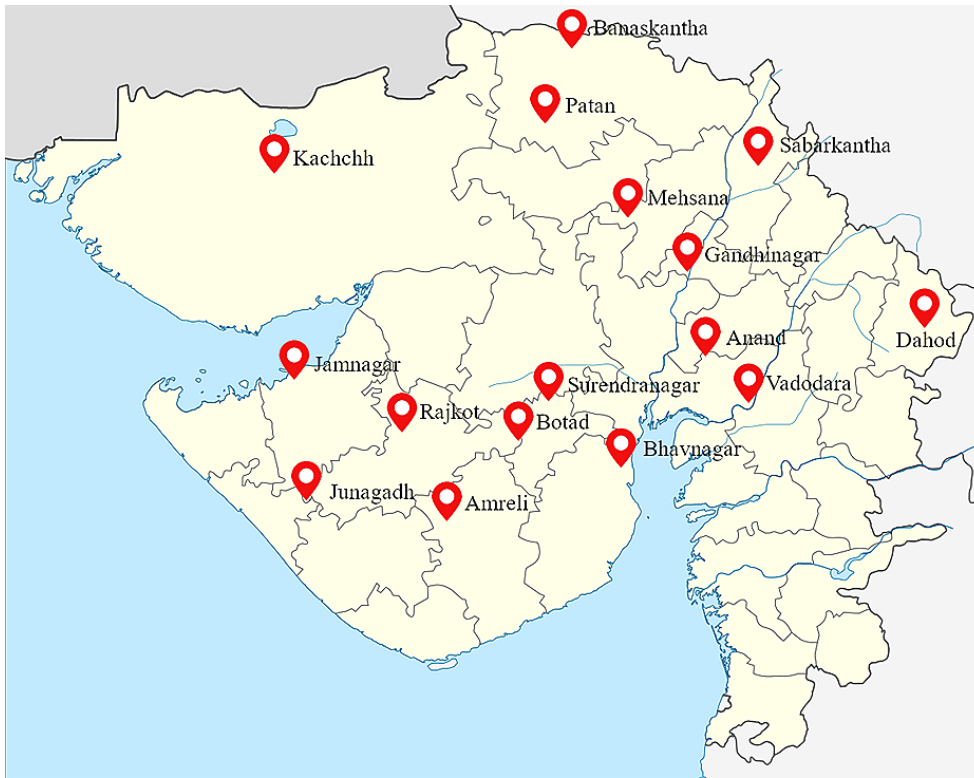


Fig. 3: Highest Methi Seeds (Fenugreek) Producing region of Gujarat. ²¹

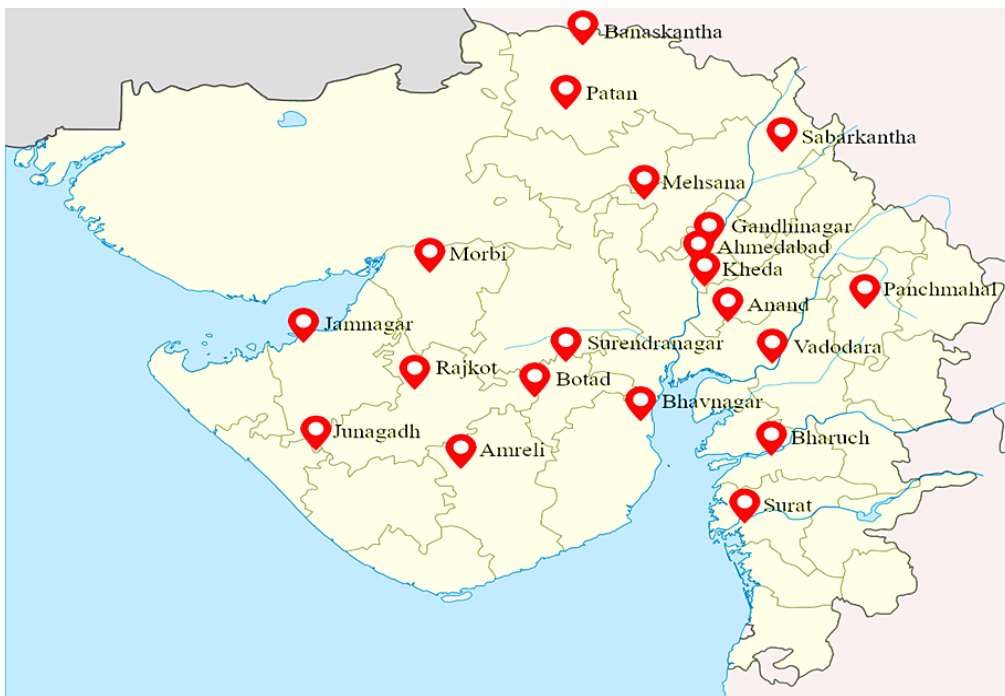


Fig. 4: Highest Methi Leaves Producing region of Gujarat. ²¹



Fig. 5: Highest Isabgol (Psyllium Husk)Producing region of Gujarat.²¹

Factors Influencing Cultivation of Commodities

Cultivation is performed to enhance root vital nutrients and moisture in the soil, to allow for improved root growth and consequently better tree anchorage, and to enhance the quality of planting. Plant growth is primarily influenced by four variables: light, water, temperature, and nutrients. These four components have an impact on the hormones that regulate plant growth, affecting how rapidly or slowly the plant grows. Plant stress can result from any one of the four alterations, which can either improve or inhibit growth.

