SOCIO-ECONOMIC ANALYSIS OF KINNOW GROWERS IN RAJASTHAN AND PUNJAB: A COMPARATIVE STUDY

Thesis Submitted for the Award of the Degree of

DOCTOR OF PHILOSOPHY

In

Economics

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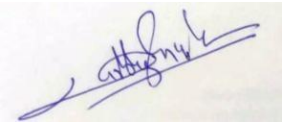
2024

DECLARATION

I, hereby declared that the presented work in the thesis entitled "**Socio-Economic Analysis of Kinnow Growers in Rajasthan and Punjab: A Comparative Study** " in fulfilment of degree of **Doctor of Philosophy (Ph. D.)** is outcome of research work carried out by me under the supervision **Dr. Rajender Singh**, working as **Associate Professor**, in the Economics of Lovely Professional University, Punjab, India. In keeping with general practice of reporting scientific observations, due acknowledgements have been made whenever work described here has been based on findings of other investigator. This work has not been submitted in part or full to any other University or Institute for the award of any degree.



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CERTIFICATE

This is to certify that the work reported in the Ph. D. thesis entitled "**Socio-Economic Analysis of Kinnow Growers in Rajasthan and Punjab: A Comparative Study**" submitted in fulfillment of the requirement for the reward of degree of **Doctor of Philosophy (Ph.D.)** in the **Economics, Mittal School of Business**, is a research work carried out by **Nirbhy Singh** (Registration No.) **41801016,** is Bonafede record of his/her original work carried out under my supervision and that no part of thesis has been submitted for any other degree, diploma or equivalent course.

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ABSTRACT

To analyze the growth trends of Kinnow in terms of area, production, price, and productivity, secondary data from 2010-11 to 2020-2021 was collected. To compare the socio-economic status of Kinnow growers, evaluate the role of supportive infrastructure for expanding the Kinnow production area, and analyze the constraints faced by Kinnow growers in the study area the study collected primary data by conducting personal interviews with Kinnow growers using a structured schedule. Two districts were selected for the study, namely Sriganganagar in Rajasthan and Fazilka in Punjab, both known for their high Kinnow production. Using a multi-stage sampling approach, four blocks were selected, namely Srikaranpur and Sriganganagar in the Sriganganagar district, and Abohar and Khuian-Sarwar in the Fazilka district. These blocks were selected based on their excess Kinnow production. From each block, six Kinnow-producing villages were selected through purposive sampling, resulting in a total of 24 village panchayats. To select participants for the study, 20 Kinnow growers were randomly sampled from each village, resulting in a total of 240 Kinnow growers from Rajasthan and 240 Kinnow growers from Punjab. In total, 480 Kinnow growers were selected for the study. The area under cultivation of Kinnow oranges in Fazilka and Sriganganagar has been increasing, as indicated by the positive slope of the linear trend equation for Fazilka and the exponential trend equation for Sriganganagar. However, the coefficient of determination for Sriganganagar is very low, indicating that the trend is not very strong. The production of Kinnow oranges in both districts has been increasing over time, as indicated by the positive slope of the linear trend equations. The productivity of Kinnow in Fazilka has been increasing, as indicated by the positive slope of the linear trend equation, while in Sriganganagar; it has remained relatively stagnant. Our other objective is to compare socioeconomic and infrastructure status and constraints faced by Kinnow growers. The study suggests that medium-sized farms dominate the Kinnow farming landscape in these regions. The Gini coefficient value for Fazilka indicates a higher degree of inequality in the distribution of landholding among Kinnow farmers as compared to Sriganganagar. a

large proportion of farmers (50.417%) fall in the medium category, indicating a concentration of landholding among a relatively small group of farmers. In contrast, in Sriganganagar, a relatively higher percentage of farmers (72.917%) fall in the medium category, indicating a more equal distribution of landholding among farmers. Looking at the age-wise distribution, we can see that the majority of respondents in both regions are in their middle age. The study shows that the age-wise distribution of respondent Kinnow growers is similar in both regions, with the majority of respondents falling in the age group of 35-40 years. The mean age and standard deviation of the age distribution were also quite similar between the two regions. The study suggests that the Kinnow-growing industry is predominantly male-dominated, with very few female growers. From the Study, it can be inferred that the majority of Kinnow growers in both districts are married. The difference in percentage between the two districts is negligible. The majority of Kinnow growers in all regions belong to the general caste category. However, there are also significant numbers of OBC and SC category respondents in some regions. Overall, the education level of Kinnow growers appears to be relatively high, with a significant number of respondents having completed graduation or post-graduation. The distribution of education levels among respondents is quite similar in both locations. The study suggests that there are more options for senior secondary education near the Kinnow growers in both Fazilka and Sriganganagar. This could have implications for the quality and accessibility of education for young children in these areas. the data suggest that the traditional joint family structure is still prevalent among Kinnow growers in these areas. Understanding family structures is important for understanding the social dynamics and support systems available to Kinnow growers. For example, joint families may provide a built-in support system for agricultural activities, with multiple generations contributing to the labor and knowledge required for successful cultivation. The study suggests that the family size of Kinnow growers in Fazilka and Sriganganagar is similar, with the majority of families having 4 to 8 members. The majority of Kinnow growers in both regions consume electricity in the range of 200 to 600 units per month. The majority

of Kinnow growers in both regions live in villages rather than cities. This could be due to several reasons such as the availability of land for farming, lower cost of living, and a preference for a rural lifestyle. Pucca houses are the most common type of house owned by Kinnow growers in both regions, with a combined percentage of 86.87%. The data suggests that a significantly higher proportion of Kinnow growers in Fazilka, Punjab have access to all-weather roads connecting to their houses compared to Sriganganagar, Rajasthan. The data suggests that a higher proportion of respondents in Fazilka, Punjab have access to paved drains compared to Sriganganagar, Rajasthan. Cooking Gas is the most common source of cooking used by Kinnow growers in both regions. Kinnow growers in both regions rely on a variety of secondary income sources to supplement their farming income. Livestock is the most common secondary income source. The majority of respondent Kinnow growers in both regions have an annual income between 3 to 6 lakh rupees, with a smaller proportion reporting higher incomes. The study suggested that Kinnow cultivation had the potential to improve the socio-economic status. Data suggests that landholding is strongly associated with annual income for Kinnow growers. Study suggests that wheat, cotton, mustard, and barley are among the most commonly grown crops in both locations. A higher proportion of Kinnow growers in Fazilka are involved in the production of biopesticides, fungicides, and organic fertilizers compared to those in Sriganganagar. Canal water is the predominant source of irrigation for Kinnow orchards in these regions. The majority of Kinnow growers in both locations have irrigation water storage tanks available in their orchards. The study suggests that electricity connection is the most commonly used source of energy for irrigation in Fazilka, while in Sriganganagar, a higher proportion of respondents reported using solar panels and diesel for irrigation. This difference may be attributed to the availability and cost of energy sources in the two regions. The study suggests that drip irrigation may be more popular or more commonly used among Kinnow growers in both locations. The study highlights the lack of road connectivity to orchards of Kinnow growers in both districts, with a higher percentage of respondents in Sriganganagar

