

Value Chain Analysis of Sugarcane in Ayodhya District of Eastern Uttar Pradesh

काशी हिन्दू
विश्वविद्यालय



BANARAS HINDU
UNIVERSITY

Thesis submitted in partial fulfilment of
the requirements for degree of

Master of Science (Agriculture)

in

Agricultural Economics

Supervisor

Dr. Anoop M.

Submitted by

Atul Singh

**DEPARTMENT OF AGRICULTURAL ECONOMICS
INSTITUTE OF AGRICULTURAL SCIENCES
BANARAS HINDU UNIVERSITY
VARANASI – 221 005
INDIA**

ID No. 20412AGE002

2022

Enrollment No. 390143

काशी हिन्दू
विश्वविद्यालय



BANARAS HINDU
UNIVERSITY

Dr. Anoop M.
Assistant Professor



**INSTITUTE OF
AGRICULTURAL
SCIENCES**

Department of Agricultural Economics
Institute of Agricultural Sciences
Banaras Hindu University
Varanasi-221005 (India)

Ref.

Date.....

CERTIFICATE

To
The Registrar (Academic)
Banaras Hindu University
Varanasi-221005 (India)

Through The Head, Department of Agricultural Economics,
Institute of Agricultural Sciences. B.H.U, Varanasi.

Dear Sir,

I have great pleasure in forwarding the thesis entitled **Value Chain Analysis of Sugarcane in Ayodhya District of Eastern Uttar Pradesh** submitted by **Mr. Atul Singh, I.D No. 20412AGE002**, in partial fulfillment of the requirements for the degree of **Master of Science (Agriculture)** in **Agricultural Economics**, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi and placing on record that he has completed the requisite residential requirements as contained in the statute of the University.

I certify that the entire scheme of investigation presented herein was planned and carried out solely by the candidate under my guidance and supervision. The data presented in the thesis, to the best of my knowledge and belief, are genuine and original.

Thanking you

Yours faithfully

Forwarded

Dr. Anoop M.
(Supervisor)

(Head)

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EASTERN UTTAR PRADESH**



By
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APPROVED BY MEMBERS OF ADVISORY COMMITTEE

Chairman

Dr. Anoop M.

Assistant Professor
Department of Agricultural Economics
Institute of Agricultural Sciences
Banaras Hindu University, Varanasi

Member

Dr. Rakesh Singh

Professor and Head
Department of Agricultural Economics
Institute of Agricultural Sciences
Banaras Hindu University, Varanasi

Dr. A.K. Singh

Professor
Department of Agricultural Extension and Communication
Institute of Agricultural Sciences
Banaras Hindu University, Varanasi

External Examine

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Date:

Place: BHU, Varanasi

(Atul Singh)

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LIST OF ABBREVIATIONS USED

LMT	Lakh Metric Tonne
GoI	Government of India
HL	Human Labor
FRP	Fair and Remunerative Prices
ECA	Essential Commodities Act
CACP	Commission on Agricultural Costs and Prices
CCEA	Cabinet Committee on Economic Affairs
ARIMA	Autoregressive Integrated Moving Average
CAGR	Compound Annual Growth Rates
AIC	Akaike Information Criteria
SNA	Social Network Analysis
TCD	Tons of Cane per Day
ACF	Autocorrelation function
PACF	Partial Autocorrelation Function
ADF	Augmented Dickey Fuller
MLE	Maximum likelihood method
SE	Standard Error
KVK	Krishi Vigyan Kendra
SGVS	Sahkari Ganna Vikas Samiti

INTRODUCTION

In India, sugarcane is a significant cash crop. Sugarcane farming and the development of the sugar industry is as old as agriculture and has grown with human civilization. Sugar is the second largest agro-based industry of India next to cotton. Sugar is used extensively and has a profound impact on the socio-economic milieu of the country. By utilizing rural resources, creating employment and greater income, as well as providing transportation and communication infrastructure, sugarcane cultivation and the sugar industry have become a focal point for socio-economic development in rural regions in the modern rural economy setup. The cultivation of sugarcane and related operations include around 5 crore sugarcane farmers and agricultural laborers in India. (*NITI Aayog, March 2020*)

Sugarcane (*Saccharam officinarum*) is a native to India and has been cultivated from historic times over the years and also it is a major commercial crop next to cotton in India. Sugarcane is the most important source of sugar. Uttar Pradesh is the country's largest sugarcane-growing state followed by Maharashtra. Other important cane-growing states in the tropical region include Karnataka, Tamil Nadu, Gujarat, and Andhra Pradesh. Aside from Uttar Pradesh, the primary cane-growing states in the sub-tropical region include Bihar, Haryana, Uttarakhand, and Punjab. The farmed canes are divided into two groups: thin, resistant north Indian varieties *S.barberi* and *S.Sinense*, and thick, luscious noble canes *Saccharum officinarum*. Germination, tillering, early growth, active growth, and elongation are the several critical stages of sugarcane. The ideal temperature for stem cuttings to sprout (germinate) is 32° to 38°C. It slows down below 25°C and reaches a plateau between 30°C and 34°C.

Global Scenario

According to the International Sugar organization 2022, sugarcane accounts for about 80% of global sugar output on an average. The top 10 sugarcane producing countries (India, Brazil, Thailand, China, the United States, Mexico, Russia, Pakistan, France, and Australia) accounted for over 70% of global output during the September/October season. (International Sugar Organization, 2022). India, the EU, China, Brazil, the United States, Indonesia, Russia, Pakistan, Mexico, and Egypt are all major sugar consumers.

The following graph shows sugar production and consumption worldwide in 2020-21 by the leading countries in million metric tons.

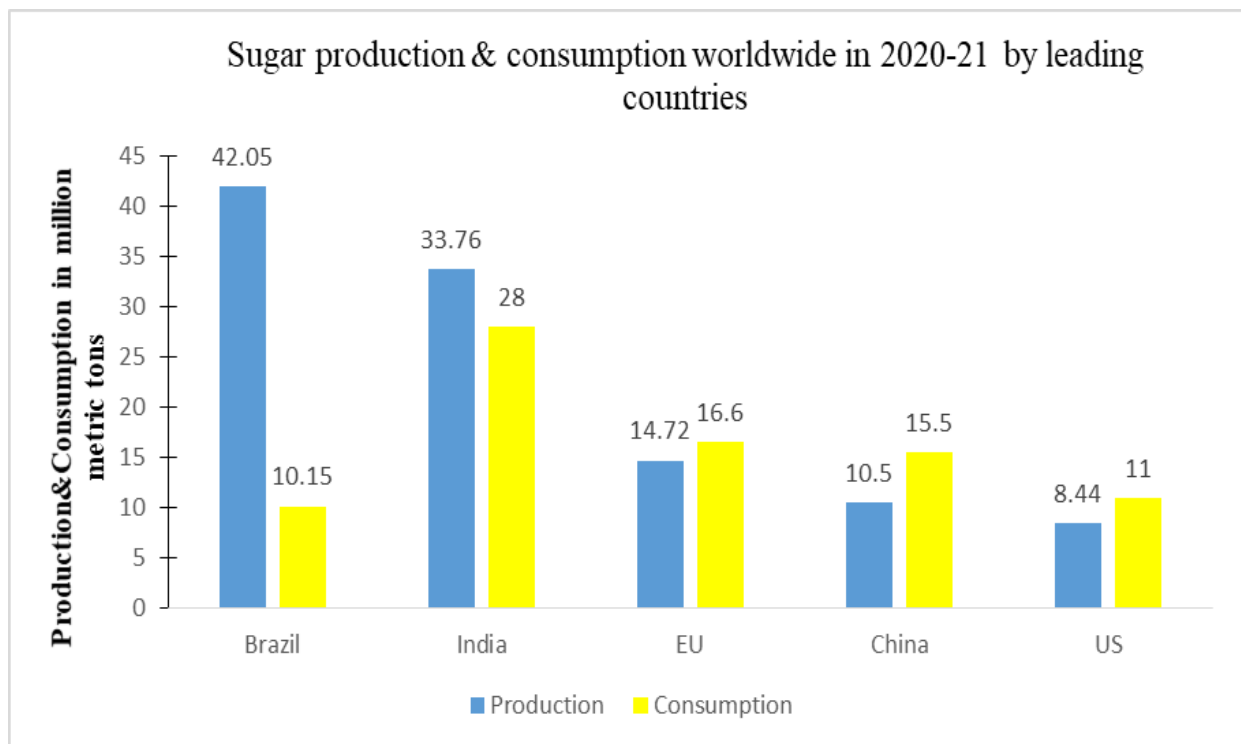


Figure 1.1: Sugar production and consumption worldwide in 2020-21 by the leading countries (Source: Indiastat, 2022)

Indian Scenario

According to the Indian Sugar Mills Association (ISMA), 516 mills crushed sugarcane, producing 252.87 lakh tonnes of sugar between October 2021 and February 2022 as against 503 mills producing 234.83 lakh tonnes during the same period last season.

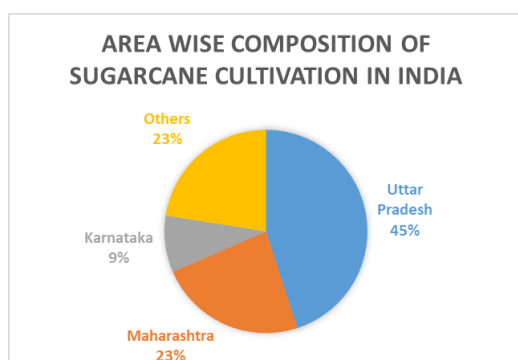


Figure 1.2: Area wise composition of sugarcane cultivation in India (2021)

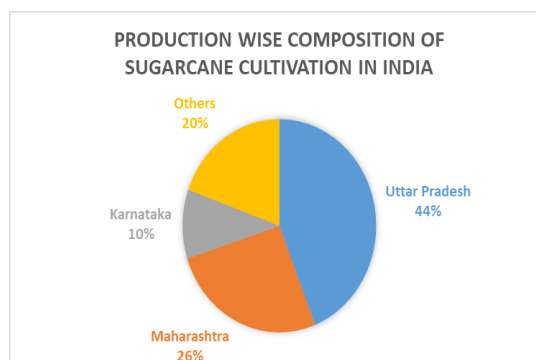


Figure 1.3: Production wise composition of Sugarcane cultivation in India (2021)

Source: Indiatat,2022

According to the Ministry of Consumer Affairs, Food & Public Distribution, in sugar season 2020-21, around 70 LMT of sugar was exported, compared to 59.60 LMT in sugar season 2019-20. Furthermore, for the sugar season 2021-22, contracts for around 30 LMT of sugar export have already been inked. Sugar mills/distilleries have produced revenue of almost 35000 crore from the sale of ethanol to Oil Marketing Companies during the last four sugar seasons.

Sugarcane production scenario in Uttar Pradesh

Uttar Pradesh is India's leading sugarcane producer. In UP, the sowing of sugarcane begins in October-November, and harvesting takes place during October-December of the following year. In some places the harvesting of the crop may continue up to February of the year after. Sugarcane is important to the state's economy and provides employment opportunities to a huge group of individuals. In the state of Uttar Pradesh, the areas with the most sugarcane concentration are in the Upper Ganga-Yamuna Doab, Rohilkhand, and Trans Saryu areas, which provide around 70%

of the total output of the state's total sugarcane production. According to the UP government, there were 120 sugar mills in the state during 2020-21. Out of the 22.32 crore tonnes of sugarcane produced in UP during 2020-21, 10.27 crore tonnes were crushed to produce 110.59 lakh tonnes of sugar. The data show that the quantity of sugarcane crushing has increased to 10.27 crore tonnes in 2020-21 from 8.27 crore tonnes in 2016-17.

The sugar business began in sugarcane-producing districts in eastern Uttar Pradesh, but many other factors influenced its growth. Eastern Uttar Pradesh has a monsoon climate, alluvial soil, and a significant number of agricultural laborers, all of which contribute to a favorable environment for sugarcane farming, the region's only lucrative crop. While sugarcane is grown in most parts of the state, 27 districts — Kheri, Bijnor, Muzaffarnagar, Sitapur, Saharanpur, Meerut, Bareilly, Gonda, Baghpat, Amroha, Pilibhit, Kushi Nagar, Shamli, Bulandshahr, Moradabad, Hardoi, Balrampur, Basti, Shahjahanpur, Hapur, Sambhal, Rampur, Budaun, Bahraich, Ghaziabad, Faizabad and Maharajganj, reported an area more than 20,000 hectares under sugarcane during 2018-19. (Indian Express, Jan 2022)

Sugarcane production scenario in Ayodhya district

According to the Government of U.P., about 20% of the total agricultural land of the Ayodhya district is used for sugarcane cultivation. Farmers of Ayodhya are using different varieties of sugarcane such as EAR0238, EAR94184, EAR0118, GEN97261, GEN01434, GEN05191, REJ92423, REJ8102 etc. According to the Directorate of Economics and Statistics, Ministry of Agriculture and Farmers Welfare, the area under sugarcane cultivation in Ayodhya has been increased from 13894 hectares in 1997-98 to 21844 hectares in 2019-20. The production of sugarcane in Ayodhya has also been increased from 7.3 lakh tonnes in 1997-98 to 16.7 lakh tonnes in 2019-20. Patterns of year wise area under sugarcane cultivation and year wise production of sugarcane in Ayodhya are represented through the following figures.

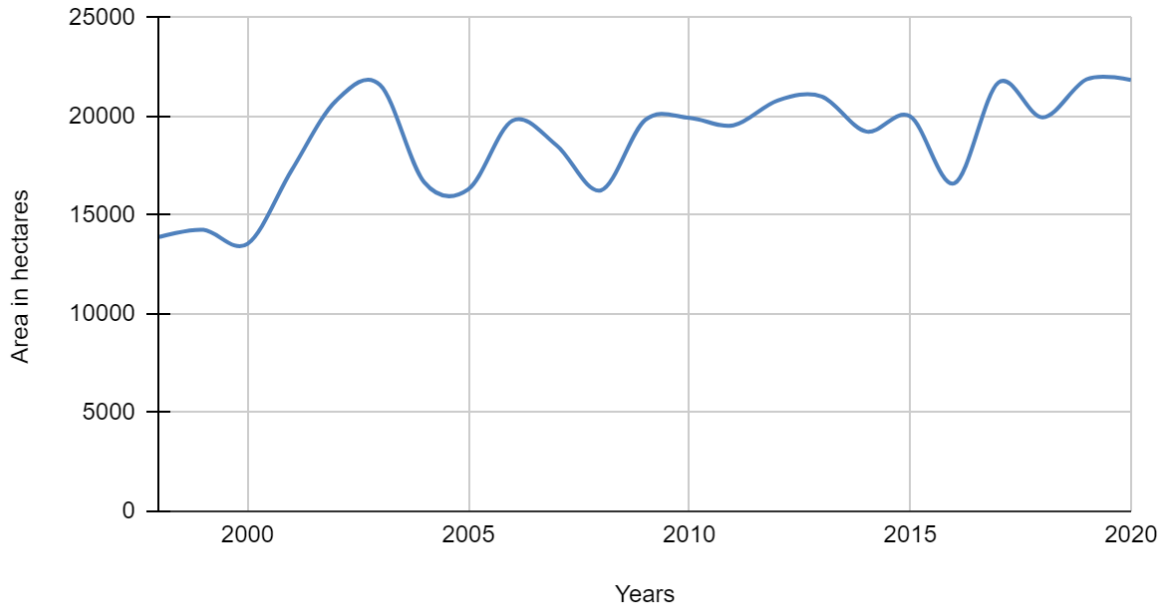


Figure 1.4: Year wise area under sugarcane cultivation

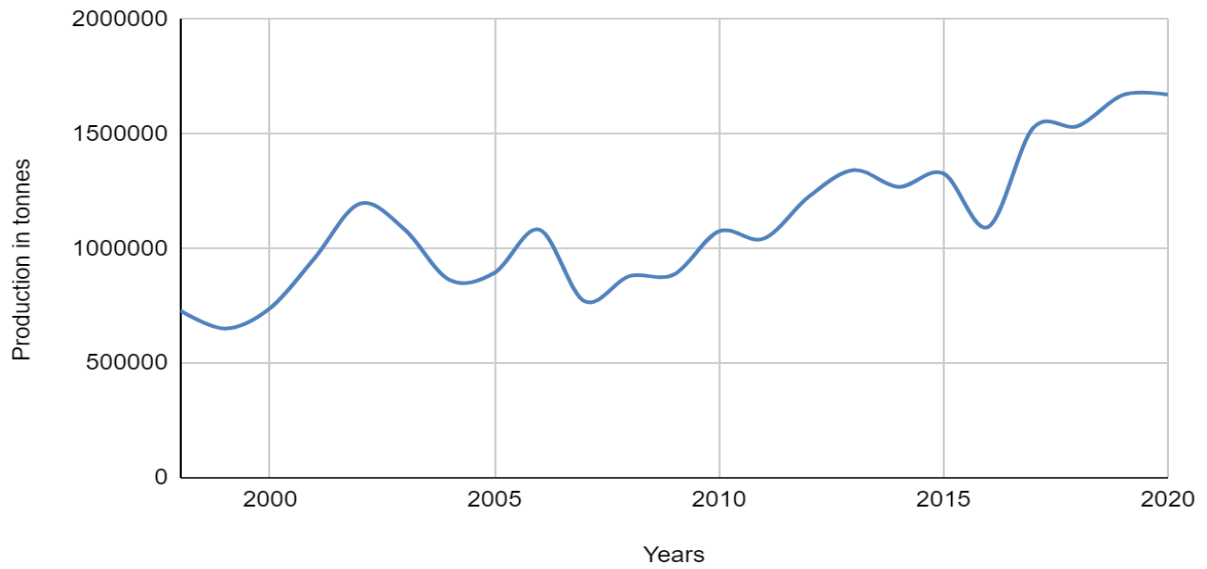


Figure 1.5: Year wise production of sugarcane

Importance of Sugarcane

Sugarcane is an important crop because of its ability to produce various products such as ethanol, biodegradable products, energy generation, and animal feed. The importance of sugarcane crop is discussed as follows:

Health Benefits

In various regions of the world, sugarcane juice is used to treat a variety of human ailments. The juice of Sugarcane per serving (28.35 grams) contains Energy-111.13 kJ (26.56 kcal), Carbohydrates-27.51 g, Protein-0.27 g, Calcium 11.23 mg (1%), Iron 0.37 mg (3%), Potassium 41.96 mg (1%), Sodium 17.01 mg (1%). Sugarcane extracts have been found to have a variety of biological effects, including immunostimulation (El-Abasy et al. 2002), anti-thrombosis, anti-inflammatory action, vaccine adjuvant, modulation of acetylcholine release (Kadam et al. 2008), and anti-stress properties.