Altitude is the main factor influencing the cultivation of medicinal plants. As altitude increases, the temperature and air pressure decrease while the wind speed, relative humidity, and light intensity all increase. As a result of the shifting climate with height, the pattern of vegetation also changes. The most typical altitude for growing tea, cinchona, and eucalyptus is between 1000 and 2000 metres. Unlike cinnamon, cardamom, and other spices, which must be produced at elevations of 1,000 metres or above, senna can be grown at sea level. Another crucial element in the cultivation of the medicinal plant is temperature and humidity. Drought and desiccation eventually lead plants to perish.

Sudden drops in temperature led to the production of ice crystals in the intercellular spaces of the plants. Changes in temperature have an impact on how quickly photosynthesis occurs. With an increase in temperature, breathing becomes more rapid. Water vapors, a type of humidity, are present. Atmospheric humidity refers to this. Indicative of humidity are clouds and fog. In plants, humidity impacts transpiration, shape, and structure. Most plants, with the exception of xerophytes, require water, correct irrigation, and enough rainfall for growth. Rainwater is the primary source of water for the soil. The amount of precipitation and snowfall significantly influences the weather. Plants absorb the water-dissolved soil minerals after they have been dissolved. Water affects a plant's physiology and morphology. Since it helps all plants develop, soil is the most crucial natural resource. In addition to providing mechanical support and anchoring, soil also contains vital plant food components. Soil fertility is the ability of the soil to provide plants with the necessary amounts and ratios of nutrients as well as a favourable environment for plant growth. give nutrients and a chemical foundation for growth. Generally, the soil is the loose, shallow upper layer in which plants can grow and get nutrients.

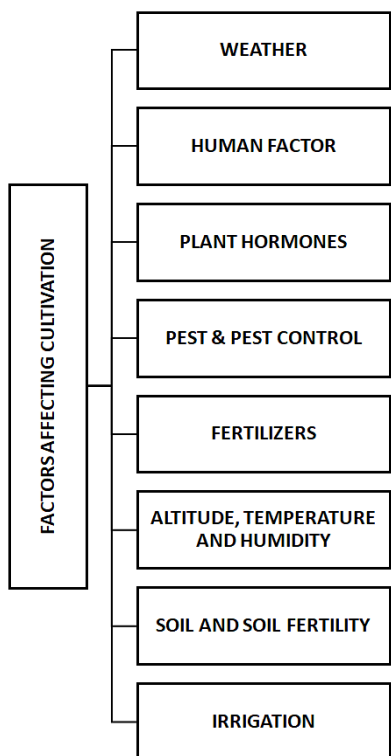


Fig. 6: Factors affecting crop cultivation. ²⁵

One of the most weathered parts of the soil is clay; it is made up of tiny particles that have cohesive and adhesive qualities and can contain nutrients for plant growth that have been lost to leaching. Minerals are responsible for the variation in soil

formations, and soil is made up of mineral stuff, air, water, and organic material. Air and water combine to form pores; if half of the pores are filled with water and the other half with air, the result is good aeration for root nutrient absorption. Any form of soil that has less than 0.5 percent organic matter is referred to as poor soil. Organic matter is made up of cleansed and decomposed plant and animal parts. Rich soil is any sort of soil that contains between 1.5 and 5% organic matter. Any sort of soil that ranges in organic matter content from 0.5 to 1.5 percent is referred to as intermediate soil. pH between 6.5 and 7.5. Alkaline soils can be reclaimed by gypsum, while acidic soils can be limed to produce neutral soil. Leguminous plants cannot grow in acidic soil because nodule bacteria cannot properly develop in these conditions.

Experimental Analysis and Discussion

Popular herb cultivation can turn out to be profitable. The cultivation of therapeutic plants including Amala, Isabgol, Ajwain, turmeric, and rawturmeric is transforming the agrarian Ayurveda landscape of India and offering farmers exceptional opportunities to boost their revenues. The Jamnagar district of Gujarat has displayed maximum production of ajwain (Figure 7). The Jamnagar district of Gujarat has displayed maximum production of ajwain (Figure 11).