reporting no road connectivity. The majority of respondents in both regions have bank branches located within a distance range of 5-10 km from their orchards. However, more respondents in Sriganganagar have bank branches located farther away (more than 15 km) than those in Fazilka. Kinnow growers in Fazilka tend to have their nursery plants located closer to their orchards compared to those in Sriganganagar. Study indicates that Kinnow growers in Sriganganagar have to travel longer distances to get their produce waxed, graded, and packed, which could potentially increase their transportation costs and reduce their profitability. Orchards of Kinnow growers in Sriganganagar are slightly away from the nearest cold store (14.96 km) than in Fazilka (13.625 km). The study suggests that there are some differences in the availability of CHCs for Kinnow growers in Fazilka and Sriganganagar. The study suggests that the respondents in Fazilka were closer to the Extension Service Office than the respondents in Sriganganagar. This could have implications for the accessibility of extension services and the effectiveness of outreach programs in these areas. The study highlights the significant challenges faced by Kinnow growers in both Fazilka and Sriganganagar. The constraints related to knowledge, input availability, and environmental factors are the most commonly reported. "Polluted water supply in canals damaging orchards" and Pre-harvest losses due to rapid weather changes are major environmental issues. Kinnow growers in both regions face similar marketing constraints. Lack of information, high input costs, inadequate infrastructure, and low prices are the major challenges faced by these growers. , policymakers could encourage and support farmers to adopt modern farming practices and technologies to improve yield and efficiency. To improve productivity, policymakers could focus on providing technical assistance, such as training and education, to farmers in Sriganganagar, where productivity has remained stagnant. Policymakers could also invest in research and development to identify new and improved varieties of Kinnow oranges that are better suited to local conditions and have higher yields and productivity. Punjab has implemented various measures to promote horticulture crops, such as setting up dedicated offices that have contributed to expanding the area under Kinnow

cultivation and improving orchard management. However, to increase productivity, it is crucial to adopt scientific cultivation techniques and ensure sustainable agriculture practices. Kinnow cultivation requires regular irrigation, which poses a significant challenge in Sriganganagar due to water scarcity. Therefore, the Rajasthan government must extend support and resources to farmers and emulate Punjab's successful Citrus Estate model to enhance yield. Additionally, the uninterrupted regulation of irrigation water can promote Kinnow production. Hence, priority grant-in-aid should be available for the construction of additional 'diggis' (water tanks) in established Kinnow orchards (5-6 years old) under the government's grant-in-aid scheme for canal areas' water management. Additionally, efforts could be made to improve market access for Kinnow oranges, such as developing better transportation infrastructure and strengthening market linkages, to help farmers fetch better prices for their produce and increase their income. Policies and programs aimed at promoting gender equity in the industry are needed, including measures to encourage and support women's participation in Kinnow cultivation and related activities. There is a need for policymakers and researchers to understand the energy usage patterns in agriculture in different regions and to plan for sustainable and cost-effective energy sources for irrigation. Required improving the infrastructure, such as building new roads or improving existing ones, to, better connect orchards to markets. Suggests that there may be a need for more bank branches in Sriganganagar, particularly in areas where farther away bank branch from respondents' orchards, to increase accessibility and convenience for farmers. Need to encourage Kinnow farmers to establish nursery plants in Rajasthan. Need to promote the establishment of new waxing-grading units in Rajasthan. Need to establish more cold store units in both Rajasthan and Punjab. The study recommends that extension services should be decentralized and made available at the village level to improve access. Policymakers and stakeholders need to address the problem of water pollution in canals. Policymakers could consider setting up a system to provide real-time price and export information to growers. In addition, interventions to mitigate canal water pollution, such

as wastewater treatment plants and promoting sustainable farming practices, could improve the productivity of the agricultural sector. Finally, setting up nearby extension services or training programs could help growers access these services and improve their overall productivity.

PREFACE

Completing this PhD work has been one of the most significant challenges of my academic and professional career. It has been a journey filled with highs and lows, but one that has ultimately led me to a better understanding of the world around us.

Over the years, I have been fortunate enough to work with some of the most brilliant minds in various fields, and their influence and guidance have helped shape my thinking and approach to research. This thesis work is a reflection of their collective wisdom and my own understanding of the world.

I am grateful to my supervisor, Dr. Rajender Singh. whose expertise and guidance have been invaluable throughout my academic journey. Their unwavering support and encouragement have been instrumental in shaping my thinking and approach to research.

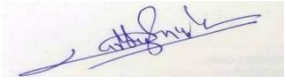
I am also grateful to my family, especially my Father Sardar Sukhdev Singh Sandhu, Mother Charanjeet Kour Gill and Spouse Paramjeet Kaur Sekhon, for their unwavering support and encouragement throughout this journey. Their love and support have been a constant source of inspiration and motivation for me.

To all the participants who took part in the study, I want to express my sincere gratitude for their willingness to contribute their time and effort to this research work. Without their participation, this study would not have been possible.

Finally, I want to express my gratitude to the all-faculty members of economics in Mittal School of Business for providing me with the resources and support necessary to complete this work. Their contribution has been invaluable and has made this work possible.

To all those who have supported me on this journey, I say a heartfelt thank you. Your support and encouragement have been invaluable, and I could not have completed this work without you.

Thank you.



[Nirbhy Singh]

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CHAPTER-1

INTRODUCTION

Agriculture has been the main occupation of society since the beginning of civilization. Although many other occupations have become important for livelihood after industrialization, agriculture remains important even today. A large number of people in the world are still adopting agriculture as a profession for subsistence. In India also a large part of the population is dependent on agriculture, out of which a large part is engaged in the productifon of fruits and vegetables. Horticulture is representative of good health for any nation or society in terms of production, availability, and consumption. Horticulture is a determinant of good health. It is also important in the context of increasing the income of farmers, targeting the nutritional aspect of food security. While the area under horticulture is only 12%, its contribution to agricultural value creation is 24% (Committee on Doubling Farmers' Income, 2017).

Indian horticultural production has gone beyond food grains production to reach 313.85 million metric tons in 2018-19. India has consistently maintained its second position in terms of the production of fruits and vegetables globally. Fruit production in India reached 98.58 million metric tons in the year 2018-19. For India, this production fulfills the requirements of fruits and vegetables in the diet prescribed by "ICMR-EC 2008" 400 grams per person per day. Also very close to completion the estimated demand for fruits and vegetables in" Vision 2030" is 110 million metric tons of fruits and 180 million metric tons of vegetables. The contribution of Indian farmers in fulfilling the food and nutritional security of the nation reflects the entrepreneurship of Indian farmers. Horticulture is a profitable business in terms of income, as well as environmental protection. There has been a steady increase in horticultural production in India in the last few years. An increase in both the area and production of horticulture is reflected. For the past decade, where the area of horticulture has grown at a rate of 2.6% per year, production has increased at a rate of 4.8% per year (Horticulture Statistics Division, 2018).

In India, Citrus fruits are the third most-produced fruit after banana and mango. Citrus fruits are produced on a large scale in India. India ranks third in the world in the production of citrus fruits. China is the largest producer of Citrus fruits and is followed by Nigeria (Food and Agriculture Organisation, 2020).

In the context of the origin of citrus fruits, researchers believe that citrus fruits began to appear in Southeast Asia around 4000 BCE. The trade began during the Roman Empire after spreading to North Africa. By the middle Ages, it spread to Europe, and from there Citrus fruits were also taken to America by Spanish explorers. Although there was no worldwide trade of citrus fruits until the twentieth century. (Langgut, 2017)

In citrus fruits, the yield of mandarin is 11.92 metric tons per hectare, sweet orange 17.65, and other citrus fruits 10 metric tons/hectare show low productivity. However, in the case of sweet oranges, this 17.65 mt/ ha can be considered a satisfactory level. But in this also, there are fluctuations in productivity year by year. In the case of Mandarin and Sweet Orange, productivity has hovered around 11mt/ per hectare for several consecutive years. Due to this stability in production, farmers are attracted to its production. Out of the total area of citrus Fruits, the area of mandarin is 42.67% and the area of lime/lemon fruits is 28.51% (Horticulture Statistics Division, 2018).

India is far behind the global norms in terms of the productivity of citrus fruits. Productivity in India is 12.51 mt/ha. While in other countries Turkey, Indonesia, the United States, and Brazil it is 22 to 35 mt /ha (Food and Agriculture Organisation, 2020). There is potential for substantial improvement in India's situation in terms of productivity.

Development of the Indian Citrus Industry from 1961-2018

From 1961 to 2017-18, the area under citrus fruits in India increased from 90,700 hectares to 10.77 lakh hectares, thus registering an 11-fold increase. Production during that period increased from 823000 tonnes to 125.10 lakh tonnes. The average annual growth rate during the year 1961 to 2017-18 has been 17.40 percent in terms of area and 25 percent in terms of production (Horticulture Statistics Division, 2018).