Importance to Farmers

Sugarcane is an important cash crop of India. It involves less risk and farmers are assured up to some extent about return even in adverse conditions. The sugar industry in India has been a focal point for socio-economic development in the rural areas by mobilizing rural resources, generating employment and enhancing farm income. About 7.5 percent of the rural population, covering about 60 million sugarcane farmers is dependent and a large number of agricultural laborers are involved in sugarcane cultivation, harvesting and ancillary activities.

Importance to Indian Economy

Sugarcane is an important part of the Indian economy since it offers raw material for firms that make alcohol, paper, chemicals, and animal feed. India's economy produced 28.9 million metric tons of sugar in 2020-21, that is about 17% of the world's total sugar production of 166.18 million metric tons (Source: Statista, 2021). Sugarcane and its byproducts are used for a variety of purposes in numerous industries, hence there is an increasing demand for more sugarcane output. The sugarcane-sugar-molasses route is the country's primary source of ethanol generation. One

tonne of sugarcane yields 100 kg of sugar and 40 kg of molasses, which yields around 10 liters of ethanol. One tonne of sugarcane, on the other hand, produces 72-75 gallons of ethanol. Similarly, one tonne of molasses yields around 220-250 liters of ethanol.

Employment generation

Sugarcane is a labor-intensive crop with a long growing season (12 months in the subtropics and 12-18 months in the tropics), requiring 150-180 labor days per hectare in the subtropics and roughly 250-300 days in the tropical south. The majority of cane cultivation operations are performed by hand, with the usage of machinery confined to procedures such as field preparation by the majority of farmers. Human labor (HL) accounted for 32.3 percent of total sugarcane cultivation costs, and the factor share of labor in the value of production increased marginally from 4.5 percent to 4.7 percent at the national level. Sugarcane agriculture has shown a 28.1 percent rise in labor productivity. (GoI, 2016)

Fair and Remunerative Prices

The FRP is the government-set price that mills are legally obligated to pay farmers for cane purchased from them. Farmers have the option of negotiating a contract with mills that allows them to pay the FRP in installments. Payment delays can result in interest of up to 15% per year, and the sugar commissioner can recover unpaid FRP as revenue recovery dues by attaching mill assets. The Sugarcane Control Order, 1966, established under the Essential Commodities Act (ECA), 1955, governs the payment of FRP across the country, requiring payment within 14 days of the date of cane delivery. It was decided on the Commission on Agricultural Costs and Prices (CACP) recommendations and announced by the Cabinet Committee on Economic Affairs (CCEA). The FRP is based on the sugarcane's sugar recovery. For the sugar season of 2021-22, the FRP has been set at Rs 2,900 per tonne with a base recovery of 10%. Sugar recovery is the percentage difference between the amount of sugar produced and the amount of sugar crushed from the cane. The greater the recovery, the greater the FRP, and the more sugar produced. The trends in FRP for the last 10 years are represented by the graph below.

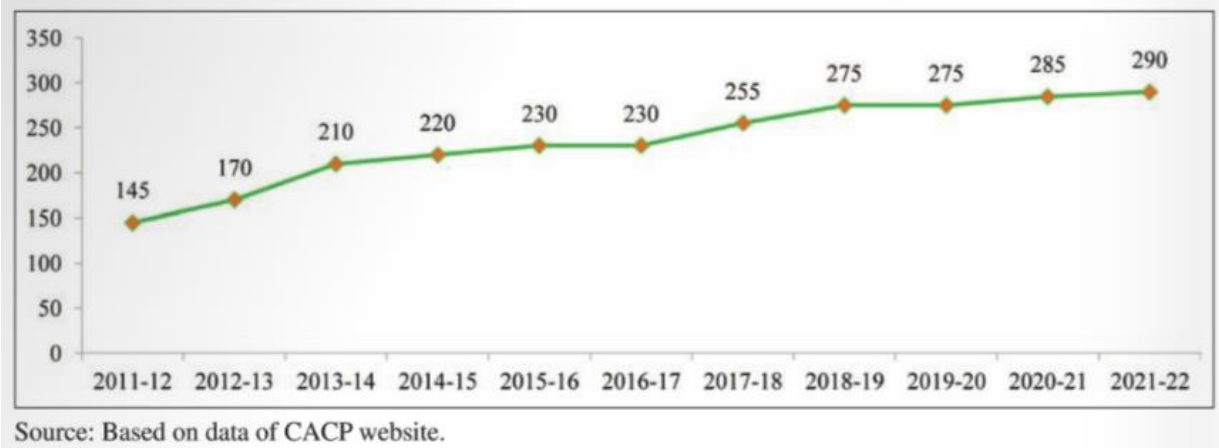


Figure 1.6: Trends in FRP per quintal

Concept of value chain and value chain Analysis

Value Chain

Michael Porter's "Competitive Advantage," a seminal study on the execution of competitive strategy to achieve superior business performance, popularized the Value Chain concept in 1985. Porter defined value as the price consumers are willing to pay for a product or service, and he defined the "value chain" as a collection of nine generic value-added activities that operate within a company and work together to create value to customers. Porter created a Value System by connecting the value chains of different organizations; however, in today's era of increasing outsourcing and collaboration, the linkage between value-creating activities of different enterprises is now generally referred to as the "value chain." Porter referred to "value chain" to describe the full range of activities, which are required to bring a product or service from conception, through the different phases of production, distribution to consumers, and final disposal after use.

Value chain Analysis:

Value chain analysis has been used to investigate and assess entire industries and industry clusters, as well as specific systems inside companies. It focuses on the dynamics of complex linkages within a network, wherein both value creation and value capture occur in a value system that includes suppliers, distributors, partners, and collaborators, thus extending the firm's access to resources and opportunities (Zott, Amit and Massa, 2011). Value chain analysis necessitates "market mapping" in order to track and analyze the contributions of the various chain participants as well as their interrelationships. Understanding the interconnections within a value chain aids in identifying the elements that affect how well or poorly the chain functions. The value chain actors, the enabling environment, and the service providers are all defined in the market map that results. Infrastructure, policies, and regulations, as well as institutions and procedures that build the market ecosystem, all contribute to the enabling environment, which contains crucial variables that generate the operational circumstances under which the value chain operates.

Sugarcane Value Chain:

The domestic sugarcane value chain is worth more than Rs 1 trillion annually with nearly 35 million farmers' families, including five million in UP, directly engaged in farming. (The Pioneer, July 2021) Its primary by-products include sugar, ethanol, molasses, spirits, press mud, etc. More recently, hand sanitizer has also become a part of the product basket necessitated by the pandemic safety protocols. A typical supply chain of sugarcane with only sugar as a product is shown below:

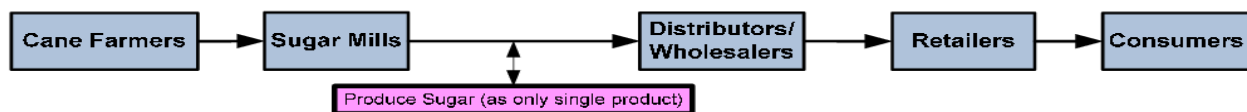


Figure 1.7: Supply chain system of sugar industry

Supply chain v/s Value chain

The supply chain comprises the flow of all information, products, materials and funds between the different stages of creating and selling a product. Every step in the process, including creating a good or service, manufacturing it, transporting it to a place of sale and selling it is a part of the supply chain. On the other hand, value chain implies the series of business operations in which utility is added to the goods and services offered by the firm so as to enhance customer value. The objective of supply chain is customer satisfaction while for value chain, it is gaining competitive advantage.

Problem Statement

Value chain analysis describes the analysis of all activities which are essential to bring a product or service from point of conception, to the different stages of production/ marketing (involving a combination of physical transformation and value addition through processing, etc.) and then followed by final disposal after use. (Kaplinsky and Morris, 2000). Farmers' success is dependent on increasing the method and efficiency with which they dispose of their products. Value chain analysis will be carried out for this purpose in order to identify the missing connections in the existing value chain. The study of the sugarcane value chain is important in order to gain a better understanding of the market, the contributions of various partners, their interactions, and the critical restrictions that limit sugarcane marketing growth and, as a result, sugarcane farmers' competitiveness. Further, Uttar Pradesh is the hub for sugarcane production and the sugar industry is widespread in the eastern parts of the state. Thus, the study "Value chain analysis of sugarcane in Ayodhya District in Eastern Uttar Pradesh" was conducted.

Objectives of study

In order to attain higher profits for the value chain's stakeholders, understanding the value chain is critical from producers to end consumers. Hence, keeping in view the prospects of study in this field, the present research was conducted with the following objectives-

- To study the trends in growth rates in area, production and productivity of sugarcane in Ayodhya and Uttar Pradesh.
- To forecast the area, production and productivity of Sugarcane in Uttar Pradesh.
- To identify and analyze the major stakeholders in the value chain of sugarcane and map the value chain for Ayodhya district of Uttar Pradesh.
- To evaluate the cost of cultivation of sugarcane, price spread and the marketing efficiency of the sugarcane value chain in the study area.
- To identify the problems and opportunities in the sugarcane value chain of Ayodhya district.

Limitations of the study

Even though every attempt was made to make the study as precise and specific as possible, some limitations are likely to remain. Limitations like these are:

- Due to resource constraints and physical constraints, only a small sample size was considered for the study.
- These are mostly small farmers who do not preserve reliable documentation, thus the data acquired from them is entirely relied on memory.
- The information gathered from the sugar mills is based on documentation and interviews with mill workers and employees.
- Due to a lack of good record keeping, the data acquired from small retailers is also based on memory.
- Since this study is limited to a single region, it cannot be applied as such to other areas.

REVIEW OF LITERATURE

The conceptual and methodological issues that are important to the thesis can be found by reviewing previous research. This helps the researchers in selecting the best tools for their research, data collection, analysis, and precise interpretation. This chapter makes an effort to study prior research papers on the following headings.

1. Trends in growth rates of Area, Production and productivity of sugarcane
2. Forecasting of area, production and productivity of sugarcane
3. Analyzing the value chain actors and value chain mapping in sugarcane
4. Marketing cost, Marketing efficiency and price spread of sugarcane
5. Opportunities and constraints in sugarcane value chain

(I) Trends in growth rates of Area, Production and productivity of sugarcane

Kumar and Singh (2014) used simple descriptive statistics and linear growth rates (compound annual growth rates) to examine the trends in sugarcane crop's area, production, and productivity in Haryana state at the district and regional levels during the period from 2000-01 to 2009-10. The area, production and productivity of the sugarcane crop had shown interesting outcomes. In both the regions and most of Haryana's districts, the sugarcane crop's growth rate was determined to be noticeably negative. Except for Bhiwani and Karnal, almost all of the districts had a similar picture of sugarcane output growth. On the other hand, the productivity of the sugarcane crop has increased in the majority of Haryana's districts. This means that in most of Haryana's districts, the rate of change in sugarcane crop area is faster than the rate of change in production.

Thakur and Rai (2017) conducted a study to determine Uttar Pradesh's sugarcane industry's growth rates in terms of area, production and yield. The study was based on secondary

data. In this study, simple statistical procedures like compound annual growth rate and percentage change were applied. In this study, time series data were used (1950-2015). This analysis found that the sugarcane industry's compound annual growth rate was positive in terms of area, production, and yield. The positive sign indicates that the pattern of sugarcane production pattern has been growing at an increasing rate. Sugarcane yield remained steady, while production and area increased by 2.25 percent and 1.96 percent, respectively, over the preceding 65 years.

Bee and Rahman (2020) analyzed growth rate of area, production and yield of sugarcane in India and performance of sugarcane crop in major sugarcane producing states of India. The research was based on secondary data. In this study, simple statistical tools such as compound annual growth rate and percentage methods were applied. According to the research, the compound annual growth rate in terms of area, production, and yield is positive. In the thirty years between 1985 and 2015, the area under sugarcane cultivation expanded by 5.63 percent, while sugarcane production climbed by 7.40 percent. Sugarcane farming is affected by a variety of factors, including monsoon conditions, government price policies, and so on, therefore the area and production of the crop fluctuates.

M.S. and Basavaraj (2021) initiated and analyzed trends in growth rates in the area, production, and productivity of cotton, redgram, sugarcane, paddy and groundnut in districts of Yadgir, Kalaburagi, Belagavi, Raichur, and Chitradurga districts respectively. Redgram showed a positive and significant growth rate in the area (3.57 percent) while Groundnut, Sorghum and Paddy showed a negative growth rate in the study area. In terms of production, the growth rate for cotton (5.99 percent) was positive, whereas for the other crops it was negative. Redgram (3.52 percent) and cotton yield were positive and significant (6.35 percent). Negative growth rates were the result of the shift from agricultural to non-agricultural activity trends. Training farmers on risk-bearing abilities at times of unseen events could further encourage them to continue agriculture by bringing all farmers into the field of crop insurance.

Singh *et al.* (2021) conducted a research study on value chain analysis of organic chilli production in North Eastern Hill Region, India. They examined the value addition possibilities and the economics of chilli cultivation (both organic and conventional) at supply chain level. The study

revealed that growing chillies were profitable, especially when done organically. The analysis of value addition reveals technological advancements that would increase the value of regional cultivars. By growing chilli organically and adding value, farmers can boost their revenue. The value chain actors should customize their business plans to the local cultivars and add value to the varieties of chilli that have the potential to succeed in local, regional, and national markets, according to the value chain map study.

(II) Forecasting of area, production and productivity of sugarcane

Suresh and Priya (2011) attempted to forecast the sugarcane area, production and productivity of Tamilnadu through fitting of univariate Auto Regressive Integrated Moving Average (ARIMA) models. The data on sugarcane area, production and productivity collected from 1950–2007 had been used for study. ARIMA (1, 1, 1) model was found suitable for sugarcane area and productivity. ARIMA (2, 1, 2) was found appropriate for modeling sugarcane production. The performances of models were validated by comparing with actual values. Using the models developed, forecast values for sugarcane area, production and productivity were developed for subsequent years. The result indicated that the predicted values of sugarcane area were slightly higher than the actual values and lower in case of sugarcane production. The predicted values were much closer to the observed values for sugarcane productivity.

Mandal (2015) used time-series methods to examine annual sugarcane output data in India from 1950-51 to 2002-03. For the data, autocorrelation and partial autocorrelation functions were constructed. A Box-Jenkins autoregressive integrated moving average model was fitted that was appropriate. Standard statistical approaches were used to test the model's validity. Sugarcane production was forecasted for three leading years using the forecasting power of an autoregressive integrated moving average model.

Vishawajith *et al.* (2016) attempted to estimate area, production, productivity of sugarcane and sugar production of the major sugarcane producing states of India through the fitting of univariate ARIMA models. The authors used time series data collected from 1950 to 2012 on sugarcane area, production, productivity and sugar production for the study. For the sugarcane area, ARIMA (3, 1, 3) and for sugarcane production, productivity and sugar production in India,

ARIMA (2, 1, 1) models were found as suitable. These models were used to forecast values for subsequent years.

Ahmad *et al.* (2017) made an attempt to forecast the area, production and yield of Pakistan. The Autoregressive Integrated Moving Average (ARIMA) model was used in the study to forecast major crop's area, production, yield, and per capita food availability. To forecast major crops and per capita food supply for 21 years, from 2014–15 to 2034–2035, annual time series data from 1947–1948 to 2013–2014 were collected. The study's findings indicated rising trends in the primary crops' production, yield, and area, with the exception of the sugarcane crop, whose yield was shown to be falling. Lack of potential resource utilization in the sugarcane crop was said to be the cause of the declining sugarcane output in the forecasted period. Forecasted per capita food availability will increase wheat production from 138.2 kg to 185 kg, for rice, it will be 36.2 kg to 50.8 kg and for maize it will increase from 26.8 to 43.5 kg for forecasted population of 188 million to 258.4 million from 2014 to 2035.

Kumar *et al.* (2017) conducted a study on sugarcane productivity in Bihar and tried to forecast the sugarcane production of Bihar by fitting the well-known Box Jenkins univariate Auto Regressive Integrated Moving Average (ARIMA) model. The ARIMA model was built using data on sugarcane productivity in Bihar from 1940 to 2010 and verified using five-year productivity data from 2011 to 2015. For the optimal model selection criteria, the Akaike information criterion (AIC) was chosen. Based on AIC model selection criteria, the ARIMA (0, 1, 1) model was found to be the best model for sugarcane productivity in Bihar. The models' results were validated by comparing them to actual sugarcane productivity numbers in Bihar data. Using the constructed ARIMA (0, 1, 1) model, sugarcane productivity in Bihar was expected to increase in 2016 and 2017 with 4.22 percent and 5.15 percent prediction standard errors, respectively.

Paswan *et al.* (2018) concluded in their research article examined the stability and long-term profitability of sugarcane production in the state of Bihar during the study period of 1939–1940 to 2019–20..The ARIMA (1, 1, 0) model, based on the minimum values of AIC (649.781) and BIC, is the best appropriate for predicting (654.545). The production of sugarcane was

projected using the ARIMA (1,1,0) model, which showed a considerable increase from 126.03 lakh to 131.67 lakh tonnes between 2020 and 2025

(III) Analyzing the value chain actors and value chain mapping in sugarcane

McCormick and Schmitz (2001) gave a definition of value chain as “set of value-adding activities through which a product passes from the design to the consumption stages. The worth of the product increases at each point of the process, hence the term value chain.” The concept of value chain in secondary literature has been divided into three major research concepts; viz. Porter’s Framework (1985), the Filiere approach (Durufle and Fabre, 1988) and the Global approach by Gereffi et. al. (2001).