Production Analysis of Agri - Commodities in Gujarat. ²¹

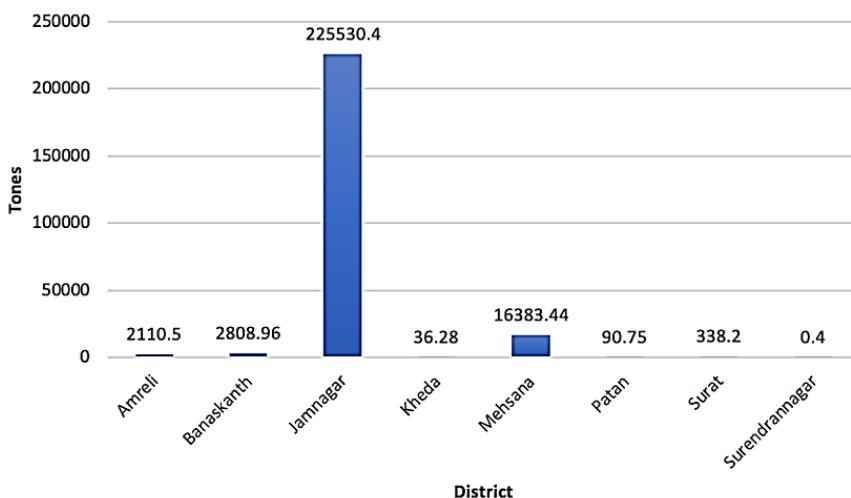


Fig. 7: Ajwain (Carom) production from January 2010 to 16th September 2020.

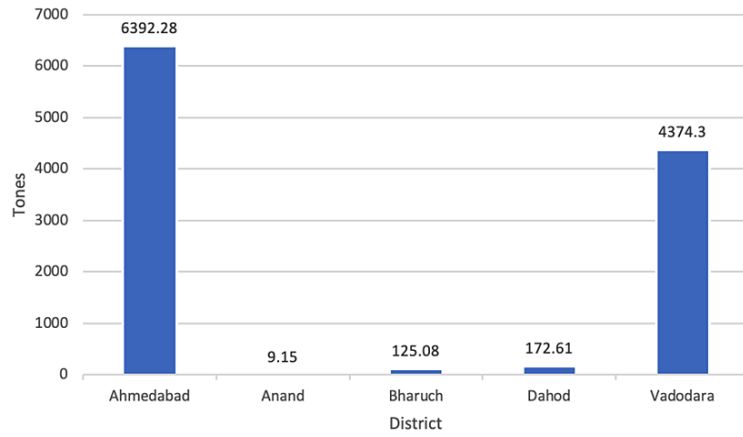


Fig. 8: Mint production from January 2010 to 16th September 2020

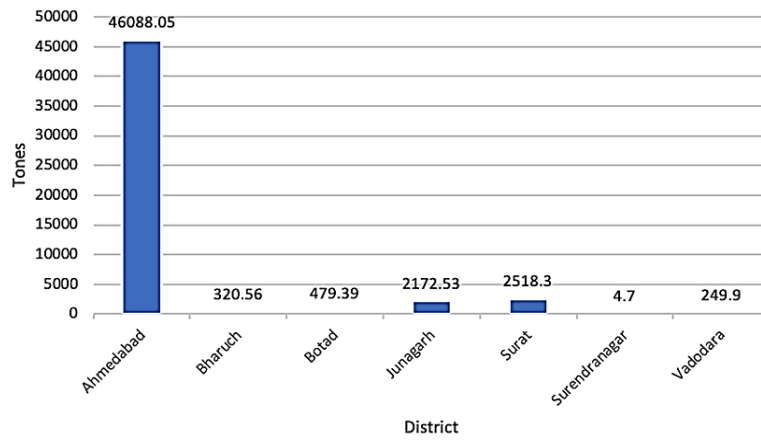


Fig. 9: Papaya Production from January 2010 to 16th September 2020

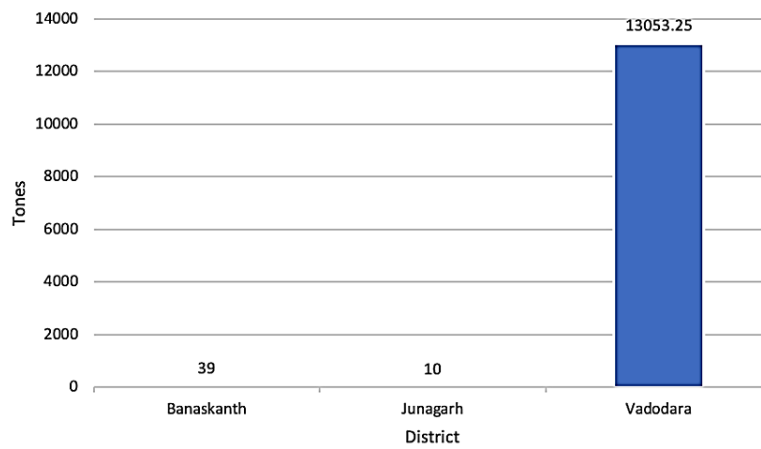


Fig. 10: Turmeric Production from January 2010 to 16th September 2020.