Important Commercial Citrus Fruits of India

Mandarin fruits are cultivated in different parts of India, Nagpur Mandarin in central India, Kinnow Mandarin in North West India, Coorg Mandarin in South India, and Khasi Mandarin in North East India. Mosambi is mainly in Maharashtra, Malta, and Jaffa in Punjab, and Sathgudi in Andhra Pradesh are types of sweet oranges grown by farmers (Ahlawat & Pant 2003).

Mandarin (Citrus reticulata Blanco)

In India, mandarins are the most extensively cultivated citrus fruits, occupying the largest area and accounting for more than 43% of the total citrus production. Different regions grow different commercial cultivars of mandarins such as 'Nagpur' mandarin in Maharashtra and Central India, 'Coorg' mandarin in Karnataka and hills of Tamil Nadu and Kerala, 'Khasi' mandarin in the north-eastern region, 'Kinnow' mandarin in Punjab, Himachal Pradesh, Haryana, Rajasthan, Western UP, and 'Darjeeling' mandarin in Sikkim and West Bengal. The cultivation of 'Kinnow' mandarin has seen remarkable growth in Punjab since its introduction in 1956, with the area under cultivation increasing from 500 hectares in 1970 to 50,360 hectares in 2015-16 (Horticulture Statistics Division, 2018). In the north-western parts of the country, 'Local' mandarin and 'Malta' orange have mostly been replaced by 'Kinnow' due to their better response to inputs and higher returns. 'Nagpur' mandarin has established itself well in Central India, with producing centers in the Vidarbha region of Maharashtra and other states such as Madhya Pradesh and Rajasthan.

Sweet orange (Citrus sinensis Osbeck)

Sweet oranges, also known as tight-skin oranges, constitute a major share of citrus production in India. Different commercial cultivars of sweet oranges are grown in various regions such as 'Mosambi' or 'Musambi' in Maharashtra, 'Sathgudi' in Andhra Pradesh and Telangana, and 'Hamlin', 'Pineapple', 'Jaffa', 'Valencia Late', 'Blood Red' and 'Malta' in Punjab, Rajasthan, and Haryana (Rattanpal et al., 2017).

Acid lime (Citrus aurantifolia Swingle) and Lemon (Citrus limon (L.) Burm.)

Acid lime and lemon together account for nearly 25% of total citrus production in India, with an area of 252,000 hectares. Andhra Pradesh alone has about 45,800 hectares of acid lime cultivation, while other major producing states include Maharashtra, Gujarat, Orissa, and Tamil Nadu. The total production of limes and lemons in the country was 2,546,000 tonnes during 2017-18 (Horticulture Statistics Division, 2018). Limes prefer warm, moderately moist to dry climates, while high rainfall increases the problem of bacterial canker. Therefore, arid irrigated areas suitable for sweet oranges are also suitable for acid lime cultivation (Gora et al., 2019). The commercial cultivar of acid lime is the small round and thin-skinned 'Kagzi', while lemons are grown commercially only to a limited extent in northern and north-eastern states, with 'Galgal', 'Baramasi' and 'Assam' lemons being the most common varieties. Locals in the NEH region grow several landraces of citrus fruits for domestic consumption and medicinal purposes (Singh et al., 2001).

Citrus scenario in Punjab and Rajasthan

Citrus fruits are also cultivated in many districts in Rajasthan. In terms of productivity per hectare, Rajasthan is included in the leading five states in terms of Mandarin fruits (M.orange, Kinnow, Orange) while in the case of sweet orange (Mosambi), it is in the leading four states. The four parameters of productivity set by the horticulture department are blue, green, yellow, and red which are indicative of highest, high, normal, and low productivity respectively. Rajasthan comes under the green criterion (high productivity) in the production of both these fruits is an achievement reflected in the Rajasthan state, geographically largest and hostile conditions and the scarcity of water resources. But Rajasthan is almost behind the big states in terms of area under fruits. Rajasthan has 23190 hectares in 2017-18 under the area of citrus fruits. The area of sweet oranges is only 200 hectares. The area under Lime / Lemon is 2690 hectares. In citrus fruits, Rajasthan has mostly area of Mandarin fruits, which is mainly concentrated in the Jhalawar and Sriganganagar districts. Apart from Kinnow Mandarin, the area of other Mandarin fruits is higher in Jhalawar district while Kinnow Mandarin

has the maximum area in Sriganganagar district. The total area of Kinnow Mandarin in Rajasthan was reported to be 12400 hectares in the year 2017-18. Of which 10781 hectare area was reported in Sriganganagar district alone. According to 2018-19 data the productivity per hectare of Kinnow in Sriganganagar is 22 MT. Total Kinnow production in Sriganganagar was 280000 metric tons. The area of Kinnow Mandarin was 11062 hectares in the year 2011-12; it has become 10781 hectares in the year 2018-19 (Office Report of Assistant Director Horticulture Sriganganagar).

The neighboring state of Rajasthan, Punjab is the largest producer of Kinnow in the country. There are a total of 51649 hectares in the year 2017-18. Punjab produced 1208400 metric tons of Kinnow in the year 2017-18. As per the APP-2013 draft, the target of increasing the area of Kinnow production in Punjab to 80000 hectares was set in the next 5 or 7 years. Fazilka district is the leading district in the production of Kinnow Mandarin in Punjab and all over India. Southern Punjab and northern Rajasthan districts seem to have borders. There is a similarity except for a few points in the agricultural climate. Kinnow Mandarin is being cultivated in an area of 30758 hectares in the Fazilka district in the year 2017-18, with 734962 metric tons of production being received from the Fazilka district. The productivity per hectare in the Fazilka district is 23.39 metric tons (Report of Department of Horticulture Punjab).

In terms of the area of Kinnow Mandarin, although the Sriganganagar district of Rajasthan is far behind the Fazilka district of Punjab, there is not much difference in terms of productivity per hectare. The Abohar region of Fazilka district is famous for the production of Kinnow Mandarin throughout India. At the same time, in Rajasthan, a special geographical identity of Kinnow of Sriganganagar district has developed.

Kinnow and its importance:

The Kinnow mandarin, also known as the Kinnow orange, is a citrus fruit that is a hybrid of the King and Willow-leaf mandarins. It is known for its sweet taste, juicy flesh, and easy-to-peel skin. The Kinnow mandarin is important for several reasons, including:

Nutritional Value: Kinnow mandarins are rich in Vitamin C, Vitamin A, and other essential nutrients that are beneficial for maintaining good health (Khan et al., 2020).

Agriculture: Kinnow mandarins are a major crop in several countries, including India, Pakistan, and China, and provide income and employment opportunities for farmers (Sohi & Matharu, 2018).

Exports: Kinnow mandarins are exported to several countries and can be an important source of foreign exchange for producing countries. Exporting 'Kinnow' mandarins continues to pose challenges, attributed to the rise in competition, evolving market demands, and hurdles in accessing markets (Malik et al., 2014, August).

Adaptability: Kinnow mandarins are adaptable to a wide range of climates and soil types, which makes them suitable for cultivation in many regions.

Climate resilience: Kinnow mandarins are more resistant to adverse weather conditions like frost and drought as compared to other citrus fruits (Gill et al., 1991).

Taste: Kinnow mandarins are known for their sweet and juicy taste, which makes them a popular fruit among consumers.

Health Benefits: Kinnow mandarins are low in calories and high in antioxidants and other beneficial compounds that can help protect against certain diseases.

Versatility: Kinnow mandarins can be consumed fresh, juiced, or processed into various products such as jams, jellies, marmalades, and candies.

Overall, Kinnow mandarin is a valuable crop that offers a wide range of benefits to farmers, consumers, and the economy. In Punjab, the groundwater level is continuously declining in rice and wheat-cultivated areas. Due to this, Kinnow has emerged as a major option for crop diversification. Selling crops on MSP is also challenging due to the government's minimum support price policy setting a procurement target of only 25% of production. Kinnow has now emerged as an important option for the 'study area' with a view to the aspect of crop diversification in the agrarian crisis. During the covid-19 pandemic society understands the importance of vitamin-c Enriched fruits for immunity.