Norton and Fearne (2009) covered the concepts underpinning sustainable value stream mapping or value chain analysis (SVCN) and how the approach might be applied, highlighting the significance of collaborations and information exchanges between food manufacturers and merchants. Waste in any industry includes physical byproducts and ineffective resource use. Choosing waste reduction solutions requires assessing current operations and trash generated therefrom. Value stream mapping (VSM) is a diagnostic technique that was developed in lean manufacturing to reduce wasteful processes and shorten lead times for production. A recently created framework called SVCN uses the VSM approach to integrate organizational steps as well as a number of environmental metrics in determining a product's value stream. Evidence from case studies demonstrates how manufacturers struggle with order volatility and predictability.

Zott et al. (2011) emphasized on the value chain analysis and concluded that the value chain analysis focuses on the dynamics of complex linkages within a network, wherein both value creation and value capture occur in a value system that includes suppliers, distributors, partners, and collaborators, thus extending the firm’s access to resources and opportunities.

Morgan (2012) in his book *Social Networks and Value Chain Development* defined that the Market development professionals have a way to map a market from input supplies to the final customer because of the value chain framework. It is a method for creating projects that can

expand, reach thousands of micro, small, and medium-sized businesses, and promote a market that ensures livelihoods for the most vulnerable. But generally, efforts pass over the most vulnerable because of their minimal, hardly visible contribution in a value chain.

Kumar et al (2012) analyzed the marketing of jaggery. The study was undertaken in Belgaum district of Karnataka, with the objective of assessing Jaggery marketing. The major marketing channels were identified in respect of jaggery marketing were as follows:

Channel 1: Producer → Commission agent → Wholesaler → Retailer → Consumer

Channel 2: Producer → Wholesaler → Retailer → Consumer

Channel 3: Producer → Retailer → Consumer

Out of the three marketing channels, Channel 2 (Producer → Wholesaler → Retailer → Consumer), was the most popular channel in which 72.25 percent of the producers sold their produce through this channel.

In the book “Human cost of Sugar: A farm- to-mill assessment of sugar supply chain in Uttar Pradesh”, published by **Oxfam India (2018)** analyzed the key stakeholders involved and their roles in the sugarcane value chain in Uttar Pradesh. Some of the key stakeholders involved at various stages of the value chain in Uttar Pradesh are listed as- farmers, farm workers, Cane Development and Sugar Industries Development Department, cane societies, sugar mills, traders, food and beverage companies, certification bodies, civil society organizations and trade unions.

Dubey et al. (2020) in their research article studied about value chain and supply chain. According to this article, A value chain is made up of all the internal processes a company uses to provide its customers with valuable goods and services. The value chain has additional value added at each stage. By identifying the thousands of individual processes involved, the value chain offers a method for visualizing a company's productivity. The functional operations of a business that add value for its customers are referred to as its value chain. A company must create value through its value chain activities and then capture that value. This chain's value creation should be more than the total value added by each individual activity. Value-chain analysis aims to boost production efficiency so that a business may provide the most value for the least amount of money.

(IV) Cost of cultivation, Marketing cost, Marketing efficiency and Price spread

Kumar *et al.* (2014) conducted a survey during the years 2009 to 2011, to study the cost and return of sugarcane production in Meerut district of Uttar Pradesh. For the research, 80 farmers (33 small, 27 medium, and 20 large) were randomly chosen from among the sugarcane cultivators in the blocks, which was based on the sugarcane (planted and ratoon) cropping system. The expected cost of sugarcane per hectare (planted) was Rs. 89712.33; the net returns per hectare (ha) were Rs. 16914.66; the estimated cost of production per quintal (q) was Rs. 160.91; and the profit margin (p) was Rs. 42.35. The cost of sugarcane (ratoon) production per hectare was assessed to be Rs. 78668.60; net returns were Rs. 85741.30; the cost of production per quintal was Rs. 98.00; and the profit margin was Rs. 106.94.

Mishra and Singh (2014) made an effort to research the organized retail chain's commercial channels and marketing efficiency. The present study has purposefully chosen the Uttar Pradesh district of Varanasi. There were 60 customers, a seller, four intermediaries, and 45 producers altogether. Tomatoes, peas, okra, and brinjal were among the vegetables chosen for the study. The expenses per kilogram of vegetables were significantly lower in the organized supply chain, or channel II, than they were in the traditional supply system, or channel I. For all the vegetables under consideration in Channel I, Channel II had a higher net return and commercial efficiency than Channel I. At the same time, the smallest price spread of the organized supply chain was found. As a result, coordinated (channel-I) supply chains were found to be more successful than unorganized (channel-II) supply chains. Therefore, farmers should sell their goods through a modern supply chain, specifically channel II, as it is more effective as the products were bought directly from the producer. However, the APMC Act prohibited Commercial retailers from making direct purchases from farmers. Therefore, it was suggested that policy reform be implemented to facilitate direct marketing.

Krishnakant *et al.* (2015) analyzed the cost of sugarcane crop cultivation and discovered that in the Meerut district of Uttar Pradesh. From the purposively selected district and block on the

basis of maximum area under the crop. From a selected block, four villages were selected randomly and a complete list of the farmers were prepared and categorized into four categories of marginal, small, medium and large. 100 respondents were selected from the total cane growers in probability proportion according to their population. The study revealed that the cost of plant and ratoon sugarcane crop cultivation was Rs. 172679/- per ha and Rs. 129753/- per ha, respectively.

Peerzado *et al.* (2016) studied economic assessment of sugarcane production and its marketing constraints in Sindh, Pakistan. The study area's studied sugarcane farmers had a moderate level of production inefficiency, according to the data, and there was therefore a significant scope for improvement. Operating at optimal scale, which entails medium-sized farms, can result in an additional cost savings. Given the importance of cane production for contribution to food safety, income, employment and export in Sindh province and Pakistan. The benefits from enhancing farm efficiency would be substantial. The findings indicated that a variety of issues, including a lack of education, a failure to accept new kinds, a failure to apply the necessary fertilizers or pesticides efficiently, and a major factor the absence of water at the time of sowing influence crop efficiency.

Upreti *et al.* (2017): In order to identify the factors influencing sugarcane productivity in the two major sugar-producing states of Uttar Pradesh and Maharashtra, an attempt had been made to evaluate changes in sugarcane production, area, productivity, costs, returns, and profitability. Although productivity had remained stagnant, it had been noted that area expansion has significantly contributed to increasing sugarcane production. The price of growing sugarcane also showed an upward tendency, and because Maharashtra used more inputs than Uttar Pradesh, it was judged to be more expensive. However, the growth of output value had exceeded the growth of cultivation costs, leading to a growing trend in profitability that was larger for Uttar Pradesh than for Maharashtra. According to the study, the productivity of sugarcane was positively and significantly influenced by human labor, machinery, fertilizers, pesticides, and the size of the plot. As a result, effective management of these inputs can certainly increase the productivity of sugarcane in India.

Rao (2017) made an effort to estimate the economic effectiveness of the jaggery production and value chains in Andhra Pradesh. The study's objectives were to calculate the costs and returns associated with producing sugarcane and jaggery, to determine whether jaggery production units were financially feasible, to examine the price spread and marketing effectiveness of jaggery, and to identify the major production and marketing challenges that jaggery producers face. To determine various aspects of the production and value chains, as well as the challenges faced by cane jaggery producers in 2015–16, a multistage sampling technique was used. He investigated that the price spread of sugarcane jaggery farmers and the producers' share in the consumer's rupee and marketing efficiency were 67.94, 73.10, and 2.72 and 2.12, respectively.

Santosa (2018) reviewed the farmers' share price, the price transmission elasticity, and market integrated, and so the structure of the people's sugar market. 25 retailers from around 85 retailers and 10 wholesalers from a total of 36 wholesalers in Ngawi (Indonesia) were sampled for this study. 25 retailers and 10 wholesalers were chosen from among the 87 farmers in the sample to collect all of their cane harvests, with the expectation that these traders can speak for other retailers and wholesalers in Ngawi. The research's findings indicate that (1) in the marketing process phase, the longer the cane marketing chain (the first and second marketing pattern) makes the marketing margin the larger so the lower farmer's share price, (2) the longer the cane marketing chain, the lower the transmission elasticity (not quite perfect), and market integrity occurs in the long run, which makes the marketing pattern less efficient, and (3) on the short chained marketing pattern (t), market integrity occurs in the long run, which makes the marketing pattern more efficient.

Asha et al. (2019) studied the production and marketing of sugarcane cultivation in Visakhapatnam district of Andhra Pradesh and concluded that as per the price spread analysis for the selected channel, the producer earned 70.83 percent of the price paid by the consumer in channel 1 (sugar), and 81.43 percent in channel 2. (jaggery). As per the price spread analysis for the chosen channel, producers received 70.83% of consumer price for channel 1 (sugar), and 81.43% for channel 2. (jaggery). Channel 1 had a 34.30 percent higher total marketing cost than Channel 2. (18.80 percent). Channel 2 had a high marketing efficiency index of 3.33, compared to 1.06 for channel 1.

(V) Opportunities and constraints in sugarcane value chain

Lahoti *et al.* (2010) conducted a study in the command area of Vaidyanath Co-operative Sugar Mill Ltd, Pangari (Maharashtra) by interviewing 150 sugarcane growers from ten different villages with the aim of identifying the barriers to the adoption of sugarcane production technology. The challenges experienced by sugarcane growers in adopting technology for sugarcane production were operationalized as the research variable constraint. Most respondents reported that the adoption of sugarcane production technology was hampered by inconsistent electricity supply, expensive pesticides, inadequate irrigation water at necessary times, a lack of labor for cross-cultural operations, expensive fertilizers, a lack of high-quality manure, and a lack of knowledge about insecticide spraying. The sugarcane growers also had to deal with transportation issues and the lack of a contact office nearby the village. Sugarcane growers made some suggestions, including the timely and regular supply of inputs at lower prices, the regular supply of electricity, and ensuring a remunerative price for sugarcane growers.

Singh. *et al.* (2018) had computed the economics of sugarcane production, resources use efficiency and production constraints in East-Champaran district of Bihar. In the study, primary data were collected from 68 sugarcane growers on various aspects of costs and returns spread over two blocks in West-Champaran district of Bihar. According to the findings, the usage of appropriate intake levels is critical in closing the gap. Sugarcane growers had identified labor scarcity at critical periods as a major production constraint, with an average score of 80.0 in Garret's ranking. Unavailability of fertilizers on time (76.92 average score in Garrett's ranking) was recognised as the second most serious limitation. Pest and disease infestation (77.0), lack of planting material (70.20), inability to obtain a loan on time (61.10), and high cost of plant protection chemicals (56.75) were the other restraints. As a result of the study, it was recommended that farmers be motivated to use optimal and sustainable resource inputs and improved variety of seeds to increase sugarcane productivity in the state through visits to progressive farmers of field demonstrations, seminars, and other forms of communication.

Hanabar *et al.* (2021) studied the constraints in the production and marketing of sugarcane in Belagavi district, Karnataka (India). The findings of the study showed that the Belagavi district as a whole faced a number of challenges, including the lack of irrigation water, irregular rainfall patterns, delayed monsoon arrival, high wage rates, low local market pricing, expensive commission fees, and high transportation expenses. According to the suggestions of 80.14 percent of respondents, the government should offer drip irrigation facilities in the area to all sugarcane growers in order to overcome these limitations. The majority of farmers strongly suggested that suitable measures be taken to ensure that the farmers were charged the minimum support price for the output.

Deshmukh *et al.* (2021) in their research article related to the constraints in the cultivation and marketing of sugarcane production in Kabirdham district of Chhattisgarh, suggested that the main restraint in sugarcane production was a labor scarcity during peak season (76.79), followed by rising human labor wage rates (64.04). Growers encountered a substantial marketing limitation (71.67), which was followed by delayed payment of sugarcane and bonus. In the research area, there was a delay in weighing and purchasing by the factory (56.96). Given that 71.67 percent of growers had mentioned the issue of low pricing in the local market, relevant policymakers should emphasize this issue and make necessary preparations to ensure that growers get paid on time.

Mishra *et al.* (2021) used Garrett ranking to rank the constraints in the sugarcane value chain in eastern Uttar Pradesh. The study suggests that the most important issue for the farmers of that region was lack of financial resources. The second barrier was the lack of sugarcane revenues from sugar mills. Other issues included agriculture facilities, a lack of plant protection chemicals, a lack of high yield sugarcane varieties, a lack of seed at the right time, and a lack of technical knowledge. The opportunities lie in strengthening the extension services, better use of machinery to tackle labor problems, having precise knowledge about input management, crop planning and budgeting, disposal of farm produce and market information.

Singh. *et al.* (2022) revealed that, in terms of production restrictions, a lack of labor facilities during peak periods ranked-I. (59.78 percent). Pest and disease hazards were ranked-II (59.57 percent), which could be attributable to improved pest-management measures and high

pesticide costs ranked-III (57.18 percent), as well as unfavorable weather ranked (57.18) percent. Non-availability of fertilizers on time (31.88 percent) was the next least severe constraint. Again, due to financial restrictions, high labor wage rates ranked I (61.67%), high borrowing interest rates ranked II (41.88%), scarcity of adequately trained labor ranked III (38.43%), and expensive enhanced technology rated IV (29.23 percent). Lack of storage facilities placed first (37.28 percent), followed by a lack of adequate marketing channels (34.67 percent), high marketing and transportation costs (30.90 percent), and a lack of proper marketing facilities (23.65 percent) in terms of marketing restraints.

Singh *et al.* (2022) studied the constraints faced by the farmers in adoption of farming system approach in Terai zone of Uttar Pradesh. The study was carried out in the Terai region of Uttar Pradesh. Information gathered from 400 respondents using the interview schedule. According to the research, the respondent adopted an integrated farming system that included crops and dairy, crop and livestock, crop and vegetables. In the Terai Zone of Uttar Pradesh, the major challenges reported by respondents included "heavy capital investment, lack of inputs availability, lack of infrastructure facility and fragmented landholdings, lack of knowledge about value addition, unskilled family labor, non-availability of improved varieties of seed / breeds at farm site, and lack of technical knowledge."

RESEARCH METHODOLOGY

In this chapter, characteristics features of the area selected for the study, the methods used in the sampling, the nature and sources of data and statistical tools/techniques employed in data analysis are discussed.

The methodology is presented under the following headings:

1. Selection and description of study area
2. Sampling procedure
3. Nature and source of the data
4. Analytical tools and techniques

Selection of study area

In the Eastern Uttar Pradesh, there are 27 districts. Although the sugar mills are initiated in the eastern Uttar Pradesh, the production of sugarcane is less as compared to the Western Uttar Pradesh, which is a major area of concern. In the Eastern Uttar Pradesh, Ayodhya is producing 1671765 tonnes of sugarcane in the area of 21844 hectares which is about 20% of the total agricultural land of the district. Sugar production and Jaggery making in Ayodhya has been carried out traditionally since generations. The district mainly produces sugar, jaggery and other value-added jaggery-products. The Government of India has recognized the district for its jaggery production under the 'One District One Product' scheme as sugarcane, the raw material required for making jaggery, is present here in abundance.

Sampling procedure

Purposive sampling followed by snowball sampling was adopted for the study to collect the necessary information from all the actors who are involved in the value chain of sugarcane.

Primarily, the information regarding the production, marketing and other aspects of the value chain was collected from farmers. This was followed by interviewing the Sugarcane Development Cooperative Societies, processors, wholesalers, retailers and consumers to collect the information regarding marketing and value chain aspects. The details of the respondents such as growers/farmers and various stakeholders are given in the table. For the selection of farmers, the total sugarcane cultivators list was ascertained from village records possessed by the Village Pradhan and with the help of an online portal 'e-Ganna'.

Marginal farmers, small farmers and medium farmers were considered for the purpose of selection of the sample farmers. The rest of actors involved in the sugarcane value chain were selected based on snowball sampling. In Ayodhya district, sugarcane was processed in two forms viz., sugar and jaggery. Therefore, while selecting the sample proper care was taken to have the representation the actors involved in both channels were considered. All 11 blocks of Ayodhya has been considered for the survey from which a sample size of 90 was taken while doing the study which included the following:

Table 3.1: Number of Respondents involved in study

Category of Respondents	No. of Respondents
Farmers	30
Sahakari Ganna Vikas Samiti (SGVS)	3
Sugar-mills	2
Wholesalers	15
Retailers	15
Consumers	15
Gur (Jaggery) sellers	10

Nature and Sources of Data

The study is based on both primary as well as secondary data. Primary data was obtained from the farmers, commission agents, processors, wholesalers, retailers and consumers using a pre-tested schedule through a personal interview method for evaluating the objectives of the study. The information elicited pertaining to land holdings, educational level, variety of sugarcane, output realized and marketing aspects were collected from farmers. The primary information regarding value chain aspects like mapping, degree of value addition etc. were collected from other players in the sugarcane marketing channel. The necessary secondary information regarding area and production of sugarcane was collected from the Directorate of Economics and Statistics.