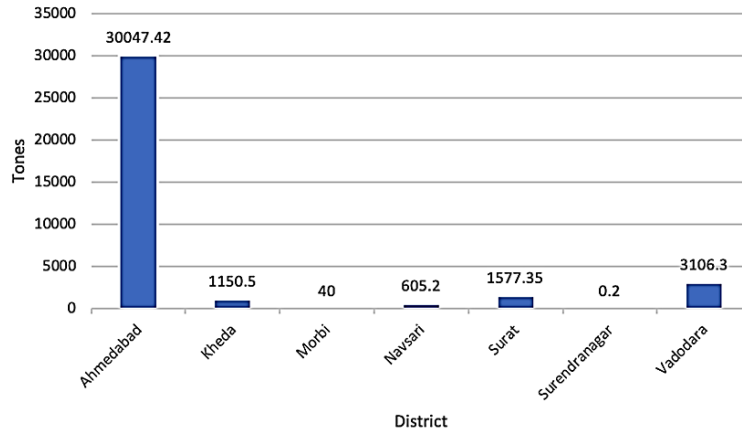


Fig. 11: Raw Turmeric Production from January 2010 to 16th September 2020.

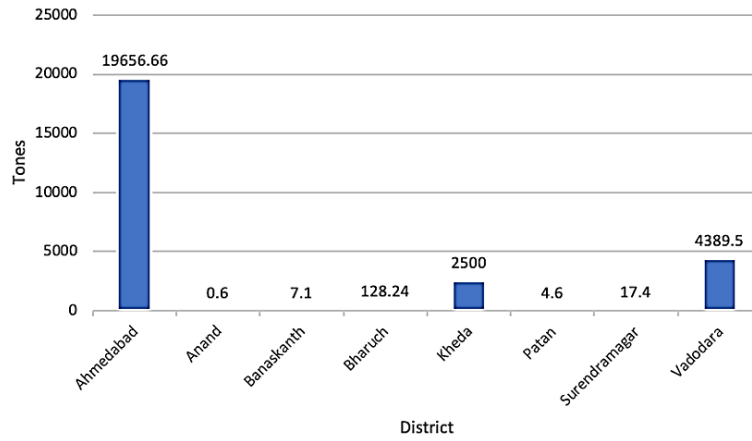


Fig. 12: Amla (Indian gooseberry) Production from January 2010 to 16th September 2020.

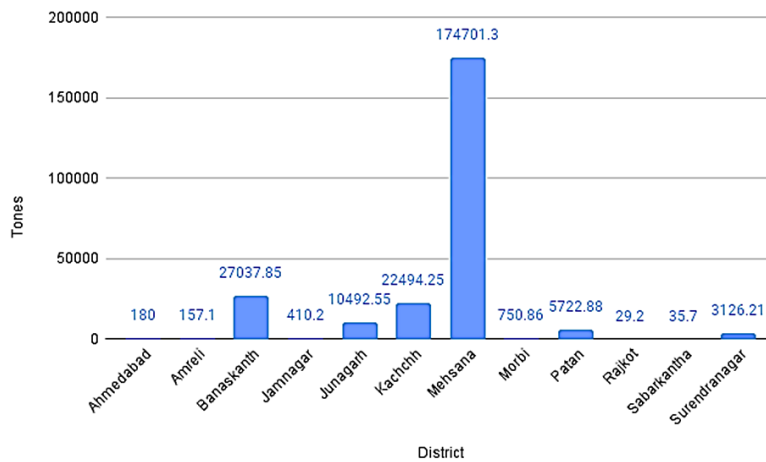


Fig. 13: Isabgol Production from January 2010 to 16th September 2020

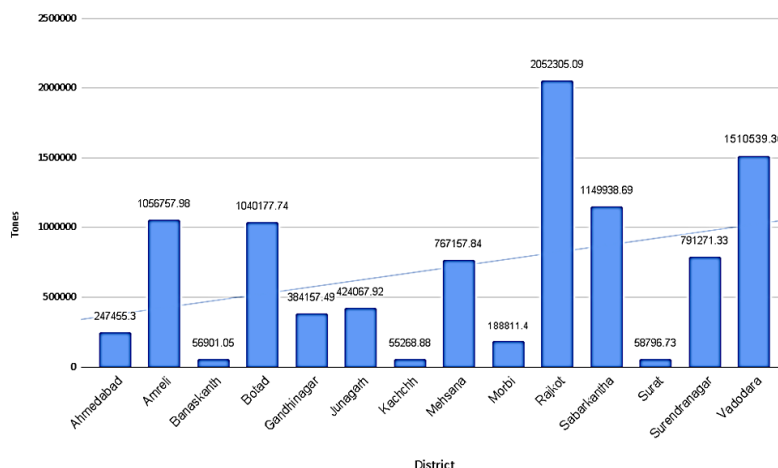


Fig. 14: Production of cotton from January 2010 to 16th September 2020

Study of Medicinal Commodities

Region and Need

Optimum conditions for various crops are depicted in Table 1 – 3.