Background of Kinnow production in Rajasthan and Punjab region:-

The credit for bringing it from California to Punjab Agricultural University's Regional Fruit Research Station Abohar goes to Mr. J.C. Bakshi. That is, its first commercial cultivation in India started in the current Fazilka district at the time of independence. Shri Kartar Singh Narula first started commercial farming in Rajasthan's district Sriganganagar in 1952. That is why Mr. Kartar Singh Narula was awarded by former Prime Minister Jawaharlal Nehru the title of 'Udyan Pandit' in 1963 (ICAR-Central Institute of Post-Harvest Engineering and Technology, 2009).

Kinnow production started in the areas of both states just after Indian independence, but in the Punjab region, it expanded faster than in Rajasthan. The area in Rajasthan grew comparatively slowly and most of the increase was in the last decades only. The expansion of Kinnow depends on several important aspects. Profitability is the most important aspect of expanding the area of any crop. Therefore, it is necessary to compare the profitability of Kinnow to compare the expansion of the Kinnow area in both Rajasthan and Punjab. Along with the profitability, the investment in setting up Kinnow orchards and the time it takes to get initial returns is very important. In this view, the landholding of farmers becomes important for the expansion of Kinnow. It is also necessary to compare it in both the states. The development of pre-harvest and post-harvest ancillary activities also has a significant impact on the expansion of a crop. Comparing the level of development of ancillary activities in both states is very useful from the point of view of the expansion of the Kinnow area. Easily available specialist services, development of nurseries, availability of skilled laborers, availability of training services, etc. are important pre-harvest ancillary activities. The level of ancillary activities indirectly affects the area expansion of a crop. In addition, the development of post-harvest ancillary activities is also important in establishing Kinnow orchards. The development of facilities such as the availability of waxing plants, availability of cold chain, availability of packaging facilities, transport, mandi, etc. is also important in this context. Therefore, it is very important to compare the two states from this point of view. What are the challenges and potentials facing farmers in both states in terms of Kinnow

production? It is necessary to study to compare the area expansion under Kinnow. To draw a meaningful conclusion based on the comparison of both states, it's essential to consider various factors and their implications.

SIGNIFICANCE OF STUDY:

A comparative socio-economic study of the two Kinnow Mandarin-producing states Punjab and Rajasthan can be useful in the context of policy formulation. In the context of the area and water resources of Rajasthan, what are the possibilities of expansion in the area of Kinnow Mandarin? A comparative study of the two states may clarify the status of wage employment in other activities related to Kinnow mandarins such as nursery, processing, packaging, waxing, cold chain, roadside fruit selling and harvesting, and other crop work. The technical assistance given to farmers in both the states and the status of institutions promoting Kinnow production can be compared. What is the difference between the two states, and what its implications are? A comparative study of the challenges that Kinnow producers are facing in both states can be useful. Based on these points, both states can get economic benefits in the future through better planning for Kinnow growers. Kinnow is being produced on a large scale in the district of Sargodha in Pakistan on the other side of the international border and is exported internationally. Kinnow production and export is taking place on a large scale from this region of India (Punjab and Rajasthan) and there are more possibilities in it.

RESEARCH QUESTIONS:

1. Are there any differences on the basis of Socio-economic conditions for Kinnow growers between Punjab and Rajasthan?
2. What are the trends and patterns of Kinnow production?
3. What is the role of supporting infrastructure in Kinnow production?
4. What are the challenges faced by Kinnow growers?

RESEARCH OBJECTIVES:

1. To study the trends and patterns of Kinnow area expansion
2. To compare socio-economic status of Kinnow growers
3. To evaluate the role of supportive infrastructure for expanding the Kinnow production area.
4. To analyze the constraints faced by Kinnow growers in the study area.
5. To suggest policy recommendations for the Kinnow growers in Rajasthan and Punjab.

RESEARCH METHODOLOGY:

Scope of study:

There is a lot of potential in the area of Kinnow production. The role of the horticulture sector is worth considering increasing the trend of youth toward farming. In an era marked by agricultural challenges in India, The government is also constantly trying to increase the income of farmers. The government aims to double the income of farmers by 2022 compared to the year 2014. Crop diversification is an important aspect of increasing the income of farmers. The practice of farmers adopting the cultivation of Kinnow excluding traditional crops is also an effort towards crop diversification. Increasing its area in areas likely to produce Kinnow can lead to various benefits. There is ample scope for employment generation in the production of Kinnow and related nursery processing and packaging. So this study may help to improve policymaking.

Research hypothesis:

(1) H0= there is no difference in socio-economic status of Kinnow growers of Punjab and Rajasthan.

H1= There is a difference in socio-economic status of Kinnow growers of Punjab and Rajasthan.

(2) H0= There is no difference in the level of supportive infrastructure for Kinnow between Rajasthan and Punjab.

H1= There is a difference in the level of supportive infrastructure for Kinnow between Rajasthan and Punjab.

Data sources:

The reliability and relevance of research work are determined by reliable data. Both primary and secondary data will be used in the research work.

Primary data sources:

The primary data for this study was meticulously gathered through personal interviews with Kinnow growers, conducted using a structured questionnaire between June and December 2022. To ensure a representative and comprehensive sample, a multi-stage sampling approach was employed.

District and Block Selection

1. District Selection:

Sriganganagar District (Rajasthan): This district was selected due to its prominence in Kinnow production within the state.

Fazilka District (Punjab): Similarly, Fazilka was chosen as it is a key area for Kinnow cultivation in Punjab.

2. Block Selection:

Within each district, two blocks were identified based on their high levels of Kinnow production. In Sriganganagar District, the selected blocks were Sriganganagar and Srikaranpur. In Fazilka District, the chosen blocks were Abohar and Khuian-Sarwar. These blocks were selected to ensure the sample focused on areas with significant Kinnow cultivation.

3. Village Selection:

From each of the four selected blocks, six villages were chosen that were known for their Kinnow production. This resulted in a total of 24 village panchayats: Sriganganagar District (12 villages):

Sriganganagar Block: 13q, Daulatpura, Mahiyan Wali, 15z, 11q, Manphool Singh Wala.

Srikaranpur Block: 14 ff, Malkana Khurd, 7s (Kikkar Wali), Dalpatsinghpura, Fuse Wala, Gulabe Wala (52 gg). Fazilka District (12 villages):

Khuian-Sarwar Block: Danewala Satkosi, Panjkosi, Patre Wala, Diwankhera, Maujgarh, Kallar Khera.

Abohar Block: Kullar, Bhagu, Waryam Khera, Shergarh, Shere Wala, Patti Sadiq.

4. Farmer Selection

In each selected village, 20 Kinnow growers were randomly selected, ensuring that the sample included a diverse range of farmers. This random sampling method was employed to minimize bias and provide a representative sample. The total number of Kinnow growers selected was:

Rajasthan (Sriganganagar District): 240 growers

Punjab (Fazilka District): 240 growers

Total Sample Size: 480 growers

Categorization of Farmers

After selection, the Kinnow growers were further categorized based on two key criteria:

Land-Holding Size:

Farmers were grouped according to the size of their land holdings, which could influence their farming practices and productivity.

Age of Orchard Establishment:

Growers were also categorized based on how long their Kinnow orchards had been established. This distinction is crucial for understanding the impact of orchard age on production techniques and yield.

Implications of the Sampling Methodology

This detailed and systematic sampling approach ensures that the data collected is both representative and robust, reflecting the diversity of Kinnow farming practices across different regions. The equal representation from each village panchayat allows for meaningful comparisons and insights into regional differences.