Analytical tools and techniques

Statistical tools like bar graphs, line charts etc. have been used for visual representation of the data. Other analytical tools used for the objectives of the study are as follows:

3.1 Trends in growth rates in area, production and productivity.

Compound Annual Growth Rate

The trends in growth rates in area, production and productivity for sugarcane is estimated by using Compound Annual Growth Rates (CAGR). The Compound Annual Growth Rates are estimated by using the following formula:

The exponential compound annual growth rates are estimated by using log linear functions on the time series data on area, production and productivity for sugarcane. The semi log exponential functional form is used to analyze the trend in growth rate, which is one of the appropriate functional forms to estimate the growth rate. That is, the growth rate is estimated by using the following semi log functional form:

$$\text{Log} Y_t = a + bt \dots\dots\dots (1)$$

This equation (1) can be elaborated in details as:

$$Y_t = Y_0 (1+r)^t \dots\dots\dots (i)$$

Taking log on both sides, we get

$$\text{Log } Y_t = \text{Log } Y_0 + t \text{Log } (1+r) \dots\dots\dots (ii)$$

Equation (ii) can be rewrite as

$$Y = a + bt \dots\dots\dots (iii)$$

Where $Y = \text{Log } Y_t$; $a = \text{Log } Y_0$; $b = \text{Log } (1+r)$,

In equation (iii)

$Y_t =$ area/production/ productivity, as the case may be, of sugarcane as discussed above

$a =$ constant

$t =$ Time variable in year (1, 2,...n)

$b =$ Regression Coefficient that shows the rate of change or growth rates in a series

The annual compound growth rate (s) can be worked out by using:

$$\text{Antilog } (b) = \text{Antilog } (\log (1+r)).$$

$$\text{Antilog } (b) = 1+r$$

and

$$r = \text{Antilog } b - 1$$

When multiplied by 100, it gives the percentage growth rate in area, production and productivity of sugarcane. That is, **Compound Annual Growth Rate (CAGR) (%) = $r = (\text{Antilog } B - 1) \times 100$.**

3.2. Forecast the area, production and productivity

ARIMA

In general, an ARIMA model is characterized by the notation ARIMA (p, d, q) where p, d, q denote orders of auto-regression, integration (differencing) and moving average respectively. In ARIMA, time series is a linear function of past actual values and random shocks. A stationary ARIMA (p,d, q) process is defined by the equation

$$Y_t = \phi_0 + \phi_1 Y_{t-1} + \phi_2 Y_{t-2} + \dots + \phi_p Y_{t-p} + \varepsilon_t \omega_1 \varepsilon_{t-1} - \omega_2 \varepsilon_{t-2} \dots \omega_q \varepsilon_{t-q}$$

where, Y_t is the response (dependent) variable at time t . $Y_{t-1}, Y_{t-2} \dots Y_{t-p}$ is the response (dependent) variable at time lags $t-1, t-2, \dots, t-p$ respectively; these Y 's are independent variables. $\phi_1, \phi_2 \dots \phi_p$ is the coefficient to be estimated. ε_t is the error term at time t that represents the effects of variables not explained by the model; the assumptions about the error term are the same as those for the standard regression model. $\varepsilon_{t-1}, \varepsilon_{t-2} \dots \varepsilon_{t-q}$ is the error term that represents the effect of variables not explained by the model. The assumptions about the error term are the same as those for the standard regression model. $\omega_1, \omega_2 \dots \omega_q$ is the coefficient to be estimated.

ARIMA Model Building

(i) Identification

The foremost step in the process of modeling is to check for the stationarity of the series, as the estimation procedures are available only for the stationary series. There are two kinds of, viz., stationarity in 'mean' and stationarity in 'variance'. Visual examination of graphs of the data and structure of autocorrelation, and partial correlation coefficients helps to check the presence of stationarity. Another way of checking for stationarity is to fit a first order autoregressive model for the raw data and test whether the coefficient ' ϕ_1 ' is less than one. If the model is found to be non-stationary, stationarity is achieved by differencing the series.

If 'Xt' denotes the original series, the non-seasonal difference of first order is

$$Y_t = X_t - X_{t-1}$$

The next step in the identification process is to find the initial values for the orders of non-seasonal parameters, p and q. They are obtained by looking for significant autocorrelation and partial autocorrelation coefficients. There are no strict rules in choosing the initial values. Though sample autocorrelation coefficients are poor estimates of population autocorrelation coefficients, still they are used as initial values while the final models are achieved after going through the stages repeatedly.

(ii) Estimation

At the identification stage, one or more models are tentatively chosen that seem to provide statistically adequate representations of the available data. Then precise estimates of parameters of the model are obtained by least squares. Standard computer packages like SAS, SPSS etc. are available for finding the estimates of relevant parameters using iterative procedures.

(iii) Diagnostics

Different models are obtained for various combinations of Auto Regressive and Moving Average individually and collectively. The best model is selected based on the following diagnostics:

- a) Low Akaike Information Criteria (AIC)
- b) Insignificance of auto correlations for residuals (Q-tests)
- c) Significance of the parameters

(iv) Forecasting

The best model selected based on the analysis can be used for the forecasting of area, production and productivity of sugarcane for subsequent years.

3.3 Identify and analyze the major stakeholders in the value chain and map the value chain

Social Network Analysis

A social network is defined as a set of relationships developed among the members of a group. From an abstract perspective, a social network can be a representation of series of nodes and lines in which the nodes describe an individual, a team, an organization, a community or a country and the lines emphasize a relation that has been established between two nodes, based on preferences or necessity (Sandru, 2012). It describes the information, tacit and explicit knowledge that exists within a group of people; each node represents an individual who can act as a knowledge holder (transmitting emotions, values, ideas, experiences, advice, stories, best practices, and so on to others) or as a knowledge receiver (interacting with some of the other members to receive answers to his or her actual or prospective problems).

The application and utilization of social networks in value chain analysis improves each member's and the value chain's overall innovation capability. As a result, network leaders serve as distributors, conveying the picture of what they are as a value chain and what they hope to become. As a result, members have a better understanding of what happens to their products when they leave the factory, what role they play in the larger system (the value chain), and which organizations they should collaborate with more to increase their strengths and reduce their vulnerabilities.

The value chain analysis helps to map the market from producers to end consumers. But too often, the minority sections face exclusion errors because they are not visible or their number/participation is too less. Thus, SNA identifies all such actors and helps us to give them a place in the value chain. The main advantage of this approach is that it does not rely on subjective judgment but on real data. Hence, this approach has been used in this study to identify the flow of product (sugarcane) in the system and thus, arrive at the real value chain.

3.4. To evaluate the cost of cultivation of sugarcane, price spread and the marketing efficiency

(i) Cost of cultivation

Cost of cultivation has been used based on the recommendations of CACP and contains the following components:

Cost A1: All actual expenses in cash or kind incurred in production by owner

Cost A2: Cost A1+ rent paid for leased in land

Cost B1: Cost A1+ interest on value of owned fixed capital assets (excluding land)

Cost B2: Cost B1+ rental value of owned land (net of land revenue) and rent paid for leased in land

Cost C1: Cost B1+ imputed value of family labor

Cost C2: Cost B2+ imputed value of family labor

Cost C3: Cost C2+ 10% of Cost C2 as an account of managerial function performed by farmers

(ii) Total Cost of Marketing

The total cost incurred on marketing of sugarcane by the farmers and intermediaries involved in the process of marketing was computed as:

$$C = C_F + C_{M1} + C_{M2} + C_{M3} + \dots + C_{Mn}$$

Wherein, C = Total cost of marketing

C_F = Cost incurred by producer in the marketing of sugarcane

C_{Mi} = Cost incurred by the middlemen in the market of sugarcane

Marketing margin for the adopted marketing channel was worked out by comparing the prices prevailing at successive stages of marketing. The used prices were related to a particular point of

time and the channels involved in the study are: Producer-Sugar factory- Wholesaler- Retailer- Consumer and Producer- Processor (Gur)- Wholesaler-Retailer- Consumer.

(iii) Marketing margin of Middlemen

This is the difference between the total payment (cost + purchase price) and receipts (sale price) of middlemen (i^{th} agency).

Absolute margin of i^{th} middlemen (A_{Mi}) = $PR_i - (PP_i + CM_i)$

Wherein, PR_i = Total Value of receipts per unit (sale price)

PP_i = Purchase value of goods per unit (purchase price)

CM_i = Cost incurred on marketing per unit.

(iv) Price Spread

Price spread is defined as the difference between the price paid by the consumer and the net price received by the producer for an equivalent quantity of farm produce.

Price spread = Price paid by consumer - Price received by producer

The costs included in price spread are:

- i) The cost involved in moving the product from the point of production to the point of consumption (marketing cost).
- ii) The profit of the various market functionaries involved in moving the product from the initial point of production till it reaches the ultimate consumer.

Price spread is inversely proportional to the marketing efficiency.

(v) Marketing Efficiency

According to Acharya (2003), an ideal measure of marketing efficiency, particularly for comparing the efficiency of alternate markets channels should consider all of the following:

- a) Total marketing costs (MC)
- b) Net marketing margin (MM)
- c) Prices received by the farmer (FP)
- d) Prices paid by the consumer (RP)

Further, the measure should reflect the following relationship between each of these variables and the marketing efficiency.

- i) Higher the (a), the lower the efficiency
- ii) Higher the (b), the lower the efficiency
- iii) Higher the (c), the higher the efficiency
- iv) Higher the (d), the lower the efficiency

As there is an exact relationship among four variables, i.e., $a+b+c = d$, any three of these could be used to arrive at a measure for comparing the marketing efficiency.

The following measure is suggested by Acharya,

$$\mathbf{ME = FP \div (MC + MM)}$$

1. To identify the problems and opportunities in the value chain.

(i) Garret's Ranking Technique

The Garret ranking technique (*Garret and Woodworth, 1969; Kathiravan et al., 1999; Kumar and Kumar, 2008, Sedaghat, 2011 and Sushila et al., 2012*) was used to assess the major constraints and opportunities of the intermediaries in the tomato value chain. A schedule with the open-ended question was developed to find out the constraints and opportunities. Various constraints and opportunities for the study were framed, taking into account the reports from the literature available. Prioritization of the constraints was performed using Garrett's ranking methodology as follows:

$$\text{Percent position} = \frac{R_{ij} - 0.5}{N_j} * 100$$

Where, R_{ij} = Rank given for the i^{th} item by the j^{th} , respondent and

N_j = Number of items ranked by the j^{th} , respondent

The percent place values were translated into Garrett values with the aid of Garrett's conversion table. The total scores of each person were then multiplied by Garrett value for each constraint and opportunity, and each score of particular constraint and opportunity were added, and mean score values were determined afterward. The constraint or opportunity with the lowest average value has given the lowest rank and the constraint or opportunity with the highest average value has marked the highest rank.

Description of Study Area

Uttar Pradesh, the heart of India, is a land of epics, holy rivers, ancient cities and pilgrimage. In modern times, it is emerging as a driver of the nation's economy with its network of expressways, industrial corridors, international airports, centers of educational and medical excellence, and an exporter of indigenous products. With over 200 million inhabitants, it is the most populated state in India as well as the most populous country subdivision in the world. The forest cover in the state is 6.1 percent of the state's geographical area. According to census 2011, The cultivable area is 82 percent of total geographical area and net area sown is 68.5 percent of cultivable area. The state is bordered by Rajasthan to the west, Haryana, Himachal Pradesh and Delhi to the northwest, Uttarakhand and an international border with Nepal to the north, Bihar to the east, Madhya Pradesh to the south, and touches the states of Jharkhand and Chhattisgarh to the southeast. It covers 240,928 km² (93,023 sq mi), equal to 7.3% of the total area of India.



Fig 4.1: Map of Uttar Pradesh

Table 4.1: Salient features of the State

Languages	Hindi, Bhojpuri, English, Braj Bhasha, Kannauji, Bundeli, Bagheli, Awadhi, Urdu
Districts	75
Cities & Towns	689
Development Blocks	820
Crops	Paddy, Wheat, barley, Millet, Maize, Urad (Black Gram), Moong (Green Gram) Arhar etc.
Rivers	Ganga, Yamuna, Gomti, Ram Ganga, Ghagra, Betwa

Geography:

Cultivation is intensive in the state. Uttar Pradesh falls under three agro-climatic zones viz. Middle Gangetic Plains region (Zone–IV), Upper Gangetic Plains region (Zone–V) and Central Plateau and Hills region (Zone–VIII). The valley areas have fertile and rich soil. There is intensive cultivation on terraced hill slopes, but irrigation facilities are deficient. The Siwalik Range which forms the southern foothills of the Himalayas, slopes down into a boulder bed called 'bhabhar'. The transitional belt running along the entire length of the state is called the terai and bhabar area. It has rich forests, cutting across it are innumerable streams which swell into raging torrents during the monsoon.

Climate:

Uttar Pradesh has a humid subtropical climate and experiences four seasons. The mean annual rainfall ranges from 650 mm in the southwest corner of the state to 1000 mm in the eastern and south eastern parts of the state. The rain in Uttar Pradesh can vary from an annual average of 170 cm in hilly areas to 84 cm in Western Uttar Pradesh. Given the concentration of most of this rainfall in the four months of the monsoon, excess rain can lead to floods and shortage to droughts. As such, these two phenomena, floods and droughts, commonly recur in the state.

The study is restricted to the Ayodhya district of eastern Uttar Pradesh. There are 27 districts, 117 tehsils, and 341 community development blocks in eastern Uttar Pradesh. The Ganga, Ghaghra, and their tributaries have left behind a lush alluvial plain. The region's agriculture is primarily during the monsoon, but a network of canals also serves as an irrigation system, with 64.94 percent of the land irrigated. In eastern Uttar Pradesh, agriculture is practiced by 88.99 percent of the population (Census of India, 2011). Agricultural infrastructure such as alluvial soil, irrigation, appropriate rainfall, and labor availability are accessible in this region, however adequate raw materials are not available to agro-based companies due to various agricultural and industrial challenges.

Ayodhya District

The study has been conducted in the Ayodhya (Faizabad) district of Eastern Uttar Pradesh. Eastern Uttar Pradesh extends between 23° 51' N to 28° 31' N latitudes and 81° 30' E to 84° 39' E longitudes, covering an area of 85298.79 km² (29.10 percent of the state). Ayodhya is a city situated on the banks of holy river Saryu. It has an average elevation of 93 meters (305 feet). As per the religion data of 2011 Census, the majority population is of Hindu religion with 93.23%, and Muslims comes second with 6.19%.

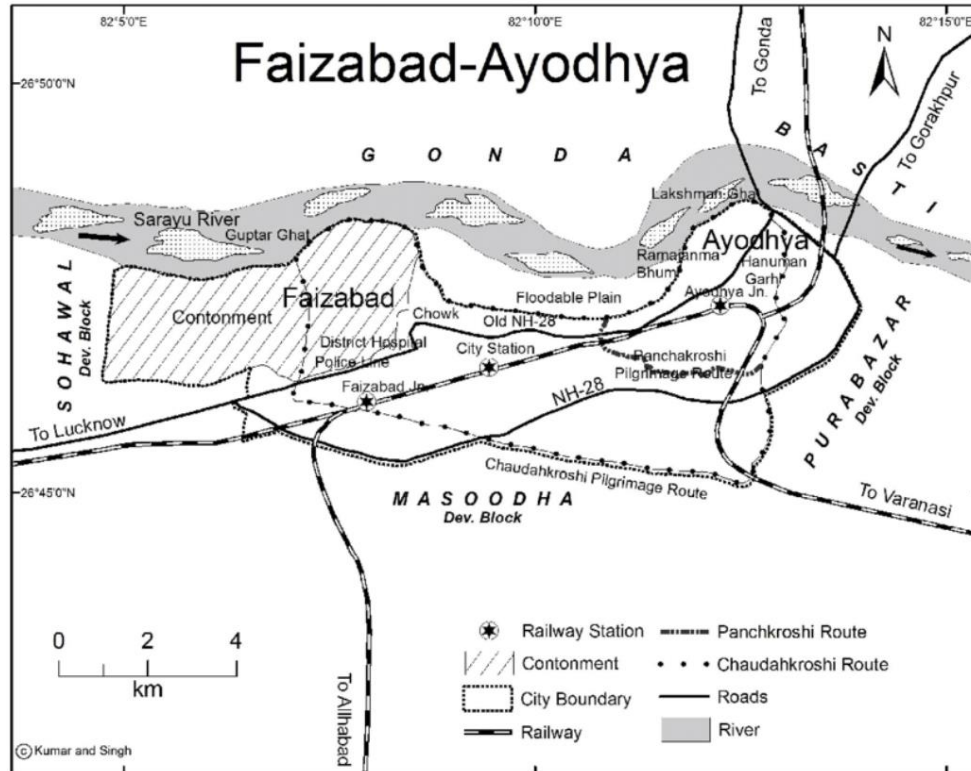


Fig 4.2: Location and extent of Ayodhya District in Uttar Pradesh

Geography and Climate:

Ayodhya district falls under Eastern Plain Agro Climatic Zone (UP-9) and has an area of 2764 km². Ayodhya has a humid subtropical climate, typical of central India. Summers are long, dry and hot, lasting from late March to mid-June, with average daily temperatures near 32 °C (90 °F). They are followed by the monsoon season which lasts till October, with annual precipitation of approximately 1,067 mm (42.0 in) and average temperatures around 28 °C (82 °F). Winter starts in early November and lasts till the end of January, followed by a short spring in February and early March. Average temperatures are mild, near 16 °C (61 °F), but nights can be colder.

According to census 2011, the geographic and demographic details of the district are represented below.

Table 4.2: Demographic details of Ayodhya

Area	2,341 Sq. Km
Total Population	24,70,996
Male	12,59,628
Female	12,11,368
Average Density of Population	1,056 per km ²
Literacy rate	80.03%
Language	Awadhi
No. of Blocks	11
No. of Town Area	3
No. of Gram Panchayats	835
Net Cultivated Area	171000 ha
Net Irrigated Area	123970 ha (approx.)
Total Forest Area	3038 Ha
Annual Rainfall	1067 (mm)

The study area covers all the 11 blocks of Ayodhya district including Sohawal, Bikapur, Milkipur, Masodha, MayaBazar, PuraBazar, Haringtonganj, Amaniganj, Tarun, Mawai and Rudauli.

Sugar Mills in Ayodhya District:

There are two private sugar mills. KM Sugar Mills Ltd. and Balrampur Chini Mills Ltd. There is a distillery at KM Sugar Mills Ltd. The present capacity of KM Sugar Mills Ltd. and Balrampur Chini Mills Ltd. is approx 9500 TCD and 5000 TCD respectively. Collectively, they crushed approx 363.05 Lakh Tonnes of sugarcane and processed 41.94 lakh tonnes in 2018-19. In addition, 17 small scale sugar units (2.51 percent) were operating in the district, employing 70 people (2.85 percent) as of 2020.

RESULTS AND DISCUSSION

(I) Trends in growth rates in area, production and productivity of sugarcane in Ayodhya and Uttar Pradesh

The present section of the study is based on secondary sources of data on area, production, and productivity/yield of sugarcane. The data has been collected from the Directorate of Economics and Statistics (Ministry of Agriculture and Farmers Welfare). In this study, we are considering the data of Ayodhya district and Uttar Pradesh. It is a fair idea to compare the trends in growth rates in area, production and productivity of sugarcane for Ayodhya and Uttar Pradesh.