Many herbal industries sell Isabgol husk, seeds, and powder under the name Isabgol - *Psyllium Husk*, which helps to avoid flatulence and indigestion. constipation is quickly relieved by this. On Amazon, the cost of 200G of Isabgol *Psyllium Husk* Flake

Table 1: Optimum conditions for Isabgol (*Psyllium Husk*)in Gujarat^{11,20,21,22}

State	Gujrat, Banaskatha, Kutch, Mehsana, Jamnagar, Rajkot, Rajsthan, Hariyana
Weeding	Regular hoeing and weeding are necessary.
Climate	Winter is the best time to sow crops since they need chilly, dry weather.
Temperature	The recommended temperature range for seed germination is 20 to 300C.
Propagation	The seeds germinate in 6-7 days when they are sown at a rate of 4–8 kg per hectare after being treated with any mercurial seed-dresser at a rate of 3 g/kg of seed.
Irrigations	For good productivity [medium sandy soils], it required a total of 6-7 irrigations. Light soils are best for this irrigated crop's growth; soils with poor drainage are not ideal.
Post harvest technology	In February or March, the crop becomes ready for harvest (110-130 days after sowing).

is 400Rs. The price range of 400 GM Powder of ISABGOL POWDER (*Psyllium Husk*) for Rs. 1200. Table - 2,3 Shows the cultivation criteria of Ajwain, Mentha commodities for the Gujarat

region respectively. Figure 14 shows a comparative analysis of Ajwain commodity prices in the past 10 years. Observed that year 2019 and 2020 price was highest as compared to other years.

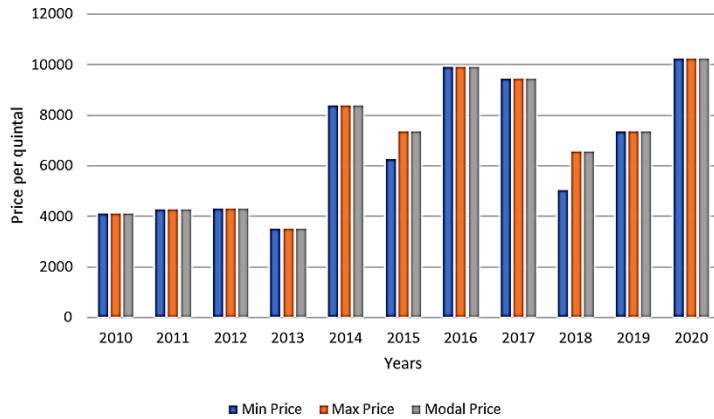


Fig. 15: Price variation of Isabgol (Psyllium Husk) from 2010- 2020. ²¹

Table 2: Optimum crop condition for Ajwain in Gujarat^{23,24}

State	Rajasthan and Gujarat
Weeding	Weeding should be done carefully using either manual techniques or chemical spraying.
Demand	Ajwain or carom seeds are in demand all year long. Carom seeds or Ajwain are mostly consumed by the food processing industry.
Harvesting	Using a thresher or bashing the sticks from the plants that were removed.
Soil	Fruit matures between 120 and 140 days after planting. Well-drained soils [ideal for Carom seeds or Ajwain cultivation], The cultivation of Carom seeds or Ajwain is not at all appropriate for sandy soils.
Pesticides	Aphids and Powdery Mildew affect the yield drastically thus, it should be managed by chemical spraying.
Seeds	Sown from August to November.
Fertilizers	For better production, 0.2 kg of manure is given to the soil along with fertilisers like FYM (0.2 kg per acre).
Irrigations	5–6 irrigations are sufficient.