Table 1.1: Sampling details

State	District	Block	Village panchayat	Farmer
Rajasthan	Sriganganagar	Sriganganagar	13q	20
			Daulatpura	20
			Mahiyan wali	20
			15z	20
			11q	20
			Manphool singh wala	20
		Srikaranpur	14 ff	20
			Malkana khurd	20
			7s(kikkar wali)	20
			Dalpatsinghpura	20
			Fuse wala	20
			Gulabe wala (52 gg)	20
Punjab	Fazilka	Khuian sarwar	Danewala satkosi	20
			Panjkosi	20
			Patre wala	20
			Diwankhera	20
			Maujgarh	20
			Kallar khera	20
		Abohar	Kullar	20
			Bhagu	20
			Waryam khera	20
			Shergarh	20
			Shere wala	20
			Patti sadiq	20
Total				480

Furthermore, the categorization of farmers based on land size and orchard age facilitates a nuanced analysis, helping to identify specific needs and challenges faced by different groups of farmers. This comprehensive dataset can be used to inform policy decisions, enhance extension services, and drive targeted agricultural interventions aimed at improving Kinnow production and supporting farmers in these key agricultural districts.

Land-holding

Marginal: Below 1.00 hectares of land

Small: 1.00-2.00 hectare

Semi Medium: 2.00-4.00 hectare

Medium: 4.00-10.00 hectare

Large: 10.00 hectare and above categories.

Table 1.2: Selected Kinnow grower for study by land size and orchard age

Type of farmer↓	Fazilka (Punjab)							Sriganganagar (Rajasthan)						
Block→	Khuian Sarwar			Abohar				Srikaranpur			Sriganganagar			
Age of orchard in years>	1-4	5-7	8-25	1-4	5-7	8-25	Total	1-4	5-7	8-25	1-4	5-7	8-25	Total
Marginal	1	1	0	1	0	0	3	0	0	0	0	1	0	1
Small	2	3	4	2	2	2	15	1	1	0	1	1	1	5
Semi medium	5	9	29	6	9	31	89	2	3	12	3	3	10	33
Medium	10	11	38	9	12	41	121	11	15	62	11	10	66	175
Large	1	1	5	0	1	4	12	0	3	10	1	4	8	26
Total	19	25	76	18	24	78	240	14	22	84	16	19	85	240

Secondary data sources:

To analyze the growth trends of Kinnow in terms of area, production, and productivity, secondary data from 2010-11 to 2020-2021 was collected. The data was sourced from various governmental entities related to Kinnow, including the Horticulture and Agriculture Departments, published reports, research papers, journals, books, and other plan-related documents. Additionally, data from government offices in the districts of both states was also used.

Analytic tools:

Gini coefficient, Lorenz-curve, etc. techniques are used for economic comparison of income and landholding conditions of selected Kinnow growers. To calculate the Gini coefficient, use the following formula:

$$\mathbf{G = 1 - 2A}$$

Where:

A is the area between the Lorenz curve and the line of perfect equality, normalized by the area under the line of perfect equality.

Other statistics tools like correlation, chi-square test, average, etc. are used.

To calculate the chi-square value for landholding and income relation we can use the formula:

$$\boldsymbol{\chi^2 = \Sigma\ [(O_i - E_i)^2 / E_i]}$$

Where:

O_i *is the observed frequency*

E_i *is the expected frequency*.

To calculate Cramer's V value, we can use the following formula:

$$\mathbf{V} = \sqrt{[x^2 / (\mathbf{n} * (\mathbf{k} - \mathbf{1})]}$$

Where:

x^2 *is the chi-square value, n is the total sample size, and k is the minimum number of rows and columns*

Statistical tools like average, Standard Deviation, t-value were used for analysis. All collected data was analyzed by tables and graphs. The theoretical approach is used for data interpretation and comparison. To study the trend and pattern for Growth in area, production, price, and productivity of Kinnow for 2010-11 to 2020-2021 periods to determine the trends in the area, production, and productivity of Kinnow, the least-square method was applied. The trend was analyzed through linear and exponential models.

Compound Growth Rate:

The exponential function was used to calculate the Compound Growth Rate (CGR) of the area, production, and productivity of Kinnow.

Instability Index:

The instability of the area, production, and productivity of Kinnow was determined through the use of the Coefficient of Variation (CV). This method was used specifically for analyzing Kinnow production in Fazilka and Sriganganagar. The calculated CV was used to determine the variability of the aforementioned factors.

Coefficient of Variance (CV) = [Standard Deviation (σ)/Mean] ×100

A linear trend was established for the area, production, and productivity data of Kinnow over 10 years. The significance of the trend coefficients was tested, and the Instability Index was calculated using the formula proposed by Cuddy and Della (1978), which measured the variation around the trend instead of around the mean.

The questionnaire included sections on the distance of the orchard from various supportive infrastructures: nearest bank branch, nursery plant, waxing/grading/packaging unit, cold store, custom hiring center, fruit market, and extension service office.

Respondents were asked to provide the approximate distances in kilometers to these facilities from their orchards.

The collected data were organized and analyzed to calculate the mean and standard deviation (S.D.) for each type of facility in both regions. The mean distance represents the average distance from the orchards to each facility, providing a measure of central tendency. The standard deviation indicates the variability or dispersion of the distances around the mean, reflecting how spread out the distances is in each region. The mean distances for each facility were compared between Fazilka and Sriganganagar.

To test the hypothesis that there is no difference in the socio-economic and infrastructure status of Kinnow growers in Punjab and Rajasthan, we performed a two-sample t-test for each parameter. The null hypothesis is that there is no significant difference between the two groups, and the alternative hypothesis is that there is a significant difference. For each parameter, we used a formula to calculate the t-statistic:

$$\mathbf{t = (X_1 - X_2) / (S / \sqrt{(n)}}$$

Where

X_1 and X_2 Are the sample means for Fazilka and Sriganganagar, S is the pooled sample standard deviation for that parameter, and n is the sample size (which is the same for both locations).

$$\mathbf{S=\sqrt{\frac{(n_1-1).S_1^2+(n_2-1).S_2^2}{n_1+n_2-2}}}$$

Where:

s_1 = *Sample standard deviation for Fazilka*

s_2 = *sample standard deviation for Sriganganagar*

We compare the calculated t-value to the critical t-value for a two-tailed t-test with a significance level of 0.05

CHAPTERISATION:

Chapter 1: Introduction: The opening chapter highlights the exploration of kinnow production, providing a thorough introduction and background to the subject matter. The research methodology was discussed

Chapter 2: Review of Literature: provides a comprehensive overview of existing research and scholarly works pertinent to kinnow production. It delves into historical perspectives, agricultural and economic aspects, technological advancements, market dynamics, challenges, policy frameworks, and global perspectives, synthesizing valuable insights for further analysis and understanding in the field. while identifying existing research gaps.

Chapter 3: Study area profile: This chapter offers a holistic portrayal of the study area, encompassing various facets beyond Kinnow production. It delves into the geographical, climatic, socioeconomic, and cultural dimensions of the regions under scrutiny, providing a comprehensive understanding of the contextual backdrop for the research. Through an exploration of key features such as land use patterns, demographic trends, infrastructure development, and economic activities, this chapter lays the

groundwork for comprehensively analyzing the dynamics at play within the study area. By elucidating the broader context in which the study is situated, it aims to offer valuable insights into the interplay of various factors shaping the landscape under investigation.

Chapter 4: Trends and patterns of kinnow Production: This chapter serves as a foundational framework for the comprehensive exploration of Kinnow production trends and patterns in Rajasthan and Punjab. The least-squares method, using both linear and exponential models, was employed to determine trends in area, production and productivity of kinnow. In particular, the exponential function facilitated the calculation of compound growth rates (CGR) for these variables. Variability, production and productivity of kinnow field were assessed through coefficient of variation (CV). The resulting CV values provided insight into the variability of these factors, shedding light on stability or fluctuations within the kinnow production landscape.

Chapter 5: Socio-Economic Characteristics: This chapter sets the stage for a comprehensive comparison of socio-economic conditions among Kinnow growers in Rajasthan and Punjab. Through empirical analysis and interpretation, the study seeks to identify patterns, trends, and disparities that can inform targeted interventions to enhance the socio-economic well-being of citrus growers and contribute to the overall development of citrus-growing regions. In this chapter, a comparative analysis of the socioeconomic status of Rajasthan and Punjab has been conducted using primary data sources. Socioeconomic conditions of sampled Kinnow growers have been meticulously identified through the study of primary data.