Table 5.1: Growth rates in Area, Production and Productivity of sugarcane in Ayodhya and U.P.

Variables	CAGR % (Ayodhya)	CAGR % (Uttar Pradesh)
Area	1.47	0.5
Production	3.42	1.68
Productivity	1.94	1.17

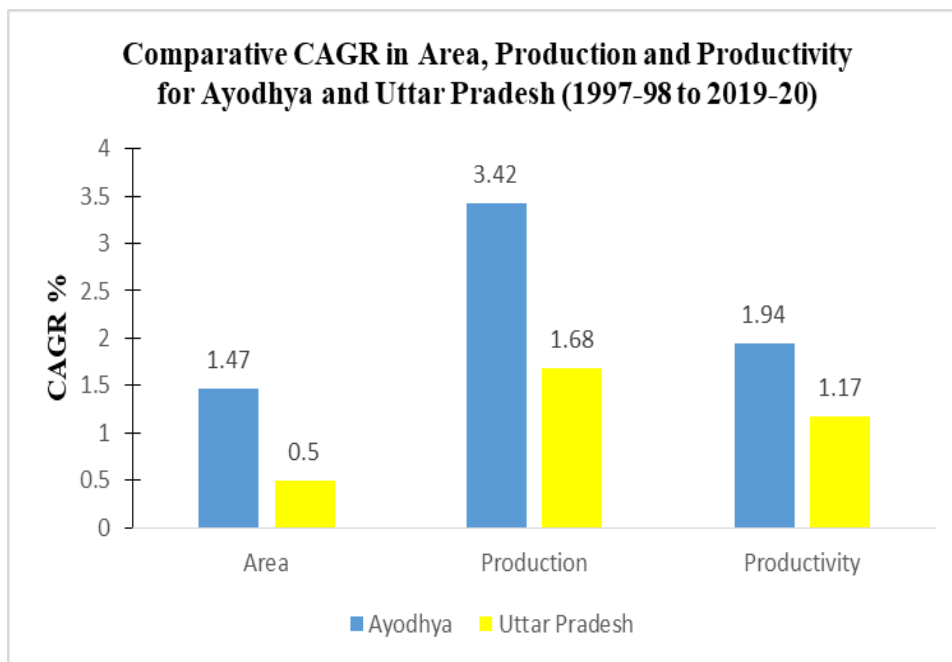


Fig 5.1: CAGR of Area, Production and Productivity of sugarcane in Ayodhya and U.P.(1998-2020)

The growth rate trends in area, production and productivity depend on many factors. For instance, the agricultural productivity in most cases depends on the area sown under the crops and total production of that particular crop. The production of a crop not only depends on area sown under the crop but also affected by technology adopted therein, entrepreneurship and economics of production. Table 1 and figure 1 show the growth rates (CAGR) from 1997-1998 to 2019-20 in the area, production and productivity of sugarcane in the Ayodhya District and Uttar Pradesh.

The area under sugarcane has been increased from 13,894 hectares in 1997-98 to 21844 hectares in 2018-19 and 1985 thousand hectares in 1997-98 to 2151 thousand hectares in 2019-20 for Ayodhya and Uttar Pradesh respectively. The compound annual growth rate (CAGR) of sugarcane area for the period 1997-98 to 2019-20 was 1.47 percent for Ayodhya which shows significant at 1 percent level and 0.50 percent for Uttar Pradesh which shows significant at 1 percent level.

In case of production of sugarcane during the study period, it was increased from 7,30,491 Tonnes in 1997-98 to 16,71,765 Tonnes in 2019-20 and 129267 Thousand Tonnes in 1997-98 to 173816 Thousand Tonnes in 2019-20 for Ayodhya and Uttar Pradesh respectively. The compound annual growth rate (CAGR) of sugarcane production for the period 1997-98 to 2019-20 was 3.42 percent for Ayodhya which was found insignificant and 1.68 percent for Uttar Pradesh which was found insignificant.

Similarly, the productivity of sugarcane during the study period was increasing over the year which was 52.58 Tonnes per hectare in 1997-98 and 76.54 Tonnes per hectare in 2019- 20 and 65.12 Tonnes per hectare in 1997-98 to 80.81 Tonnes per hectare in 2019-20 for Ayodhya and Uttar Pradesh respectively. The compound annual growth rate (CAGR) of sugarcane productivity for the period 1997-98 to 2018-19 was 1.94 percent which was found insignificant and 1.17 percent for Uttar Pradesh which shows significant at 1 percent level.

(II) Forecasting the area, production and productivity of Sugarcane in Uttar Pradesh

The Data on sugarcane area (000' ha), production (000' tonnes) and productivity (tonnes/ha) for a period of 71 years from (1950–1951) to (2020–2021) has been collected from the Directorate of Economics and Statistics, Ministry of Agriculture and Farmers Welfare. The data for a period of 70 years (1950–2020) was used in model building. The remaining one year data (2020–2021) was used for validation of the model.

Model identification and Estimation

The time series for which some n^{th} differences are steady are well-fitted by the ARIMA model. Here, the initial differences of the original data were used to examine the stationarity of the time-series data. The time series data on sugarcane area, production, and productivity were not stationary, according to the stationarity check of time series. The initial differencing produced a stationary time-series for our variables.

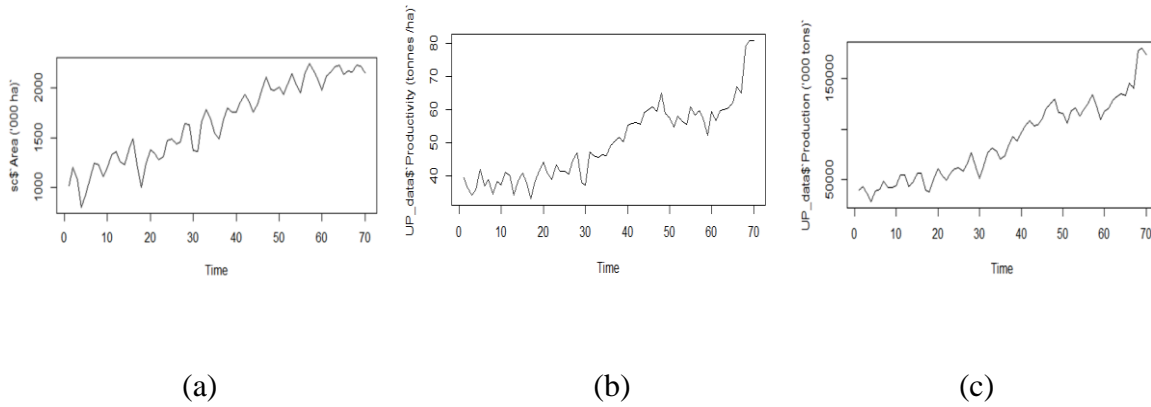


Figure 5.2. (a), (b) and (c): Trend of sugarcane cultivation area, production and productivity of Uttar Pradesh (1951-52 to 2019-20)

We performed the Augmented Dickey Fuller (ADF) test (Table 5.2) to verify the visual results. Since the test statistic was non-significant, it was clear that the initial time-series variables were not stationary. The ADF test, which showed a very significant test statistic for each variable, proved the stationarity of the three variables' time-series at the first degree of differentiation. (Table 2).

Table 5.2: Results of Augmented Dickey Fuller (ADF) test

Variables	Augmented Dickey-Fuller Test	Interpretation
Area	Dickey-Fuller = -2.0007, Lag order = 4, p-value = 0.5749	Non-stationary
Production	Dickey-Fuller = -1.5836, Lag order = 4, p-value = 0.7446	Non-stationary
Productivity	<i>Dickey-Fuller = -1.3664, Lag order = 4, p-value = 0.8329</i>	Non-stationary

After the series had stabilized, graphs of the autocorrelation function (ACF) and the partial autocorrelation function (PACF) were plotted against the lag values, and the results are presented below. We were able to determine the degree of the desired model, or the p and q order of the model, using the autocorrelation function (ACF) and partial autocorrelation function (PACF) plots

(Figure 5.3). The original time-series were not stationary, as shown by the slow decay of the ACF values, and therefore some adjustments are necessary. Due to a fast and gradual decline in area and production, the ACF and PACF of the differenced time-series show that the ARIMA model fits these time-series. The MA model appears to be the model that fits the productivity rate the best.

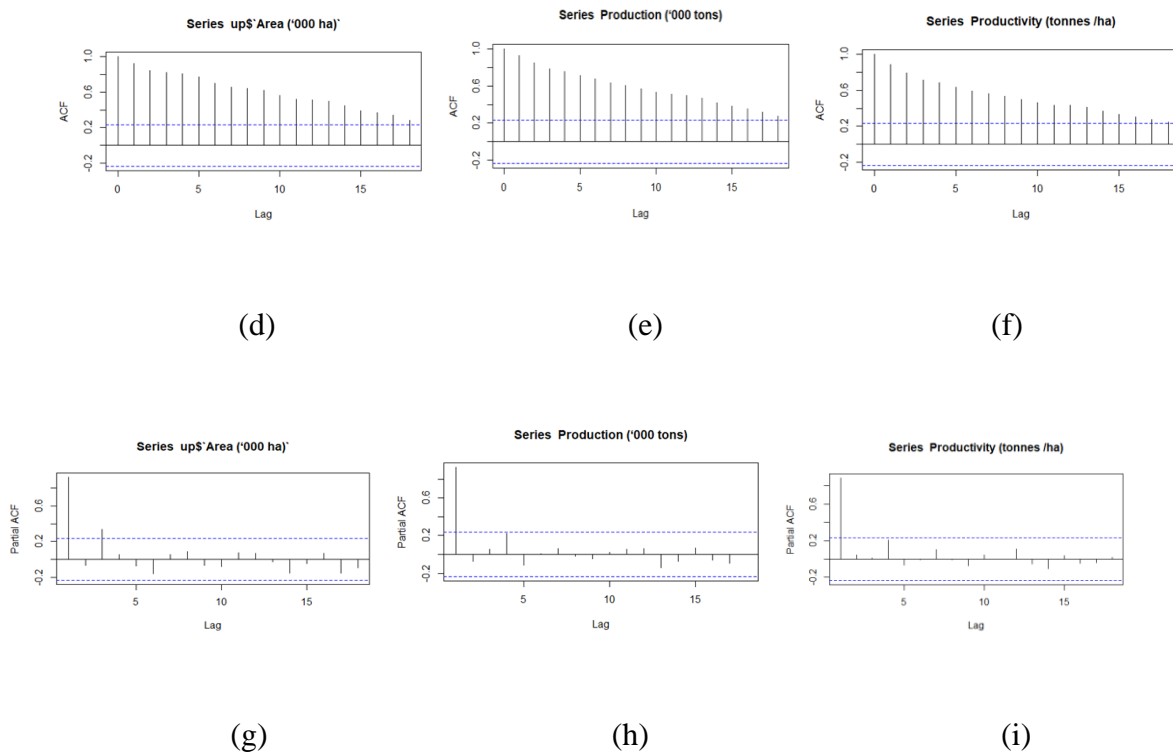


Figure 5.3. (d), (e) and (f): Autocorrelation Function (ACF) plot of the original time-series (g), (h) and (i): Partial Autocorrelation Function (PACF) plot of the original time-series data.

Following the creation of appropriate models, the model parameters (coefficients) of the variables were obtained through the maximum likelihood method (MLE), and the best model was then chosen using the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) as performance metrics. The best-fitted models were further confirmed by the usage of

"auto.arima" in RStudio. The following models for sugarcane area, production and productivity can be developed respectively based on Table 5.3.

Table 5.3: Fitted ARIMA models, and their selection criteria values (AIC and BIC) and estimates of parameters for time series data on sugarcane area, production, and productivity for Uttar Pradesh (1950-51 to 2019-20)

Parameter	AR	MLE	AIC	BIC	Estimate	SE	MAPE
Area	(3,1,0)	-396.13	806.27	821.91	ar1(-0.14)	0.11	3.793
					ar2(-0.36)	0.11	
					ar3(-0.38)	0.13	
					ma1(0.83)	0.11	
Production	(4,1,1)	-716	1441.99	1453.16	ar1(-0.74)	0.14	7.4057
					ar2(0.83)	0.12	
					ar3(-0.73)	0.13	
					ar4(0.38)	0.12	
Productivity	(0,1,1)	-186.7	379.74	386.08	ma1(-0.3708)	0.1184	5.7775

The rightmost column in Table 5.3, a lower MAPE value implies low inaccuracy in forecasting.

Diagnosis of the selected model

It is necessary to check out the presumptions of the ARIMA model before using it for prediction: The residuals should show white noise (i.e., zero mean, constant variance, and zero correlation). The autocorrelation of residuals was checked using the Box-Ljung Q test. The insignificant p-value resulting from Box-Ljung test statistics at 0.05 level of significance (Table 5.4) validated the absence of correlation of residuals of respective models.

Table 5.4: Results of Box-Ljung Test

Particulars	AR	chi-squared	p-value
Area	(3,1,0)	2.1851	0.823
Production	(4,1,1)	1.01	0.9618
Productivity	(0,1,1)	4.5897	0.468

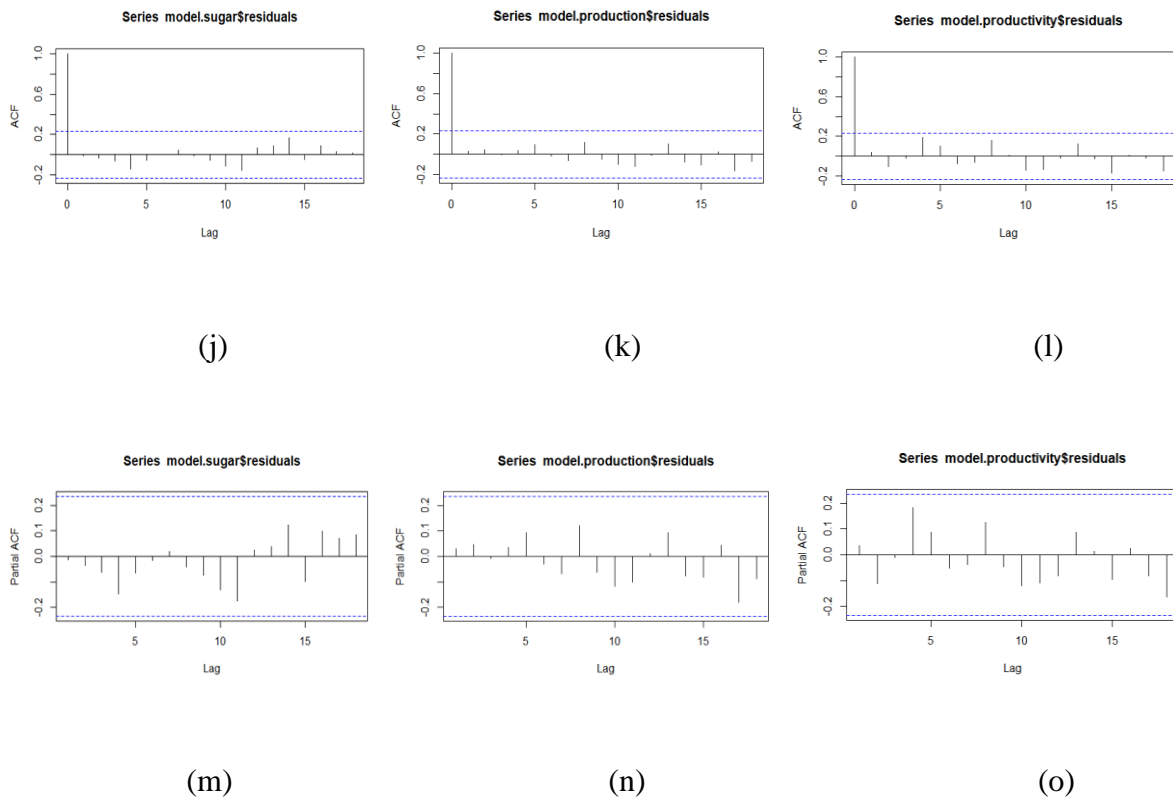


Figure 5.4. (j), (k) and (l): Autocorrelation Function (ACF) plot of the residuals (m), (n) and (o): Partial Autocorrelation Function (PACF) plot of the residuals

The absence of the autocorrelation of residuals and the normality of the residuals showed the accomplished models are the best fit for the given time-series. Further prediction and forecasting of the variables can be done. Hence the Model can be used for Forecasting.

Forecasting using ARIMA Models

The chosen models are made fit for further forecasting after selecting the appropriate model and using it accordingly. Using the ARIMA model of order (3,1,0) for area, order (4,1,1) for production and order (0,1,1) for productivity, the actual data from test series and forecasted values from the model for area, production and productivity of year 2020-21 were compared (Table 5.5).

The table shows the performance of these models during crop year 2020-21 and the forecasts that these models lead to, for the next 4 years.

Table 5.5: Performance of ARIMA Model for sugarcane area, production and productivity

Parameter	Year	Actual value	Point prediction	Relative Error
Area (000'hectares)	2020	2180	2202	-1.01
Production (000' Tonnes)	2020	177262	163323	7.86
Productivity(t/ha)	2020	81.31	80.84	0.58

The results of Table 5.5 indicated that the forecasted value of sugarcane area is slightly higher than the actual values. For sugarcane production the predicted value is lower than the actual value. From Table 5.5, it could be seen that the predicted values are much closer to the observed values for sugarcane productivity.

Based on the best model chosen from the analysis, we have forecasted the 4 years of area, production and productivity of sugarcane in Uttar Pradesh.