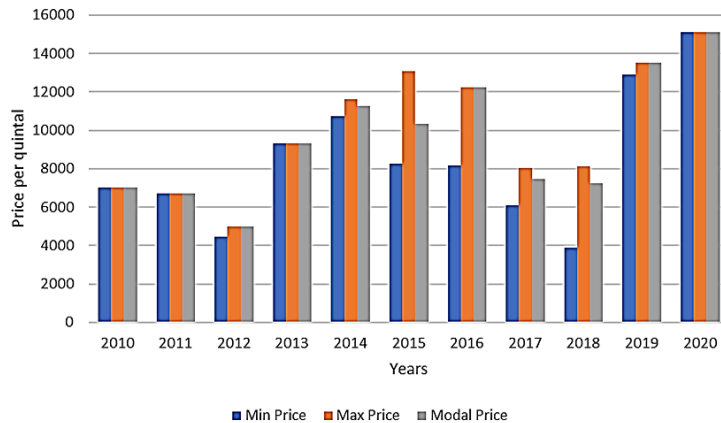


Fig. 16: Price variation of Ajwain from 2010 -2020.²¹

Table 3: Optimum crop condition for Mentha (Mint).^{11,22,25}

State	Rajasthan and Gujarat
Soil	The best foliage is found in compost-enriched, moist, well-drained soil. The ideal pH range is between 6 and 7.5.
Seasons	Winter is the season for planting. Always, late planting results in low yields.
Inter-culture and Weed Control	In the early phases of crop growth, mints require regular hoeing and weeding. After the initial harvest, hand weeding is required.
fertilizers	Strong use of nitrogenous fertilisers has positive effects on mint. The best commercial fertiliser you can use to fertilise mint is NPK 16-16-16. Mint may grow healthily with little fertilisation. In most temperate zones, mint is a hardy perennial plant. The best place to sow the plants is in a small garden bed or a sunken pot because they spread widely during the summer. If you plant mint in rich, well-drained soil, it won't need much fertiliser.
Irrigation	Mint requires a lot of water to grow. Before the first monsoon, the crop is irrigated 6–9 times, depending on the soil and weather conditions. After the monsoons, the crop needs three irrigations in September, October, and November.

Because of numerous special qualities, dried mint leaves are highly popular. They can be kept and kept in storage for a long time while preserving their original scent or aroma. Mint leaves are frequently utilised to create a variety of medications and health

products, including toothpaste with mint flavouring, mint oil, and balms. Additionally, the herbal sector sells 95 kg of Mint Dried Leaves at an average selling price of \$250 per kilogramme on India Marts.

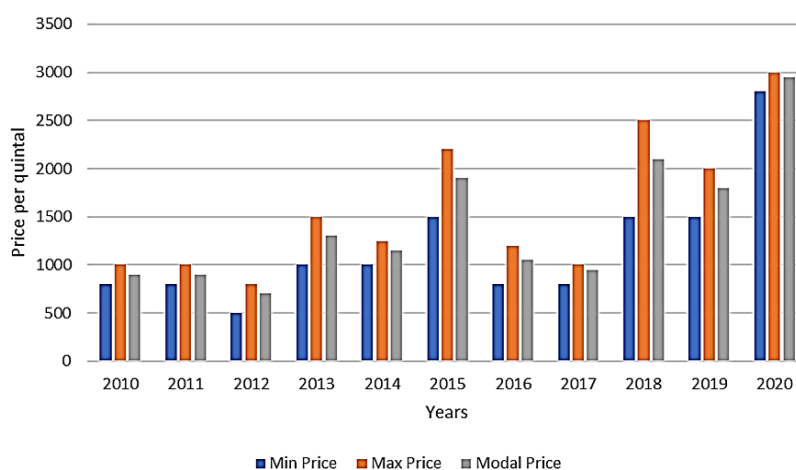


Fig. 17: Price variation of Mint from 2010 – 2020.²¹

On March 13, 2020, the highest price offered was 3500 ₹, the lowest price was 2,000 ₹ and the average price was 2750 ₹. The highest price recorded throughout all years was in 2020.

Dataset for Experimental Analysis

Using historical data²¹ from the previous five years, the volatility for the chosen crops was examined for both the Kharif and the Rabi seasons. The volatility

measurements' foundations were the standard deviation and mean price changes.

$$\text{Coefficient of Variation} = (\text{Standard Deviation} / \text{Mean}) * 100. \dots(2)$$

Analysis of Price Movement for the Past 5 Years

The standard deviation, a statistical measure of market volatility, measures how widely prices depart from the mean price. If prices fluctuate within a narrow trading range, the standard deviation will have a low value, which indicates little volatility. On the other side, a high standard deviation indicates excessive volatility as prices move quickly up and down. Volatility measures among several mandis from different states of Gujarat are displayed in Table 9 – 14.

To compute Standard Deviation (1)

$$\text{Standard Deviation} = \sqrt{\frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n-1}} \dots(1)$$

Where,

- x_i = value of i^{th} point in the Agri-commodities dataset
- \bar{x} = The mean value of the Agri-commodities dataset
- n = The number of datapoints in the Agri-commodities data

The ratio of the standard deviation to the mean is known as the coefficient of variation. With an increase in the coefficient of variation, the mean dispersion becomes more pronounced. Usually, it is expressed as a percentage. A Coefficient of Variation of 20 to 30 is considered appropriate, whereas a Coefficient of Variation of more than 30 is deemed unsatisfactory.

To compute Standard Deviation (2)

Table 4: Volatility measures of RAWTurmeric.²¹

Season	Standard deviation	Mean	Coefficient of Variation
KHARIF-2019	1157.48	3151.97	36.72
KHARIF-2018	1340.9	2926.97	45.81
KHARIF-2017	795.69	1807.91	44.01
KHARIF-2016	749.09	2447.15	30.61
KHARIF-2015	669.84	3484.21	19.22

Table 5: Volatility measures of Ajwain.²¹

Season	Standard deviation	Mean	Coefficient of Variation
RABI-2019 -2020	2169.17	10764.71	20.15
RABI-2018 -2019	3560.5	11271.44	31.58
RABI-2017 -2018	2071.09	6056.12	34.19
RABI-2016 -2017	2691.84	11054.27	24.35
RABI-2015 -2016	3092.46	13416.44	23.04