Chapter 6: Supportive Infrastructure: The chapter outlines the research questions guiding the analysis of supportive infrastructure for Kinnow production expansion. It explores key infrastructure components such as irrigation systems, transportation networks, cold storage facilities, and market infrastructure, examining their adequacy, accessibility, and functionality in Kinnow-growing regions. This chapter sets the stage for a comprehensive investigation into the role of supportive infrastructure in expanding the Kinnow production area.

Chapter 7: Challenges in Kinnow Production: The chapter begins by contextualizing the challenges faced by Kinnow growers within the broader agricultural landscape of Rajasthan and Punjab. The chapter delves into a detailed analysis of the constraints faced by Kinnow growers, drawing on empirical evidence from primary data sources such as surveys, interviews, and field observations.

Chapter 8: Findings, Conclusion, and Scope for Further Research: This chapter is critical as it summarizes the entire study's key findings and provides insights into the research problem's resolution. In the findings section, the researcher presents the study's results, interpretations, and implications. The conclusion section summarizes the study's primary findings, reiterates its significance, and makes recommendations for future research.

CHAPTER-2

REVIEW OF LITERATURE

The review of literature constitutes a pivotal aspect of any research endeavor, serving as the cornerstone upon which new insights and understandings are built. In this chapter, we embark on an exhaustive exploration of existing scholarship concerning the economic viability, utilization, marketing dynamics, and broader agricultural context surrounding Kinnow production. This comprehensive review draws upon a diverse array of research papers and theses dedicated to assessing the economic feasibility of Kinnow cultivation. By synthesizing findings from these studies, we aim to delineate the factors contributing to the economic sustainability of Kinnow production, including input costs, yield variability, market dynamics, and profitability margins. Furthermore, our inquiry extends to investigations into the myriad uses and marketing strategies associated with Kinnow. Through an analysis of pertinent literature, we endeavor to elucidate the diverse applications of Kinnow, ranging from its consumption as fresh fruit to its utilization in processed products and value-added derivatives. Moreover, we aim to discern the strategies employed by stakeholders to capitalize on market opportunities and navigate challenges inherent to Kinnow marketing. In addition to exploring the economic dimensions of Kinnow production and marketing, our review encompasses an examination of studies addressing the agrarian crisis and its implications for citrus growers. By situating Kinnow cultivation within the broader agricultural landscape, we seek to unravel the intersecting factors influencing farmer livelihoods, land tenure patterns, rural economies, and policy frameworks. The studies reviewed in this chapter collectively inform our understanding of the supporting activities essential for fostering a thriving Kinnow sector. By synthesizing insights from diverse scholarly perspectives, we aim to delineate a holistic framework for enhancing the economic viability, sustainability, and resilience of Kinnow production systems in the face of contemporary challenges.

Gill & Gill (1990) have given their views on agriculture development and industrialization, especially on the Pepsi model. The authors draw attention to crop

diversification and its benefits. Expressing consideration of the profit and losses of the Pepsi model in the context of Punjab, the authors called for attention to the economic importance of the agro-processing sector in Punjab. The need to expand the area under fruits and vegetables has also been emphasized. Compared to the foreign-investment-based Pepsi model, they described the cooperative processing model as more beneficial for local farmers. The Pepsi model does not ensure farmer participation anywhere other than raw materials. Hence the demand of farmers, the government needs to promote agro-processing units in the cooperative sector. Consequently, the participation of farmers will be more and more ensured in value addition.

Sharif et al. (2005) studied the marketing of citrus in the context of Punjab province (Pakistan). The main objective of the study was to identify the margins and socioeconomic barriers of different marketing channels. The Punjab province was selected as the largest producer of Citrus in Pakistan through the stratified random sampling intended for the study. Similarly, Sargodha was chosen as the largest citrus-producing district in Punjab, and the largest number of exporters in the district. Sargodha and Bhalwal tehsils were also selected inside the district to produce more. Three villages were selected from both tehsils on a random basis. 10-12 citrus producers from each village were selected with random sampling. As a result of the study, they found that 90% of citrus growers sell their crops on a pre-contract. For this reason, the share of producers in the consumer's purchase price is only 35%. The same contractor's share is 32% and the retailer's share is 20%. Multistage marketing channels absorb most of the profits. Return on Assumed Capital Investment (ROCE) was found to be 16% for contractors, 82% for commission agents, 86% for wholesalers and 164% for retailers. Thus the retailer gets the highest gross return and rate of return. Sargodha district was found to be more coordinated than Multan with other markets like Lahore and Faisalabad.

Ghafoor et al. (2008) this study is related to Tehsil Toba Tek Singh (Pakistan). The study focuses on the marketing challenges of Kinnow growers in 2008. A total of 120 Kinnow growing farmers were selected based on multilevel models. As a result of the study, he found that the main challenges before the farmers were lack of storage, the

monopolistic tendency of intermediaries, delayed payment, etc. are the main problems. Most of the profit in marketing is absorbed by the contractor. The producer gets very little value. Non-availability of storage was found to be the biggest problem in post-harvest activities. The biggest problem in marketing and marketing-related problems was the late payment by the dealer.

Sharma & Ghuman (2009) studied the economics of a shorter form of Kinnow waxing and grading unit. Kinnow is produced on a large scale in Punjab. Which is not possible to market only in local markets. Hence Kinnow has to be taken to distant markets. For which it is necessary to maintain the freshness of the fruit. Their study focused mainly on Punjab. The grading waxing unit set up by the Punjab Agriculture Export Corporation has very little access to farmers. Therefore, a low-cost machine that can perform waxing and grading work on the farm is needed. In this study, they developed a prototype of an on-form waxing machine. It was established on the farm in the January-February 2006 season of Kinnow Harvest. The study found that the payback time of this prototype machine is only 0.73 years compared to the current commercial machines that have a payback time of up to 5 years. The waxing grading capacity of the machine is 300 tons per season. In conclusion, they found that it is easily adaptable for farmers to do waxing and grading work on the farm itself. Its fixed cost is estimated at only 207185.5 rupees. At the same time, the cost of raw material i.e. variable cost was estimated at ₹ 1975272. Considering the net profit of ₹ 1122342.5 and the less payback period, it is eligible to be adopted by the farmers.

Bhat et al. (2011) their study, they considered the cost and returns of Kinnow production. For this, they selected the Rajouri, Jammu, Samba, and Kathua districts of the state of Jammu and Kashmir. Because the area of Kinnow was the highest in these districts of Jammu and Kashmir. Three blocks were selected from each district. 2 villages were selected from each block. The selection of blocks and villages was also done based on the maximum area. Kinnow-producing farmers were selected from each village on a random sampling basis. A total of 108 farmers were studied. The farmers were classified on a marginal, small, medium, and large basis. Because no farmer cultivates more than 7.5

acres of Kinnow, the study focused only on marginal, small, and medium farmers. They used cost-benefit analysis for the study. As a result, they found that the establishment cost in the first year is ₹ 5298 per acre, while the total establishment cost is ₹ 12707 per acre. The total return of Kinnow production is ₹ 6632 per year. As a measure of the economic value of Kinnow production, the net present value was ₹ 7927, internal rate of return 15.42%, cost-benefit ratio 1.52, and payback period 7.6 years. Marketing costs varied across channels at the producer level. Marketing costs were found in Channel First ₹ 450, Second ₹ 375, Third ₹ 303, and Fourth ₹ 203 respectively. Marketing costs are the highest in Channel-I among all channels, with Channel-I being the highest intermediary. Channel-IV has the lowest marketing costs, being the lowest intermediary. Channel-IV is the most efficient in terms of marketing. In Channel-IV, the producer has the highest share of 81% in the price paid by the consumer as compared to other channels. Because Channel-IV is the channel to sell production directly from producer to consumer. Therefore, it is most beneficial in terms of production. However, selling large-scale production directly to the consumer also has its limitations.