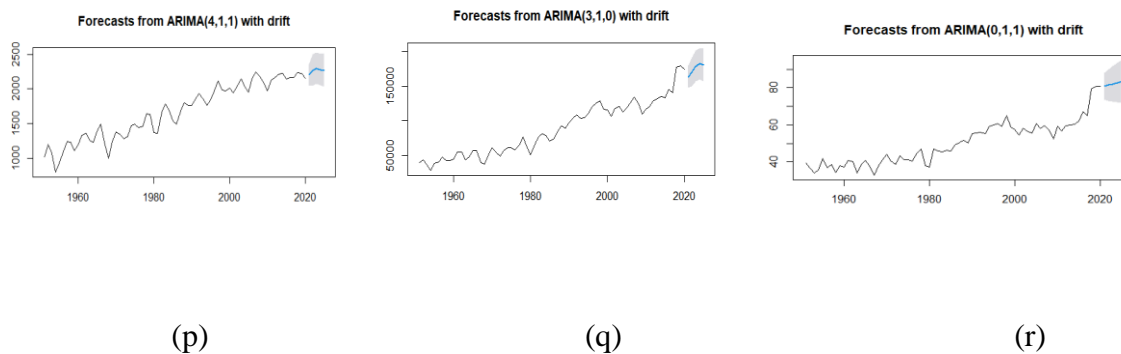


Figure 5.5. (p), (q) and (r): Trend in forecasting of sugarcane cultivation area, production and productivity of Uttar Pradesh (1951-52 to 2019-20).

Table 5.6: Forecasts (2021-22 to 2024-25) by the ARIMA models for sugarcane area, production, and productivity of Uttar Pradesh

Parameters	Years	Forecast	95% interval prediction (Low-High)
Area (000' Hectares)	2022	2268.4	2050.4 - 2353.8
	2023	2299.2	2043.8 - 2493.1
	2024	2277.3	2072.6 - 2525.8
	2025	2265.2	2050.5 - 2504.1
Production (000' Tonnes)	2022	169616.7	149074.4 - 190158.9
	2023	178409.9	156333.8 - 200486.1
	2024	182573.6	160190.1 - 204957.1
	2025	180103.4	156628.4 - 203578.5
Productivity (Tonnes per hectare)	2022	81.4	73.0 - 89.0
	2023	82.1	72.4 - 91.7
	2024	82.7	72.1 - 93.3
	2025	83.3	71.7 - 94.9

The forecasted values of the area, production and productivity of sugarcane from 2021-22 to 2024-25 are presented in Table 5.6, along with 95 % (low and high) prediction intervals. From the table, it can be devised that both area, production and productivity showed increasing forecasted values for the sugarcane crop with successive years. The forecasting for the year 2024-25 resulted in approximately 2265.2 thousand hectares of sugarcane area, 180103.4 thousand tons of sugarcane and 83.3 t/ha productivity.

(III) Socio-economic Analysis of major stakeholders in the sugarcane value chain and Mapping the value chain

The major stakeholders identified in this study are farmers, wholesalers, retailers and consumers.

Socio-Economic profile of farmers

The socio-economic profile of sugarcane farmers has been analyzed in the study. Majority of farmers (33.33 %) belong to the age group of 51 to 60 years, followed by 41 to 50 years (26.67%). The least number of sugarcane farmers are present in the age group of Less than 30 years, corresponding to only 3.33%. The low numbers in the particular age group can be attributed to the rural to urban migration especially among the younger generation in the district.

It is evident that the majority of the sugarcane farmers are educated up to the primary level, which has a major share of 43.33%. This is followed by 26.67% of respondents educated up to Secondary level and 10% of them have completed Higher Secondary level. However, the share of graduate farmers is a bit higher with 16.67% of respondents.

It was observed that the majority (53.33%) of the sugarcane farmers belong to the category of Marginal farmers with less than 1 Ha of land available for sugarcane cultivation. 26.67% of the respondents are small farmers, 16.67% of the respondents are semi-medium farmers and only 3.33% of the respondents belong to the category of medium farmers.

While most of the respondents sell their sugarcanes to the sugar mills, their share corresponds to 66.67%. 33.33% of the respondents also sell their sugarcanes to the gur (jaggery) production units.

Table 5.7: Socio-economic profile of sample sugarcane farmers

S. No.	Particulars	No. of Respondents	Percentage
1	Age Group <= 30 years 31 to 40 years 41 to 50 years 51 to 60 years > 60 years	1 4 8 10 7	3.33 13.33 26.67 33.33 23.33
	Total	30	100
2	Level of Education Primary Secondary Higher secondary Graduation Post-graduation	13 8 3 5 1	43.33 26.67 10 16.67 3.33
	Total	30	100
3	Landholdings (in Ha) Marginal (Less than 1) Small (1 to 2) Semi-medium (2 to 4) Medium (4 to 10) Large (More than 10)	16 8 5 1 0	53.33 26.67 16.67 3.33 0
	Total	30	100
4	Point of sale of sugarcane To sugar Mill To Gur (Jaggery) production center	20 10	66.67 33.33
	Total	30	100

Socio-Economic profile of wholesalers

The socio-economic profile of wholesalers has been analyzed in the study. Majority of wholesalers (33.33 %) belong to the age group of 41 to 50 years, followed by 31 to 40 years (26.67%). The least number of respondents are present in the age group of Less than 30 years, corresponding to only 6.67%. It was seen that the majority of the wholesalers are educated either up to the primary level or secondary level, as both have an equal share of 26.67%. This is followed by 20% share of respondents educated up to each Higher secondary and graduation level. The least share (6.67%) is captured by respondents educated up to post-graduation level. The respondent wholesalers mainly deal in two types of sugarcane value added product, i.e. sugar and gur (Jaggery). Majority of them (66.67%) deal with sugar, followed by Gur (33.33%).

Table 5.8: Socio-economic profile of sample wholesalers:

S. No.	Particulars	No. of Respondents	Percentage
1	Age Group		
	a) <= 30 years	1	6.67
	b) 31 to 40 years	4	26.67
	c) 41 to 50 years	5	33.33
	d) 51 to 60 years	3	20
	e) > 60 years	2	13.33
	Total	15	100
2	Level of Education		
	a) Primary	4	26.67
	b) Secondary	4	26.67
	c) Higher secondary	3	20
	d) Graduation	3	20
	e) Post-graduation	1	6.67
	Total	15	100
3	Products sold		
	a) Sugar	10	66.67
	b) Gur (Jaggery)	5	33.33
	Total	15	100

Socio-Economic profile of retailers

The socio-economic profile of retailers has been analyzed in the study. The sample size has been kept similar in number to the sample of wholesalers. Majority of retailers (33.33 %) belong to the age group of 31 to 40 years, followed by less than years (26.67%). The least number of retailers are present in the age group of greater than 60 years, corresponding to only 6.67%. It was comprehended that the majority of the retailers are educated either up to the secondary level or higher secondary level, as both have an equal share of 26.67%. This is followed by 20% share of respondents educated up to primary level. The least share (13.33%) is captured by respondents educated up to graduation or post-graduation level. The respondent retailers mainly sell two types of sugarcane value added product, i.e. sugar and gur (Jaggery). Sugar is the most popular product sold among the two, corresponding to 66.67%, followed by Gur (33.33%).

Table 5.9: Socio-economic profile of sample retailers:

S. No.	Particulars	No. of Respondents	Percentage
1	Age Group		
	a) <= 30 years	4	26.67
	b) 31 to 40 years	5	33.33
	c) 41 to 50 years	3	20
	d) 51 to 60 years	2	13.33
	e) > 60 years	1	6.67
	Total	15	100
2	Level of Education		
	a) Primary	3	20
	b) Secondary	4	26.67
	c) Higher secondary	4	26.67
	d) Graduation	2	13.33
	e) Post-graduation	2	13.33
	Total	15	100
3	Product sold		
	a) Sugar	10	66.67
	b) Gur (Jaggery)	5	33.33
	Total	15	100

Socio-Economic profile of consumers

The socio-economic profile of consumers has been analyzed in the study. A sample of 15 consumers were taken for the study. Majority of consumers (40 %) belong to the age group of 31 to 40 years, followed by 41 to 50 years (33.33%). The least number of consumers are present in the age group of 51 to 60 years and above 60 years, corresponding to only 6.67% each. It was comprehended that the majority of the consumers are graduates with a share of 46.67%. This is followed by consumers who are post graduated with a share of 33.33%. The rest hold a share of 6.67% each for primary, secondary and higher secondary level of education. Most of the consumers are either private or government employees holding a share of 33.33% each. This is followed by consumers who are self-employed, with a share of 26.67%. Only 6.67% of consumers belong to the unemployed category.

Table 5.10: Socio-economic profile of sample consumers

S. No.	Particulars	No. of Respondents	Percentage
1	Age Group		
	a) <= 30 years	2	13.33
	b) 31 to 40 years	6	40
	c) 41 to 50 years	5	33.33
	d) 51 to 60 years	1	6.67
	e) > 60 years	1	6.67
	Total	15	100
2	Level of Education		
	a) Primary	1	6.67
	b) Secondary	1	6.67
	c) Higher secondary	1	6.67
	d) Graduation	7	46.67
	e) Post-graduation	5	33.33
	Total	15	100
3	Occupation		
	a) Unemployed	1	6.67
	b) Self employed	4	26.67
	c) Private employee	5	33.33
	d) Government employee	5	33.33
	Total	15	100

Identification of value chain actors and Mapping the sugarcane value chain

The following value chain actors have been identified in the sugarcane value chain, starting from the point of production to the point of sales:

Extension services: Extension services provide a crucial link between the sugarcane researchers and the sugarcane farmers. These can either be private or public extension services, which assist and encourage farmers to adopt better farm practices, thereby increasing crop yield. Extension services can be provided by Krishi Vigyan Kendras (KVKs), State and Central Agricultural Universities etc. In the study area, the Directorate of Extension is the center for whole extension activities in the region. Eastern U.P. contains 23 Krishi Vigyan Kendras and 4 Krishi Gyan Kendras. The Ayodhya district has successfully adopted Co 0238 variety of sugarcane through the efforts of extension agents.

Input suppliers: Input suppliers supply inputs like planting material, fertilizers and other agro-chemicals to farmers on cash or credit basis. In case of sugarcane, the sugarcane crop residues are also used as inputs in the field. However, input suppliers in general, can be small retail shops, wholesalers, government agencies, NGOs etc. The farmers of Ayodhya mainly purchase inputs from local dealers and wholesalers.

Farmers/Producers: The sugarcane farmers are the most critical actor in the value chain. They purchase inputs and cultivate the crop, which undergoes value-addition after harvesting. When we confine our discussion to the study area, Ayodhya, we see that most of the cane growers are marginal and small farmers, who do not engage in large-scale production. Their produce enters the market in a limited quantity and prices are decided before-hand. In case of sugarcane, the government also provides Fair and Remunerative Price (FRP), which is fixed by the Central Government.

Commission Agents: Commission agents are a major part of the agricultural value chains. They are a crucial link between the farmers and the market. However, in the case of sugarcane grown in Ayodhya, the role of Commission agent is very limited and they are not clearly visible in the value chain. The usual task of gathering the canes and providing access to the market and points of value addition, is done by **SGVS** (Sahkari Ganna Vikas Samiti). SGVS has its collection centers, especially for those farmers whose distance from the field to market is very large.

Processors/Millers: Processing starts in the sugar mills or the factories dedicated to production of Sugar, Jaggery (Gur) or Khandsari. In the study area, sugar and jaggery are the major value added products. The area contains KM Sugar mill, which is the major hub for the canes grown in the district.

Wholesalers: Wholesalers act as the point of distribution for the value added products of sugarcane. The study area mainly has two kinds of wholesalers dealing with sugarcane products like sugar and Gur. They trade in large quantities and act as a source of supply of these products.

Retailers: The retailers purchase the value added products from the wholesalers on cash or credit basis. They mainly deal in processed products like sugar and Jaggery (Gur).

Mapping the value chain

To map the value chain of sugarcane in the study area, the product flow has been tracked using Social Network Analysis (SNA). The results are as follows:

1) Social Network Analysis for Sugar

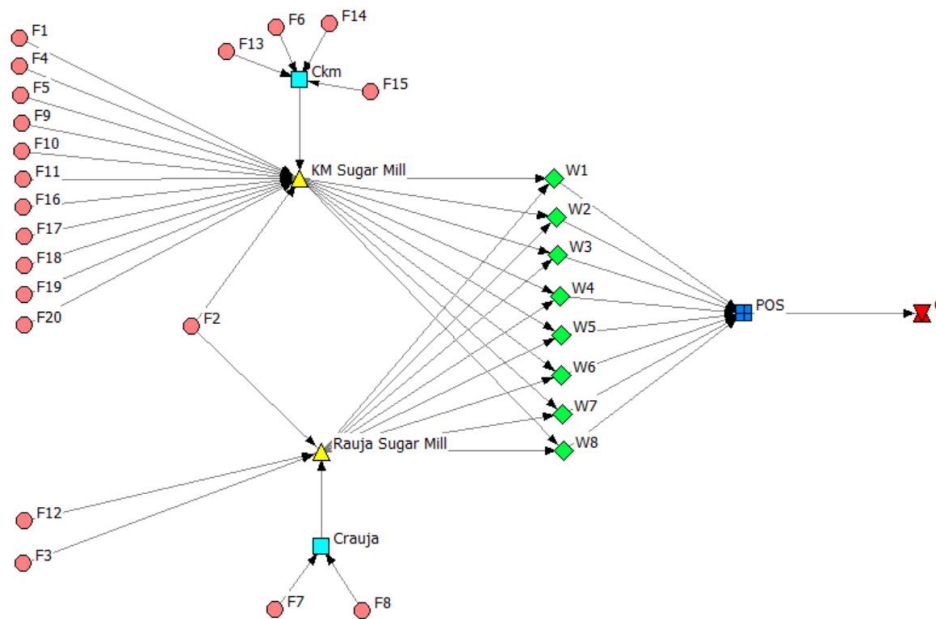


Fig 5.6: Social Network for value chain of Sugar

The above figure is a result of the social network analysis of the data gathered for the first value added product from sugarcane, ie, Sugar. In the analysis, different codes have been assigned to different actors which took the form of different colors and shapes for each. Further, the direction of arrows denote the direction of flow of product. The codes F1 to F20 have been used to denote the farmers, who sell their canes to the sugar mills. There are two sugar mills i.e., KM Sugar Mill and Rauja Sugar mill, which collect canes from the farmers either directly or through collection centers. The collection centers are denoted by Ckm and Crauja in the above figure. KM has 22 collection centers covering 527 villages and Rauja has 10 collection centers covering 126 villages throughout the district. In Ayodhya district, KM sugar mill operates in three regions i.e. Masaudha,

Faizabad and Akbarpur. There are 52 varieties in total that are procured by the mill. These are categorized into Early, General and Reject varieties. The average price paid per quintal for these varieties are:

Table 5.11: Price paid for different varieties of sugarcane

Varieties	Price (Rs per quintal)
Early	350
General	340
Reject	335

The mill is engaged in the production of sugar as a value added product with four major by-products viz. Molasses, Bagasse, Press mud and Ashes. Molasses produced are sent for ethanol production, used in sanitizers, Bagasse is used in paper industry and as fuel, Press mud is used as a farm yard manure and ashes are used for ground filling. The recovery rates of the sugarcane products and by-products, particular to this mill are shown below:

Table 5.12: Recovery percentage of cane products

Cane products and By-products	Recovery Percentage
Sugar	11.33 %
Molasses	3 %
Bagasse	33%

Once sugar is produced in the mill, the final product is sold to the brokers or wholesalers. Packaging and labeling happens in the mill itself. There are 8 brokers tied up with the mill who deal in sugar. The wholesalers are assigned codes from W1 to W8. The retailers purchase these packaged sugar and act as point of sales (POS) for these products. The consumers (C) finally purchase sugar from these retailers for consumption purposes. Hence, the first marketing channel that we got from the SNA can be simplified as C1.

C1: Farmers → Millers (Sugar mills) → Wholesalers → Retailers → Consumers

2) Social Network Analysis for Jaggery (Gur)

Jaggery making in Ayodhya has been carried out traditionally since generations. The district mainly produces jaggery and jaggery-products like sesame gajak, ladoo, chikki, gud ke ladoo etc. Sugarcane, the raw material required for making jaggery, is present here in abundance.

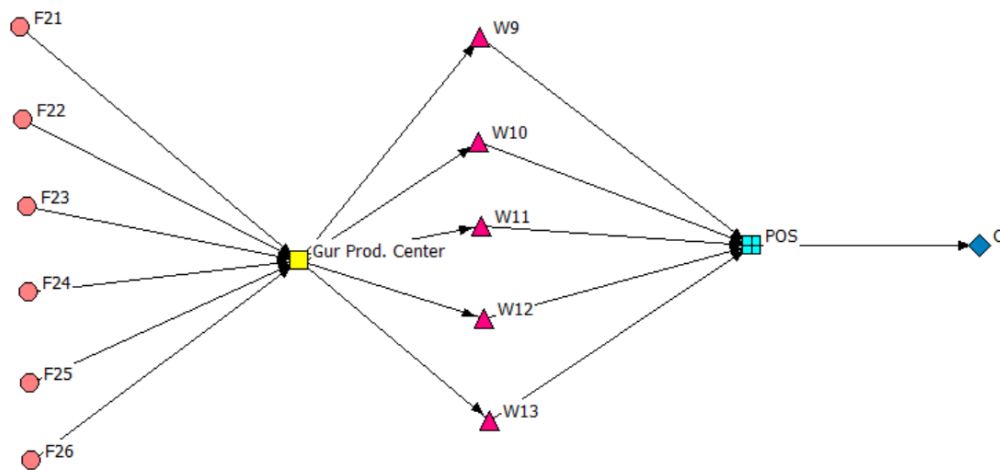


Fig 5.7: Social Network for value chain of Jaggery (Gur)

In the above figure F21 to F26 denote the farmers engaged in cane production. The direction of the arrows show that the canes directly go to the Gur Production center in the district. Since sugar is the major traded product, the volume of canes moving into production of Gur is less. The Jaggery that is produced is sold to the wholesalers (W9 to W13), where it is graded. The wholesalers are the major drivers of the market prices of Jaggery. These graded jaggery products are then sold to small retailers (POS), from where the consumers (C) purchase jaggery. Hence, the second marketing channel that comes out of this is C2.