Table 6: Volatility measures of Isabgol (Psyllium).²¹

Season	Standard deviation	Mean	Coefficient of Variation
RABI-2019 -2020	251.74	8289.3	3.03
RABI-2018 -2019	773.91	7631.61	10.14
RABI-2017 -2018	1160.7	8812.16	13.17
RABI-2016 -2017	1275.29	10648.38	11.97
RABI-2015 -2016	1330.48	8225.23	16.17

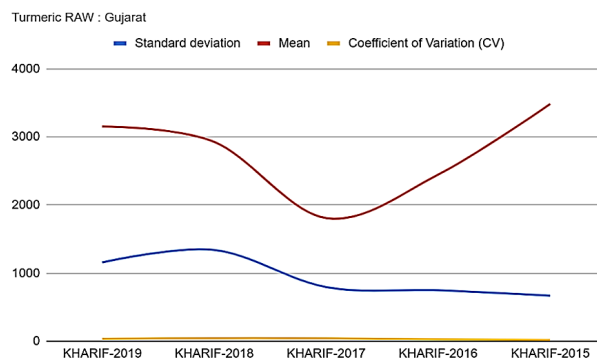


Fig. 18: Turmeric RAW price trends during a five-year period.²¹

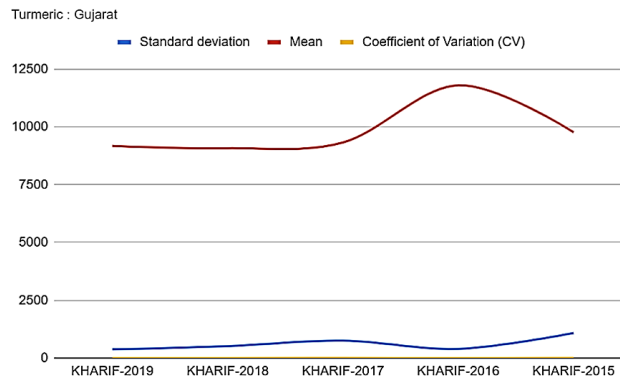


Fig. 19: Turmeric price trends for five-year.²¹

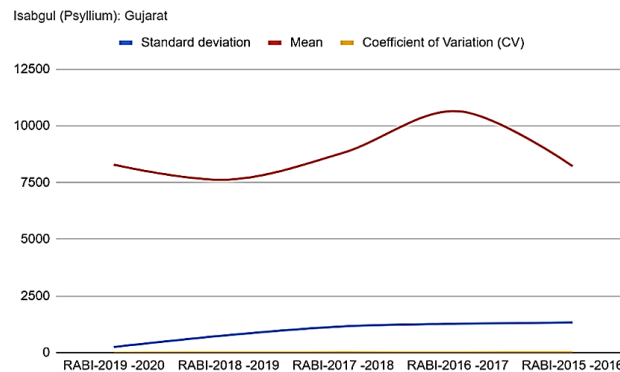


Fig. 20: Isabgol (*Psyllium Husk*) price trends during five years.²¹

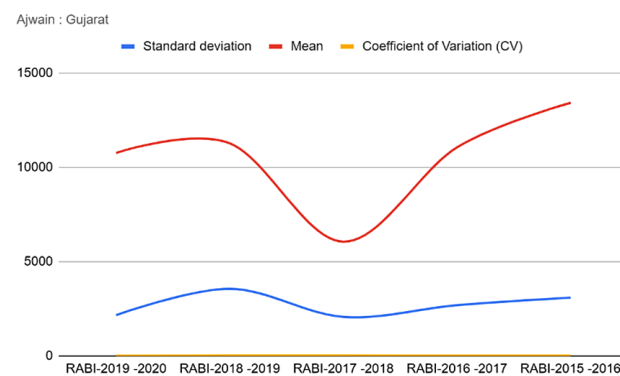


Fig. 21: Ajwain price trends during fiveyears.²¹

With increasing price volatility, the standard deviation increases. The standard deviation moves down as price movement becomes more stable. Increased standard deviation in price movements indicates strength or weakness over normal. Short-term spikes in volatility that precede market tops are signs

of anxious and unsure traders. Long-term market tops that exhibit declining volatility signify a bull market that is reaching its maturity. Better risk/reward for the asset is indicated by a lower Coefficient of Variation. It doesn't necessarily indicate the return will be higher. It simply implies that it will yield a

higher return based on the level of risk you are willing to assume to obtain that return. The standard deviation is a measure of how typical or average a value is to the mean. When every number is the same, the standard deviation is 0. As with the mean,

outliers have a significant impact on the standard deviation (it uses the mean in its calculation).