Bhat (2012) in his study emphasized that due to powerful intermediaries in the marketing system, present marketing has an inherent tendency to give more benefits to these intermediaries at the cost of apple growers. Problems faced by apple growers are as follows, less area under fruit or holding problem, communication problems, water problems, lack of improved and high-yielding varieties, lack of latest technical know-how, lack of resources, shortage of labor, lack of extension services, prevailing uptake fungicide and pesticide problem, lack of equipment and machinery, lack of servicing facilities for equipment and machinery lack of subsidized inputs, lack of financial availability, timely and insufficient availability of credit, lack of finance at a reasonable rate of interest, the problem faced by the growers in dealing with banks, highly indebted growers, lack of co-operative agencies, lack of availability and quality of pesticide, non - availability of wooden boxes, problems related with post - harvesting operation, a problem associated with apple picking (plucking), grading problem, the problem of proxy

grading, lack of labeling and registered trademark: high financial cost and lack of apni mandi "

Mavi et al. (2012) In their study, Kinnow Marketing considered various types of market models in Punjab to determine their level of efficiency, for which they selected 120 farmers based on random sampling. On a random sampling basis, 6 blocks and in those blocks 12 villages and 10 farmers in each village were also selected. Three local markets Maur, Malout, and Abohar were selected on a random sampling basis and 2 big markets Delhi and Ludhiana were selected on a random sampling basis. In the study, they found that there is ample scope for Kinnow marketing in South West Punjab. The study also shows that farmers who do pre-harvest contracts are at a disadvantage in marketing, as their share of consumer's purchase price is less. Farmers who come and sell their production in the market can make more profit; Farmers have less market information, lack of post-harvest facilities, price fluctuations, and lack of processing facilities, all these are the main obstacles to Kinnow expansion in Punjab. Their article examined that the Increase in area and production of Kinnow in Punjab has brought many problems with its marketing. The various marketing facilities, necessary for the economic disposal of produce, have however not been able to keep pace with the fast-expanding Kinnow industry. In the absence of any planned marketing program, the producers are often deprived of getting good returns and face multiple problems like poor market intelligence, inadequate post-harvest infrastructure, inadequate processing facilities, poor marketing infrastructure, price fluctuations, and malpractices.

Singh (2012) studied the institutional and policy aspects of Punjab's agriculture keeping small farmers in mind. While the size of operational holdings is decreasing in other states, it is increasing in Punjab. Out of all the states of India, operational holdings are highest in Punjab. The root cause of this article is that due to the small farm size, tillage has not been beneficial, and most of the small farmers are either renting or selling their land to big farmers. A large number of small farmers are abandoning farming. In considering the policy aspect, the author has highlighted various aspects of contract form. The contract farming model has been considered by private companies or the state

government. The declining groundwater level and lack of crop diversification have deepened the agrarian crisis in Punjab. In conclusion, he said that small farmers should be made cooperative-based companies and cultivate on a large scale. Market the product more profitably. Government policies should also be framed in such a way that the cultivation of fruits and vegetables can be promoted through crop diversification.

Ahmed et al. (2013) 'Kinnow' mandarin is an attractive and nutritious fruit available only for a short period due to its poor shelf life. The effect of different postharvest treatments and storage conditions on the postharvest quality of 'Kinnow up to 60 days was examined in this study. With the progression of the storage period, TSS and total sugars tended to increase whereas acidity, ascorbic acid, juice content, and overall acceptability decreased. Fruits stored at low temperatures (4±1°C, RH 85-95%%) and Zero Energy Cool Chamber (ZECC) (12-22°C, RH 85-95%) showed a slower rate of physicochemical changes compared to ambient conditions (18-32°C, RH 45-65%). Both waxing and PE-packaging maintained the external appearance of fruits irrespective of storage systems. However, off-flavour development was noticed in PE-packed fruits after 15 days at room temperature and 40 days in cold storage and ZECC. Waxing of Kinnow's mandarin with undiluted Sta-fresh 960 along with low temperature and low-cost storage (ZECC) may be recommended to extend the availability of fruits.

Kaur (2013) Studied the marketing of fruits in Chandigarh. She selected three states: Punjab, Himachal Pradesh, and Uttar Pradesh. From each state, she selected 2 districts for her study. Apple, mango, and Kinnow fruits were selected for study. A total of 240 respondents were selected. In her study, she also focused on the area, production, and yield of fruits she found a compound growth rate in the Kinnow area of 9.1% for the period 1990-91 to 2011-12. She states that in her research "increasing trend was all due to crop diversification and good returns earned from Kinnow crop by growers". She also concluded that in 1999-00 fall in area and production due to drought conditions and less water availability in Kinnow growing areas. Now the water management technology is more efficient and better for Kinnow growers. The study does not focus on all factors of Kinnow area expansion.

Mahajan & Singh (2014) Studied the effect on the shelf life of Kinnow using Shrink film. In the midst of the growing trend of the supermarket, attention was needed to Kinnow's marketing technology. Due to the packing of the polymeric film, the direct effect of the external environment on the fruit is less. For the study, they chose healthy and uniform size 70-72 diameter Kinnu fruits. A molded tray of 6 cell paper was used to hold the fruit. Shrink film tube wrapped on fruit tray and passed through hot-machine. The machine kept the temperature at 165 ° C, and the fruit pack kept in contact with it for 10 seconds. A similar pack was prepared by cling film but was not passed through a hot machine. The packing of both Shrink and Non Shrink Packet fruits was then kept at 18 to 20 ° C temperature and 80 to 85% RH (supermarket condition). Later on physical and chemical analysis of fruits, it was found that shrink film packaging has been more effective than normal packaging. Shrink film packaging increases the shelf life of the fruit and also maintains the quality of the fruit. In supermarket conditions, the shelf life of normal packaging was noted to be 10 days, while the Shrink packaging had a shelf life of 20 days.

Porwal (2014) the study focused on Mandarin farming costs, production, and area growth in Jhalawar district. For this, she selected 60 Mandarin growers on a sample basis. Pirawa and Jhalrapatan two tehsils of Jhalawar district were chosen because these are the main Mandarin producing tehsils. 3–3 villages were selected from both tehsils. The mandarin-growing farmers were divided into three groups based on the establishment of Orchards. Farmers with orchards older than 1 to 5 years old in Group I, 6 to 12 years old in Group II, and more than 12 years old were placed in Group III. This study is related to the agricultural year 2010-11. As a result of the study, they found that the total cost of cultivation of Mandarin is 46933.16 ₹ per hectare/per annum out of which 5941.55 ₹ is the establishment cost and 40991.61 ₹ is the maintenance cost. The total return per hectare from Mandarin farming is ₹ 112000 ₹ per year. The average net return is 65066.84 ₹ per hectare/per annum. In the study, they found that the area growth rate was higher in the period 2001–2002 to 2010–2011 than in the initial phase of economic reforms from 1991–92 to 2000–2001.

Ahmed et al. (2015) this study focuses on evaluating the economic impact of the post-harvest loss of Kinnow in Sargodha district, Pakistan. The district was chosen due to its position as the largest Kinnow producer in Pakistan. Two tehsils, Kotmoman and Bhalwal, were selected for the study as they have the largest production of Kinnow. A total of 40 farmers were chosen randomly, with 20 from each tehsil. The study reveals that post-harvest losses account for 45% of the total production of Kinnow. The loss on the farm makes up 32.4% of the total loss and is the largest contributor. Experience, time of picking, and manner were found to be important factors in reducing farm losses. The study also found an inverse relationship between the size of the orchards and loss. At the wholesale level, loading methods, storage place, and experience were identified as significant factors in reducing losses. At the retailer level, the quantity of unsold produce was found to be the most significant contributor to losses. Post-harvest losses at the wholesale level were 11.2%, and at the retailer level, they were 4.1%. The study concludes that implementing good management practices at the farm level, using effective loading techniques at the wholesale level, and improving storage systems can significantly reduce post-harvest losses.