C2: Farmers → Processors (Jaggery) → Wholesalers → Retailers → Consumers

Hence, two major marketing channels have been identified through the social network analysis, which are:

C1: Farmers → Millers (Sugar mills) → Wholesalers → Retailers → Consumers

C2: Farmers → Processors (Jaggery) → Wholesalers → Retailers → Consumers

With the above analysis, the final value chain of sugarcane can be mapped as follows:

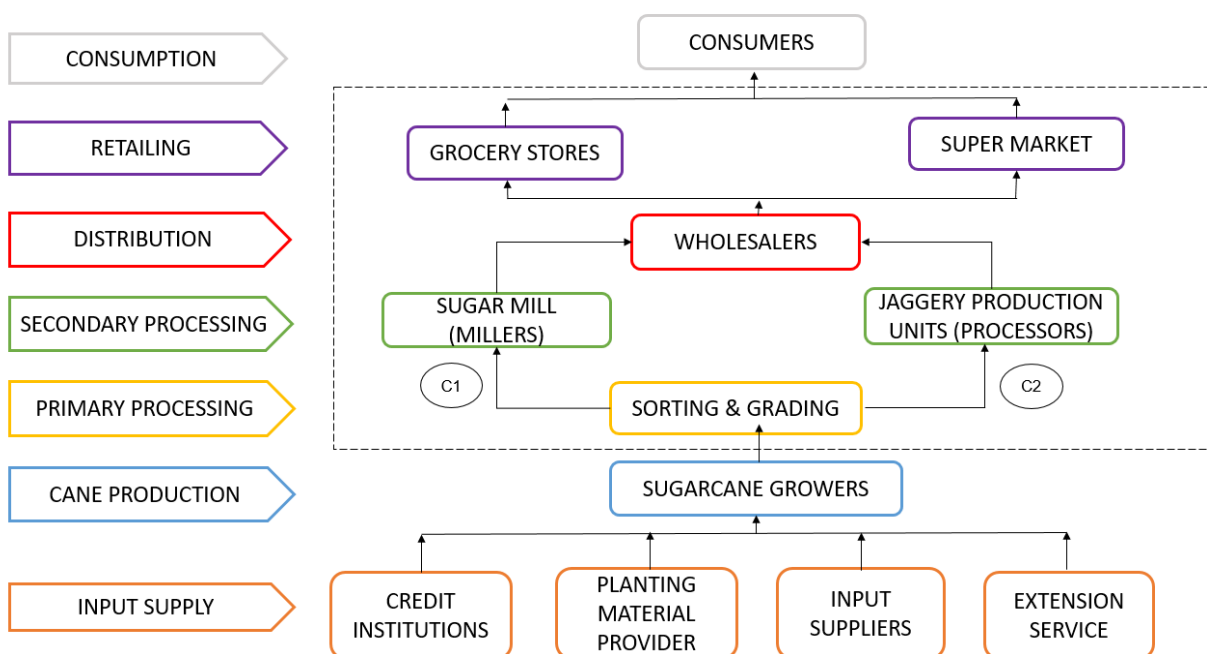


Fig 5.8: Value chain Map for sugarcane for Ayodhya District

The above value chain map shows all the actors involved in the value chain, along with the value chain activity performed by them. Another important institution specific to sugarcane is the Sahkari Ganna Vikas Samiti (SGVS).

Sugarcane Development Cooperative Societies: The coordination between sugarcane farmers and sugar mills is maintained by cane cooperative societies. On the one hand, the cooperative societies assist cane growers by supplying their sugarcane within a predetermined time frame and play a significant role in making cane payments at the rates announced by the

government. On the other hand, by providing hassle-free complete feed supplies of sugarcane according to their needs, the cane cooperative societies are also assisting in the uninterrupted operation of sugar mills. (Sugar Industry & Cane Development Department Uttar Pradesh, *upcane.gov.in*)

(IV) Evaluation of cost of cultivation of sugarcane, price spread and the marketing efficiency of the sugarcane marketing channel under the study area.

Cost of Cultivation of Sugarcane in Ayodhya district

The table 5.13 shows the cost of cultivation of sugarcane calculated for marginal, small and medium and land in Ayodhya district. The large landholders are not engaged in sugarcane cultivation in the study area, hence the cost of cultivation for large land holdings have been omitted. The average cost of cultivation of sugarcane of sample farms was Rs. 100270.69 per hectare. In total variable cost the share was found to be maximum in human labour, followed by the cost of seeds and other inputs. In total fixed cost, the rental value of land in Ayodhya district was Rs 6250 per hectare and Rs 2500 was rent paid for leased-in land. The total cost of cultivation of sugarcane was minimum in marginal farm Rs. 92368.09 per hectare. The other costs are mentioned in detail in the following table.

Table 5.13: Cost of cultivation of sugarcane in Ayodhya district

Particular	Marginal	Small	Medium	Overall
Family labor	21750.34	22650.80	15750.20	18600.44
Human Labor (hired)	2500.30	7500.21	15800.30	11437.73
Machine Labor (owned & hired)	5342.43	5981.64	6595.25	6279.34
Seed	14520.42	14880.30	14950.30	14869.06
Fertilizers	6545.32	8270.77	9617.50	8970.97
Plant protection chemicals	1575.39	1752.31	2065.72	1939.03
Irrigation	1236.45	1552.05	1898.85	1708.18
Rent paid for leased-in land	2500.00	2500.00	2500.00	2500.00
Interest on owned fixed capital assets (excluding land)	0.00	0.00	0.00	0.00
Rental value of owned land	6250.00	6250.00	6250.00	6250.00
Interest on owned land	0.00	0.00	0.00	0.00
Cost A1	53470.65	62588.08	66678.12	63804.74
Cost A2	55970.65	65088.08	69178.12	66304.74
Cost B1	53470.65	62588.08	66678.12	63804.74
Cost B2	62220.65	71338.08	75428.12	72554.74
Cost C1	75220.99	85238.88	82428.32	82405.17
Cost C2	83970.99	93988.88	91178.32	91155.17
Cost C3	92368.09	103387.77	100296.15	100270.69

Table 5.13 shows the cost concepts used for estimation of costs and return by Commission of Agricultural Price and Cost, Government of India. Cost of cultivation of sugarcane of sample farms in the study area has been worked out and presented in Table 5.13. It is envisaged that Cost A1 is designated as the variable cost including land revenue and interest on working capital and excluding family labor was found to be Rs 63804.74 per hectare on overall basis, which was added with rent paid for lease in land and dignified with Cost A2 which was found to be Rs 66304.74 per hectare. Cost B1 is cost A1 added with interest on the value of owned capital assets (excluding

land) which was found to be Rs 63804.74 per hectare. Cost B2 is cost B1 added with rental value of owned land which was found to be Rs 72554.74 per hectare. Cost C1 is cost B1 added with imputed value of family labour which was Rs 82405.17 per hectare. Cost C2 is cost B2 added with imputed value of family labour which is Rs 91155.17 per hectare. Cost C3 is cost C2 included with value of management input at 10% of cost C2 which is Rs 100270.69 per hectare.

Price Spread and Marketing Efficiency

Marketing channels followed in a market:

Based on the survey, it was found that in the marketing of sugarcane, two main products viz, sugar and jaggery are involved. In the first marketing channel (C1) the main players are producers, sugar factories, wholesalers, retailers and consumers. In the second channel (C2) the players are producers, processors (Jaggery), jaggery wholesalers, retailers and consumers.

I. Marketing channel for sugar

C1) Producers → Processors (Sugar Mills) → Wholesalers → Retailers → Consumers

II. Marketing channel for jaggery

C2) Producers → Processors (Jaggery) → Wholesalers → Retailers → Consumers

Marketing costs of actors, between producers and the customer for the services rendered and the remuneration received, are estimated first. With the help of this, marketing efficiency, Price spread were also estimated for the different marketing channels to understand the different aspects of the marketing and price structure, as well as the effectiveness of the system.

Structure of marketing cost incurred by Sugarcane producers/Farmers in different Channels (Rs/ Quintal)

Higher the marketing cost, lower the sugarcane producer's/farmer's net income. Marketing cost is one of the major factors which influence the farmer's income. The farmer was asked a set of questions regarding the cost incurred in the sale of his sugarcane. While selling, Farmers would choose the convenient channel among the identified channels based on marketing cost and price. As per table, generally in the On season, farmers sold their produce to sugar mills with the help of various cooperatives. Sugar mills paid a fixed price to the farmers which was generally higher than the FRP of sugarcane. Since the sugar recovery percentage during the year was approx 10 percent, the cost calculation for 1 quintal sugar processed had to be done by calculating the cost of 10 quintal sugarcane for the producers. During the survey, the price paid by sugar mills to farmers was Rs 3400 per quintal. Producers incurred a marketing cost of Rs 800 per quintal of sugar processed including weighing, loading & unloading, labor cost of harvesting. The time of harvesting in sugarcane is an important part of value addition. Apart from this, sorting in sugarcane also added value to the produce. In sugarcane the total value added cost is approx Rs 50 per quintal sugar processed. The net price received by farmers was Rs 2600 per quintal sugar processed.

Moreover, In the marketing channel of jaggery, the price paid to the farmers was Rs 3100 for 1 quintal of jaggery produced. Since the jaggery recovery percentage during the year was about 10 percent, the cost calculation had to be done for 10 quintal sugarcane for 1 quintal jaggery production. The transportation cost is relatively less as compared to the transportation cost incurred by the sugar processing chain. The value added cost is same for farmers of jaggery processing channel as that of sugar processing channel. The net price received by farmers was Rs 2450 for 1 quintal of jaggery processed.

Table 5.14: Costs for channel C1 and C2 for farmers/producers (Rs/ Quintal)

Particulars	Sugar Marketing Channel (C1) (Rs/ quintal)	Jaggery marketing channel (C2) (Rs/ quintal)
Weighing, loading & Unloading	300	300
Transportation	300	250
Misc.	100	100
Value added	50	50
Total	800	650
Producer's Sale Price	3400	3100
Net price received	2600	2450

Farmers had got a slightly better price of Rs 150 per quintal in the sugar processing value chain (C1) than the jaggery processing channel (C2) because the price paid to farmers for jaggery making was less as compared to the price paid to farmers for sugar processing.

Structure of marketing cost incurred by the sugar/ jaggery Processors (Rs/ quintal)

The sugar processors are the sugar mills, which played a prominent role in the movement of products in a value chain. They were involved in the active participation of purchasing sugarcane from the farmers directly and processed it for sugar and sold it to the wholesalers of the same districts as well as outer districts, towns and states with a considerable amount of margin.

In this process, they incurred marketing costs and played a major role in the value chain. There were many small scale jaggery processing in Ayodhya and that is the reason jaggery comes under the One District One Product (ODOP) scheme launched by Ministry of Food Processing Industries Government of India, lack of infrastructural facilities in production and insufficient price dissemination in jaggery marketing were major constraints faced by jaggery manufacturers in Ayodhya.

In this study, it was found that the cost incurred by the sugar factory was Rs 50 for commission to various Sahkari Ganna Vikas Samitis and other cooperatives and Rs 170 for processing cost or value added cost of sugar per quintal. The sugar factory sold sugar to various interested wholesalers through their online portal. The selling price to wholesalers or brokers was Rs 3750 per quintal sugar. For the jaggery, the total marketing cost incurred by the jaggery processing unit was Rs 210 per quintal jaggery produced. It included Rs 30 for loading and unloading, Rs 30 for labor cost and Rs 150 for jaggery processing (value added cost). The marketing margin received by processors of sugar value chain was Rs 100 per quintal which was comparatively less than the marketing margin received by the jaggery processing unit which was of Rs 290 per quintal jaggery processed.

Table 5.15: Costs for channel C1 and C2 sugar/ jaggery Processors (Rs/ quintal)

Particulars	Sugar Marketing Channel (C1) (Rs/ quintal)	Jaggery Marketing Channel (C2) (Rs/ quintal)
Loading & Unloading	10	30
Processing cost(Value added)	170	150
Labor cost	20	30
Commission to cooperatives	50	-
Total Marketing Cost	250	210
Marketing Margin	100	290
Sugar mill sale price	3750	3600

Structure of marketing cost incurred by the Wholesalers (Rs/Quintal)

In the value chain of sugarcane, wholesalers played an important role. Mainly, primary wholesalers and secondary wholesalers take part in the smooth flow of business. The primary wholesalers procure processed produce directly from processors and sell to the retailers or secondary wholesalers of different towns or states and they handle large quantities of processed produce in a day. However, the secondary wholesalers procure processed produce from the primary wholesalers and sell to nearby retailers.

Table 5.16 shows that the total marketing cost incurred by wholesalers of the sugar value chain was Rs 100 per quintal sugar processed including weighing, loading and unloading, transportation, taxes in which Rs 30 per quintal for value added cost including storage, packing and labor cost. In the marketing channel of jaggery, the total marketing cost incurred by wholesalers was Rs 130 per quintal jaggery produced. It included Rs 20 for loading and unloading, Rs 70 for transportation and Rs 40 for value addition. The wholesalers of sugar marketing channel sold sugar to sugar retailers at a cost of Rs 4000 per quintal and the jaggery wholesalers sold their jaggery to jaggery retailers at a cost of Rs 4100 per quintal so that the marketing margin received by the wholesalers of jaggery value chain was Rs 370 per quintal which was much higher than the marketing margin received by the wholesalers of sugar value chain which is only Rs 150 per quintal.

Table 5.16: Costs for C1 and C2 for Wholesalers (Rs/Quintal)

Particulars	Sugar Marketing Channel (C1) (Rs/ quintal)	Jaggery Marketing Channel (C2) (Rs/ quintal)
loading & Unloading	20	20
Transportation	50	70
Value added	30	40
Total MC	100	130
Marketing margin	150	370
Wholesaler's Sale Price	4000	4100

Structure of marketing cost incurred by the Retailers (Rs/Quintal)

In the study area, retailers are the merchant middlemen who buy processed sugarcane products from the wholesalers for resale directly to ultimate consumers. They represent numerous types of agencies involved in the marketing process such as street vendors, temporary and permanent shop-holders and modern retailers including supermarkets. In terms of undertaking marketing functions their role is no easier compared to wholesalers. In fact a retailer may have to do all the functions of marketing i.e. his job is complex. Retailers are also producers' representatives to consumers.

From the table 5.17 it is revealed that the marketing cost differed with the retailers of respective channels. In the sugar marketing channel (C1), the retailers incurred marketing cost of Rs 110 per quintal which is comparatively less than the marketing cost incurred by the jaggery retailers which incurred cost of Rs 120 per quintal. Although the marketing cost is higher for jaggery retailers, they enjoyed a better marketing margin of Rs 280 per quintal of jaggery sold than the retailers of the sugar value chain which received Rs 90 per quintal of sugar sold. Finally the retailers of the sugar marketing channel sold their sugar to consumers at a cost of Rs 4200 per quintal and the retailers of the jaggery marketing channel sold their jaggery to the ultimate consumer at a cost of Rs 4500 per quintal.

Table 5.17: Costs for C1 and C2 for Retailers (Rs/Quintal)

Particulars	Sugar Marketing Channel (C1) (Rs/ quintal)	Jaggery Marketing Channel (C2) (Rs/ quintal)
Transportation	60	60
Misc. (Shop rent, labor cost)	30	40
loading and unloading	20	20
Total MC	110	120
Marketing margin	90	280
Retailer's Sale Price	4200	4500

Price spread of sugarcane under different marketing channel

Marketing cost, marketing margin and price spread of different marketing channels is paramount important to assess the marketing efficiency of sugarcane. Although the sugar marketing channel was prevalent in and around the Ayodhya district, the study revealed that the price spread was maximum in jaggery marketing channel (Rs 2050 per quintal) than sugar marketing channel (Rs 1600 per quintal) due to the factors such as the net price received by farmers, marketing cost, and marketing margin.

Table 5.18: Price spread of sugarcane under different marketing channels

	Particulars	Sugar marketing channel (C1) (Rs/ quintal)	Percentage share in Consumer's price (%)	Jaggery marketing channel (C2) (Rs/ quintal)	Percentage share in Consumer's price (%)
I	Growers/ Farmers				
	Gross price received	3400	80.95	3100	68.89
	Value added costs	100	2.4	100	2.22
	Total Marketing cost	800	19.0	650	14.44
	Net Price received	2600	61.90	2450	54.44
II	Processors				
	Price paid	3400	80.9	2450	68.89
	Value added costs	170	4.0	150	3.33
	Total Marketing cost	250	6.0	210	4.67
	Marketing Margin	100	2.4	290	6.44
	Price received	3750	89.34	3600	80.0
III	Wholesalers				
	Price paid	3750	89.34	3600	68.89
	Value added costs	30	0.71	40	0.89
	Total Marketing cost	100	2.38	130	2.89
	Marketing Margin	150	3.57	370	8.22
	Price received	4000	95.23	4100	91.11
IV	Retailers				
	Price paid	4000	100.0	4100	91.11
	Value added costs	30	0.71	40	0.89
	Total Marketing cost	110	2.40	120	2.67
	Marketing Margin	90	2.14	280	6.22
	Price received	4200	100.0	4500	100.0
V	Consumers				
	Price paid	4200		4500	
	Price Spread	1600		2050	

Marketing efficiency and producer's share in consumer's rupee for per quintal of processed sugarcane products under different channels

The marketing efficiency of sugarcane has been assessed using Acharya's Revised Approach under two different value chains shown in table 19. For channel-1 (sugar marketing channel), the marketing efficiency was higher (1.60) than the jaggery marketing channel-2 (1.20). Owing to the low consumer's price and high net price received by farmers which made the channel-1 more efficient in the view of the farmer. The data revealed that the producer's share in consumers' rupee was more (61.90) in the sugar marketing channel than of jaggery marketing channel whose producer's share in consumer's rupee was 54.44, it means that the producers of sugar marketing channel were receiving higher price than the price received by the farmers of jaggery marketing channel. Thus, it is concluded that channel-1 (C1) found to be remunerative than channel-2 (C2).

Table 5.19: Marketing efficiency and producer's share in consumer's rupee for per quintal of processed sugarcane under different channels

Particulars	C1	C2
Consumer's purchase price	4200	4500
Net price received by the farmer	2600	2450
Total Marketing cost *	1260	1110
Total Marketing margin *	360	940
Marketing Efficiency	1.60	1.20
Producer's share in consumer's rupee	61.90	54.44

* Total marketing cost and marketing margin includes all intermediaries marketing cost and margins.