Price Variations Across Major Mandis

Table 7: Crop - Agricultural seasons for various crops.¹⁵

SEASON	CROPPING SEASON MONTH	CROP
KHARIF	APRIL –SEPT	Rice, Maize, Turmeric RAW, Turmeric
RABI	OCT –MARCH	Isabgol (<i>Psyllium Husk</i>), Ajwain, Wheat

Table 8: Price discrepancies for Isabgol (*Psyllium Husk*) amongst different mandis

Date	Dhanera	Tharad	Unjha
01-Jan-10	6105	6625	7070
11-Jan-10	11000	NA	6000
06-May-10	4512	4800	4325
17-Jan-12	4987	5880	5500

Table 9: Price discrepancies for Ajwain amongst different mandis

Date	Amreli	Jamnagar	Unjha
08-Jan-10	9430	11750	7305
11-Jan-10	9760	11000	10375
23-Mar-10	7500	10313	7500
24-Aug-17	5505	6750	5500

Farmers in Gujarat make incredibly little profits. This may be a result of the farmers' low productivity or the low prices they receive for their crops. While the economic policy may be used to address wealth generated, which largely depends on the health of the agricultural sector, productivity generally refers to the technical aspects of farming. The website Agmark Net,²¹ which is operated by the Indian government, refers to the gathering of raw data. When intra-mandi pricing was analyzed, it became clear that prices were constantly fluctuating during the peak season, with considerable variations in modal prices among different mandis for the Gujarat region. The interaction with marginal farmers led researchers to the conclusion that a variety of factors, including the presence of middlemen, a lack of market information, uneducated farmers, a lack of transportation, and selling produce to nearby markets rather than having to travel great distances to reach the main mandis markets, affect the mandi's price. It has also been suggested that these farmers may only be receiving a marginal wage for the risk they take and the services they render. Given the persistently high level of price disparity, it is likely that information and transportation costs make only a small difference in the degree of spatial pricing variances. Overall price fluctuation is caused by

region-specific, time-invariant characteristics, such as the quality and diversity of local crops, the strength of the neighborhood market, and the soil. Isabgol (*Psyllium Husk*) price variances were seen in Dhanera, Tharad, and Unjhamandis, with Unjhamandi having the highest price when compared to the other two mandis. In contrast to Amreli and Unjha, Jamnagar's mandi price was the highest for Ajwain. Rice, wheat, and maize have the lowest mandi costs as compared to medicinal crops because of their high global production and lower global demand than medicines. Instead of following a routine, marginal farmers might make more money by growing therapeutic plants. As Nutrients in the soil are depleted when the same crop is planted repeatedly on the same plot of land. The excessive use of pesticides and fertilizers required for succeeding crop generations is harmful to the environment and the people who consume the crops. Table 8 – 13 shows the Price discrepancies of different Mandis for several agri - commodities. compared to other mandis like Dhanera and Tharad, UnjhaMandi's price for Isabgol was found to be the highest for the dates 1–10 January. For Ajwain commodity, Jamnagar Mandi price was noted highest as compared to Amreli and Unjha.²¹

Table 10: Price discrepancies for Rice amongst different mandis

Date	Kheda	Vadodara	Dahod
08-Jan-10	1050	3000	3000
12-Jan-10	3000	1500	2900
18-Jan-10	3000	2100	2875
24-Aug-17	3000	1900	2400

Table 11: Price discrepancies for Maize amongst different mandis

Date	Ahmedabad	Amreli	Dahod
01-Jan-10	2100	995	1000
04-Jan-10	1100	1010	1000
06-Jan-10	1100	1020	1080
02-Apr-14	550	NA	220

Table 12: Price discrepancies for Wheat amongst different mandis

Date	Sabarkantha	Dahod	Kheda
01-Jan-10	2100	2000	1425
02-Jan-10	1625	1615	1425
29-Jun-15	1375	3050	1400
13-Oct-16	1775	1840	1725

Table 13: Price discrepancies for Turmeric Raw amongst different mandis

Date	Ahmedabad	Billimora	Surat
01-Jan-10	2100	1650	2125
02-Jan-10	2200	1650	1875
08-Jan-10	2500	1650	1750
13-Nov-13	1500	1250	1500

Conclusion

Price volatility is one of the major risks that a farmer faces today. Yet, there are limited means available to the farmer to mitigate this risk. Within this context, reliable price predictions can help farmers anticipate price movements and plan their marketing strategy. There has been significant difference within the markets. Such as some of the mandis has always been reporting highest price in comparison to any other mandi in the given study. The consistency of agmarknet's data quality and dependability is still a concern. The validity of the data is impacted by instances where modal prices are not consistently updated, frequent portal outages, and significant intraday price fluctuations. With this study, current price crisis of crops can be resolved. The amount by which the fund return deviates from the anticipated average return is indicated by a wide dispersion. Increasing the yield of medicinal crops could raise farmers' profitability compared to raising relatively common pattern crops because they have a variety of medical and culinary benefits. Analysis of intra-

mandi prices for seasonal crops and medicinal crops revealed that prices fluctuate with peak season and medicines get more attention, although they are influenced by a variety of factors and are always in demand. This data can aid to train a machine learning model for estimating the future price after consideration of market demand.

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Conflict of Interest

The author(s) state that they have no competing interests with respect to the publication of this research.

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