(V) Evaluation of constraints and opportunities for the value chain actors

Production constraints faced by Farmers

The production and marketing constraints faced by the farmers in the sugarcane value chain have been identified and ranked according to their importance to the growers with the help of Garret ranking method. The identified constraints are presented in the tables below along with their garret scores. Among the production constraints, the constraint of inadequate credit facilities has got the highest score of 71.3 and has been ranked the most important constraint. It is followed by shortage of labor, which has a garret score of 70.5 close to the previous one and is ranked the second most important production constraint for the farmers. Other important constraints are high wage rates, unavailability of fertilizers/pesticides, lack of irrigation facilities with garret scores of 65.3, 61 and 58.46 respectively.

Table 5.20: Production constraints for farmers

Production Constraints			
S. No.	Constraints	Garret Score	Rank
1	Inadequate credit facilities	71.3	1
2	Shortage of labor	70.5	2
3	High wage rates	65.3	3
4	Unavailability of fertilizers/ pesticides	61	4
5	Lack of Irrigation facilities	58.46	5
6	Losses due to stray animals	50.7	6
7	Lack of technological knowledge	44.7	7
8	Lack of improved varieties	37.03	8
9	Natural calamities	35.8	9
10	Pest and Disease	29.36	10
11	Unavailability of planting material	25.83	11

Marketing constraints faced by Farmers

Among the marketing constraints, low price offered by processors is the most important constraint with a garret score of 70.63. The second important marketing constraint faced by farmers is delayed payment with a garret score of 66.13. Other important marketing constraints are problems in storage, transport unavailability, high transportation cost and high transaction cost with garret scores of 63.10, 59.03, 56.06 and 46.96 respectively.

A farmer faces various other constraints with respect to production and marketing of sugarcane. However, the most critical ones are of importance to us. Other such constraints are indicated in tables below along with their garret scores, depicting their importance to a sugarcane grower.

Table 5.21: Marketing constraints for farmers

Marketing Constraints			
S. No.	Constraints	Garret Score	Rank
1	Low price offered by processors	70.63	1
2	Delayed payment	66.13	2
3	Problems in storage	63.1	3
4	Transport unavailability	59.03	4
5	High transportation cost	56.06	5
6	High transaction cost	46.93	6
7	Intermediaries	44.96	7
8	Low opportunities for selling	32.16	8
9	Lack of processing facilities	31.26	9
10	Price fluctuations	27.7	10

Value Chain Constraints faced by Wholesalers

The constraints faced by wholesalers were ranked according to their garret scores. The most critical constraint is delayed payments with a score of 66.2, followed by lack of proper market infrastructure having score 60.4. Third rank has been given to lack of proper information system with a score of 56.6. Close to this is the lack of proper inventory storage having a score of 54.66. The next two constraints also have scores closer to their predecessors i.e. sorting/grading constraints (53.66) and poor quality of product (46.46).

Table 5.22: Constraints faced by wholesalers

S. No	Constraints	Garret score	Rank
1	Price fluctuation	66.2	1
2	Lack of proper market infrastructure	60.4	2
3	Lack of proper information system	56.6	3
4	Lack of proper inventory storage	54.66	4
5	Sorting/grading constraints	53.66	5
6	Poor quality of product	46.46	6

Value Chain Constraints faced by Retailers

Similar to the constraints faced by farmers, constraints faced by retailers have also been identified in the sugarcane value chain. They have been given garret scores and have been ranked accordingly. According to the results, the most important constraint faced by the retailers is the competition from fellow retailers in the market, which has a high garret score of 64.46. The second most important constraint is the price fluctuation with a garret score of 59.8. However, fluctuations in price is a typical characteristic of commodities belonging to the agricultural sector. Retailers also think that the distance from the market is an important constraint and has a garret score of 55.6. The larger the distance between the point of distribution to the point of sales, the higher is the transaction cost. The problem further aggravates due to lack of proper transportation. This captures the next important constraint with a garret score of 47.66. Other constraints like

information asymmetry and poor quality of product are of relatively less importance to the retailers as indicated by them with low garret scores of 34.6 and 37.86. This might be because the quality of the product can be regulated and the products are priced accordingly. Further, in the case of sugarcane information related to prices and production are available through various sources, hence chances of asymmetry of information are relatively low.

Table 5.23: Constraints faced by retailers

S. No	Constraints	Garret score	Rank
1	Competition from fellow retailers	64.46	1
2	Price fluctuation	59.8	2
3	Distance from the market	55.6	3
4	Lack of proper transportation	47.66	4
5	Poor quality of product	37.86	5
6	Information asymmetry	34.6	6

Value Chain Constraints faced by Consumers

The ultimate objective of studying a value chain is to improve it and create value for the end consumers. For consumers, the higher product price is the most important constraint with a garret score of 62. It is followed by income constraint (54), consumer's distance from the market (45.33) and poor quality of product (38.33).

Table 5.24: Constraints faced by consumers

S. No	Constraints	Garret score	Rank
1	High Price of product	62	1
2	Low Income	54	2
3	Distance from the market	45.33	3
4	Poor quality of product	38.33	4

There are several opportunities existing in the value chain of sugarcane for different actors. These are evaluated using garret scores in the tables below.

Opportunities for farmers in the sugarcane value chain

For farmers, a large number of financial institutions are emerging in the rural area and they may provide loans to sugarcane growers. It will provide easy access to credit to the farmers and has been ranked 1, with a score of 60.66. This is followed by availability of inputs at a subsidized rate and has a score of 56.33. The existence of some established FPOs and sugarcane cooperatives provides the next best opportunity, having a garret score of 51.16. Further market information can be disseminated regularly using local radio channels (45.33). Finally, there is a huge demand for sugarcane as a cash crop in India. This will provide immense opportunities to the cane growers in India and thus has a score of 36.5.

Table 5.25: Opportunities for farmers/producers

S. No	Production/Marketing opportunities	Garret score	Rank
1	Emerging financial institutions	60.66	1
2	Providing inputs at subsidized prices	56.33	2
3	Existence of some established farmer producer organization, cooperative societies.	51.16	3
4	Use of Local F.M. radio to broadcast the market information regularly	45.33	4
5	Large local and regional demand for Sugarcane as a cash crop of India.	36.5	5

Opportunities for wholesalers in the sugarcane value chain

The brightest opportunity available to the wholesalers is the establishment of grades and standards to improve market efficiency and has a garret score of 61.66. The next best opportunity has a very close garret score of 61 and states about the high demand for sugarcane products all over the year. Increasing the number of new markets (48.66), transparency in product delivery from the manufacturer (39.66) and the use of local radio channels to broadcast market information (39) also provide a plethora of opportunities to the wholesalers.

Table 5.26: Opportunities for wholesalers

S. No	Production/Marketing opportunities	Garret score	Rank
1	Establishment of grades and standards to improve marketing efficiency	61.66	1
2	High demand for Sugarcane products all over the year.	61	2
3	Increasing the number of new markets	48.66	3
4	Transparency in product delivery from manufacturer	39.66	4
5	Use of Local F.M. radio to broadcast the market information regularly	39	5

Opportunities for retailers in the sugarcane value chain

The biggest opportunity available to the retailers is the potential for alternative marketing channels and has a garret score of 63. The next best opportunity has a garret score of 60.33 which indicates the high demand for sugarcane products all over the year. Increasing the number of new markets (48.0), developing new sugarcane products to cover more no of consumers (39.66) and the use of local radio channels to broadcast market information (39.0) also provide several important opportunities to the retailers.

Table 5.27: Opportunities for retailers

S. No	Production/Marketing opportunities	Garret score	Rank
1	Potential for alternative marketing channels	63	1
2	High demand for Sugarcane products all over the year.	60.33	2
3	Increasing the number of new markets	48	3
4	Developing new sugarcane products to cover more no of consumers	39.66	4
5	Use of Local F.M. radio to broadcast the market information regularly	39	5

Opportunities for consumers in the sugarcane value chain

Consumers are an important link in the value chain and there are some opportunities available to consumers as well. The availability of a wide range of value added sugarcane products increase the choices available to the consumers. This is of highest importance to the consumers and has a score of 59.6. A good supply of both fresh and processed sugarcane products (53.46) is of second most importance to consumers. They also have a wider range of choice in terms of alternative marketing channels for purchase of sugarcane products, which has a score of 51.33. They have access to various communication media for availing information on prices, which has a garret score of 35.4.

Table 5.28: Opportunities for consumers

S. No	Production/Marketing opportunities	Garret score	Rank
1	Availability of a wide range of value-added Sugarcane products	59.6	1
2	Good Supply for both fresh and processed Sugarcane	53.46	2
3	Potential for alternative marketing channels to purchase sugarcane products	51.53	3
4	The price information is available through different communication media	35.4	4

SUMMARY AND CONCLUSION

The value chain is the comprehensive set of activities necessary to offer a good or service from the point of production to the point of consumption through numerous stages (including a combination of physical transformation and the provision of different consumer services). The present study was done with a similar objective to provide sufficient information about functions and functionaries in the sugarcane value chain. Such knowledge contributed to the pragmatic strategies for eliminating lacunae in the sugarcane value chain and enhancing the market efficiency.

Along with the value chain, we have also forecasted the area, production and productivity of sugarcane. A precise forecast could indicate how to handle surpluses and deficits, maintain prices, and assure farmers' profitability.

Apart from this, the present study was done to analyze the change in area, production and productivity of sugarcane with the objective to find out trends as well as growth rate of area, production and productivity of sugarcane in Ayodhya district as well as Uttar Pradesh.

The study was done using a purposive sampling followed by snowball sampling for all the actors involved in the value chain of sugarcane. The findings of the study were made keeping in view the objectives of the present study, which are as follows-

1. To study the trends in growth rates in area, production and productivity of sugarcane in Ayodhya and Uttar Pradesh.
2. To forecast the area, production and productivity of Sugarcane in Uttar Pradesh.
3. To identify and analyze the major stakeholders in the value chain of sugarcane and map the value chain for Ayodhya district of Uttar Pradesh.
4. To evaluate the cost of cultivation of sugarcane, price spread and the marketing efficiency of the sugarcane value chain in the study area.
5. To identify the problems and opportunities in the sugarcane value chain of Ayodhya district.

The major findings of the present research investigation are given as follows-

1. The compound annual growth rate (CAGR) of area under sugarcane cultivation for the period 1997-98 to 2019-20 was 1.47 percent for Ayodhya and 0.50 percent for Uttar Pradesh.
2. The compound annual growth rate (CAGR) of sugarcane production for the period of 1997-98 to 2019-20 was 3.42 percent for Ayodhya and 1.68 percent for Uttar Pradesh.
3. The compound annual growth rate (CAGR) of sugarcane productivity for the period 1997-98 to 2018-19 was 1.94 percent for Ayodhya as compared to 1.17 percent for Uttar Pradesh.
4. In this study, the ARIMA of order (3,1,0) was the best-fitted model for the forecasting of area of sugarcane and the forecasted area for sugarcane cultivation is 2268 thousand hectares for year 2022 and 2265 thousand hectares for the year 2025.
5. The ARIMA of order (4,1,1) was the best-fitted model for the forecasting of production of sugarcane and the forecasted production for sugarcane is 169616 thousand tonnes for the year 2022 and 180103 thousand tonnes for the year 2025.
6. The ARIMA of order (0,1,1) was the best-fitted model for the forecasting of productivity of sugarcane and the forecasted productivity for sugarcane is 81.4 t/ha for the year 2022 and 83.3 t/ha for the year 2025.
7. The socio-economic analysis of farmers revealed that the majority of the sugarcane growers in the study area were marginal farmers (53.33 percent), followed by small land holders (26.67 percent). The maximum attainment of education level by the value chain actors in the study area were either up to primary or secondary level, indicating a low enrollment in higher studies.

8. The major value chain actors identified in the sugarcane value chain were extension services, input suppliers, farmers/producers, commission agents, processors/millers, wholesalers and retailers.
9. Through social network analysis, two major marketing channels were identified for sugar and jaggery.
For sugar (C1):
C1: Farmers → Millers (Sugar mills) → Wholesalers → Retailers → Consumers
For jaggery (C2):
C2: Farmers → Processors (Jaggery) → Wholesalers → Retailers → Consumers
10. The average cost of cultivation of sugarcane came out to be Rs. 100270.69 per hectare. For marginal lands, the cost of cultivation of sugarcane was Rs. 92368.09 per hectare. For small land holdings, the cost of cultivation was Rs. 103387.77 per hectare. For 1 hectare of medium and large land holdings, the cost of cultivation was Rs. 100296.15 and Rs. 105030.75 respectively.
11. The total marketing cost was higher in the Sugar value chain (Rs 1260 per quintal) compared to the marketing cost in Jaggery value chain (about Rs 1110 per quintal). Total marketing margin was higher in the Jaggery value chain (Rs 940 per quintal) compared to the total marketing margin of the sugar value chain (Rs 360 per quintal).
12. The price spread was higher in channel-2 (Rs 2050 per quintal) than the price spread in channel-1 (Rs 1600 per quintal) because of the higher marketing margin in the jaggery value chain than sugar value chain.
13. The sugar marketing channel was more efficient with a marketing efficiency of 1.60 as compared to the marketing efficiency of the jaggery marketing channel (1.20) because the farmers were being paid more in the sugar marketing channel (Rs 3400 per quintal) than the farmers involved in the jaggery marketing channel (Rs 3100 per quintal) .

14. Constraints in the Sugarcane value chain were analyzed using the Garret ranking method. 'inadequate credit facilities' (71.3 average score in Garrett's ranking) was ranked as the major production constraint followed by 'shortage of labor' (70.5). 'Low price offered by processors' (70.6) was ranked as a major marketing constraint for producers followed by 'delayed payment to farmers' (66.1). The first major constraint faced by wholesalers was 'price fluctuation' (66.2) followed by 'lack of proper marketing infrastructure' (60.4). 'Competition from fellow retailers (64.4) was the major constraint faced by retailers followed by 'price fluctuation' (59.8). The consumers were facing 'high price of product' (62.0) as a major constraint followed by 'low income' (54.0).

15. There were several opportunities analyzed in the value chain of sugarcane using the Garrett ranking method. 'Emerging financial institutions' (66.6) followed by 'providing inputs at subsidized prices' (56.3) were the major opportunities for production and marketing for farmers. For wholesalers, 'establishment of grades and standards to improve marketing efficiency' (61.6) and 'high demand for sugarcane products all over the year' (61.0) were the major opportunities. 'Potential for alternative marketing channels' (63.0) was the major opportunity for retailers followed by 'high demand for sugarcane products all over the year' (60.3). For consumers, 'availability of a wide range of value-added sugarcane products' was the major opportunity followed by 'good supply for both fresh and processed Sugarcane products' (53.4).

Conclusion

The findings of the present study show that sugarcane is a promising crop as far as the Ayodhya district in Uttar Pradesh is concerned. From the results of trend analysis, we can say that the CAGR of sugarcane area, production as well as productivity in Ayodhya is comparatively higher than the CAGR values for these parameters for Uttar Pradesh. This indicates that the area, production and productivity of sugarcane has increased over the years 1997-98 to 2019-20 in Ayodhya. The same rate of change has not been observed in the state.

The forecasts for area, production and productivity of sugarcane are made for the years 2022 to 2025, which show better scope for sugarcane in Uttar Pradesh. For the year 2022, the forecasted area is 2268.44 Ha, the forecasted production is 169616.70 tonnes and the forecasted productivity is 81.46 tonnes per hectare. Both the production and productivity of sugarcane has shown higher forecasted values for the year 2025. Along with identifying the value chain actors and the marketing channels for sugar and jaggery, the study also maps the entire value chain of sugarcane in Ayodhya. This not only clearly shows the involvement of actors but also states the value chain processes. These processes can be identified from the value chain map and efforts can be made for making these processes more efficient. This will improve the entire value chain of sugarcane in Ayodhya. Further, since the marketing efficiency in case of sugar is more, it gives a perspective to the value chain actors regarding resource allocation. An insight into the marketing costs and price spread, as evaluated in the study will help the farmers to get better remuneration and other actors to get better margins. The study also identifies several constraints which are acting as hurdles in the current value chain of sugarcane. These constraints can be mitigated, which will further strengthen the backward and forward linkages resulting in a more efficient sugarcane value chain. The value chain of sugarcane also opens the door to a few opportunities for each stakeholder. Emerging financial institutions in rural areas, high demand for sugarcane products throughout the year and potential for new markets are some of the important opportunities that are aiding in the growth of the sugarcane industry as a whole.

Suggestions

Based on the findings of the present study, the following suggestions are given to sustain sugarcane cultivation and to enhance the economic condition of actors involved in the value chain of sugarcane.

1. In the present study, the ARIMA model forecasted an increment in the production & productivity and decrement in area of sugarcane for the duration of 4 years (2022 to 2025). Thus, in order to shape the production, the sugarcane growers should be given proper information via training, extension activities, policy tools etc. Moreover, the policies for sugarcane in Uttar Pradesh should be planned according to the forecasts for an increased production in the upcoming years.
2. The result of the study revealed that the total marketing margin was found to be higher in sugarcane grown for jaggery preparation than sugarcane grown for sugar production. Hence it is advisable for the marketing intermediaries of the sugar marketing channel to address the existing lacunae and improve the sugar processing and marketing in order to improve the margin.
3. The farmers lose a major chunk of profits to the high labor costs. The government should provide subsidies for the necessary capital-intensive processes (equipment to plant sugarcane stems, de-weeding, and harvesting machines). There should be a provision for hired services so that farmers can get those services at low costs.
4. The study revealed that the delayed payments from the millers to the producers was the major constraint for the farmers. Hence, to address this issue of cane payments not done on time, it is recommended that the government should regulate all private millers and enter into binding agreements which ensure that all payments are done on time. In case of failures, there should be a provision of necessary actions that can be taken against those who default.

5. The sugar sector and its by-products should grow more rapidly in order to guarantee the 28 percent sustainable growth in the income of sugarcane farmers over the next five years. This can be achieved if the industrial usage of by-products and the sugar business both increase faster than anticipated. The scope for development for ethanol, bagasses, and molasses for power generation is significantly high when the full potential of sugarcane by-products is utilized. Realizing the full potential of the byproducts is therefore necessary to maximize the future potential of the sugarcane crop.



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