Bannor & Sharma (2015) studied the socio-economic characteristics of Kinnow growers of Rajasthan. The 2 most Kinnow-producing districts of Rajasthan, Sriganganagar, and Hanumangarh were selected for the study. Similarly, Padampur and Sriganganagar tehsils of Sriganganagar district and Sangaria tehsil of Hanumangarh district were elected. Three villages from Sriganganagar and Padampur tehsils and 4 villages from Sangaria tehsil were chosen on a purposive basis. 10-10 Kinnow farmers from each village were selected through random sampling. A total of 100 farmers were studied. The study used statistical methods like the Gini coefficient, chi-square test, standard deviation, etc. In conclusion, they found that 93% of the farmers' primary occupation was agriculture. The land used by all the farmers was irrigated. 97% of the farmers already had their land, while 3% had purchased land for setting up an orchard. 76% of the farmers were mid-size (from 4.1 ha to 10 ha). Large farmers (more than 10 hectares) were only 11%. The value of the Gini coefficient for land was extremely low at

0.22%, indicating that disparities in land distribution among Kinnow growers are low. The value of Kramer's V was 29.6%, indicating that there is a strong correlation between land size and age. Income inequality among farmers was less than 50%. The Gini coefficient for income was 0.17. The study results indicate that there is a strong correlation between land size and income. 19% of the farmers were educated from primary to post-graduation. Small sample size and without comparing other leading Kinnow growing state results are limited useful for any conclusion.

Kaur et al. (2016) this study examines the economic viability of Kinnow in southwestern Punjab. Fazilka district was chosen based on the area under Kinnow cultivation for study. Two blocks of Fazilka, Abohar, and Khuiyan-Sarwar, were chosen based on maximum area. 43 Kinnow growing villages from Abohar and 25 from Khuiyan Sarwar were arranged in descending order based on the Kinnow area. After this, the 3 most Kinnow area villages were selected from each block. The farmers from each village were arranged in increasing order based on the Kinnow area. The farmers were classified into three categories, small, medium, and large. After this, 100 farmers were selected at random based on their ratio. The average return rate and cost-benefit analysis were used for the study. In the study, they found that the cost of a plantation is 25. 07% of the total cost of setting up the Kinnow orchard. The cost of digging and filling the pits is 20.21% of the total cost. The cost of fencing is 19.77% of the total cost. The initial establishment cost of the Kinnow garden was estimated at ₹ 38802. Operating costs remain low in the early years, as plants grow larger, increasing operating costs. Pruning, fertilizers, and pesticides are the main operating costs. The authors found that where farmers sell produce directly in the market, the profit-cost ratio is 1.53%. Where the farmers sell through the contractor, the profit-cost ratio is 1.26%. The internal rate of return was 30.25% on direct selling in the market, and 19.24% on selling by the contractor.

Kaur & Singh (2016) studied the effect of drip irrigation systems on Kinnow production. Especially in this era of climate change when many regions of the world are facing a crisis in terms of water availability. The availability of water for agriculture is also steadily declining. His study focused mainly on the Sriganganagar district of Rajasthan.

For this, she selected 5 out of 9 tehsils of the district by random sample method. In each tehsil, 60-60 farmers cultivating Kinnow were also selected by random sampling. During his study on a total of 300 farmers, he found that the drip irrigation method has a positive effect on Kinnow production. This results in significant water savings. It is also suitable for areas with less water availability. Ease of fertilizing and efficient use of nutrients along with water savings reduces costs. This also increases the quality of Kinnow production. Therefore, adopting drip irrigation methods is beneficial for Kinnow growers, this study specifically indicates that more crops can be obtained in less water which is important for states with low water availability like Rajasthan.

Kaur & Singla (2016) have studied whether the cultivation of Kinnow can be an option for farmers facing an agricultural crisis. In this study, they focused on production and marketing activities. They selected 100 farmers from Fazilka district as a sample for their study. From two main producing tehsils Abohar and Fazilka 50-50 equal farmers were selected. From 2 villages i.e. 25-25 farmers were selected from each village. Through the cost-benefit analysis, they found that at the discount rate of 10% the benefit-cost ratio is 2.04 while the net present value is Rs. 302289.78 with an internal rate of return of 40%. They found in his study that Kinnow production is a profitable business. It was also found that the fewer chains in marketing, the less the intermediary, the more effective and profitable marketing will be. As the main problems of farmers, they have identified inefficient marketing processes, low prices, price fluctuations, lack of storage capacity, etc. in their study. They mainly emphasized that improvement in marketing facilities and a regulated market system should be available which can reduce the transportation cost of farmers. To ensure proper returns to farmers, it is necessary to encourage agro-processing industries to ensure consumption of produce.

Savandkar (2016) Has studied the impact of rural development programs on socio-economic development in the Parbhani district of Maharashtra. He selected 85 villages for his study and a total of 850 respondents. He focused on the socio-economic status of the people of Parbhani district. He found that with various government development programmes socio-economic status of people improved. He used many aspects of socio-

economic parameters for a study like age, caste category, education, gender, income, living status, assets, size of family, source of drinking water, source of cooking fuel, electricity use, sanitation, transport, and healthcare facilities, etc. he did not assess the use of the internet as a socio-economic parameter. This study only focused on govt programs and other productive activities also affecting the socio-economic condition of the study area.

Singh & Kumar (2016) Study examines the ancillary activities undertaken by Kinnow growers in Punjab, India and their contribution to the overall income and livelihoods of the growers. The authors argue that ancillary activities can help Kinnow growers diversify their income sources, reduce risks, and increase their profitability. They found that Kinnow growers engage in a range of ancillary activities such as setting up small-scale processing units, establishing nurseries, and offering tourism-related services. The authors also discuss the challenges faced by Kinnow growers in engaging in ancillary activities, such as inadequate technical knowledge, lack of access to markets, and limited credit facilities. Despite these challenges, Singh and Kumar suggest that ancillary activities have the potential to significantly contribute to the overall income and livelihoods of Kinnow growers. They recommend that policymakers and stakeholders provide technical and financial support to Kinnow growers to promote and sustain ancillary activities in the horticulture sector.

Bannor & Sharma (2017) The study aimed to investigate the determinants influencing the choice of marketing outlets among Kinnow farmers in Rajasthan, focusing on a sample of 100 Kinnow farmers from Sri Ganganagar and Hanumangarh districts. The findings revealed several significant factors affecting the volume of Kinnow sold to pre-harvest contractors. Firstly, an increase in a farmer's experience by one year was associated with a considerable increase of 1.758 quintals of Kinnow sold to pre-harvest contractors. Additionally, a one-India increase in the value of Kinnow sold to pre-harvest contractors corresponded to a minor increase of 0.0001 quintal in the quantity sold. Conversely, a one-India increase in the price received by the farmer led to a decrease of 0.080 quintals of Kinnow sold to pre-harvest contractors. Moreover, a quintal increase in

the amount of Kinnow produced by a farmer resulted in a notable increase of 0.844 quintals sold to pre-harvest contractors. Furthermore, an increase in the difficulty level of finding buyers by one level on a scale of 1 to 5 led to a decrease of 0.844 quintals in Kinnow sold to pre-harvest contractors. Additionally, having a contract reduced sales by a substantial 53.082 quintals to pre-harvest contractors compared to farmers without a contract before marketing Kinnow. A good road condition from the farmer's farm to the nearest mandi was associated with a reduction of 23.456 quintals of Kinnow sold to pre-harvest contractors compared to a bad road condition. Furthermore, farmers with storage facilities sold approximately 39.307 quintals less Kinnow to pre-harvest contractors compared to those without storage facilities. Storage emerged as a significant challenge faced by farmers in Kinnow marketing. Lastly, for every one-kilometer increase in distance from the farmer's farm to the nearest mandi, there was a rise of 0.965 quintals of Kinnow sold to pre-harvest contractors. Overall, the study sheds light on the complex interplay of various factors influencing Kinnow marketing decisions among farmers in Rajasthan, providing valuable insights for policymakers and stakeholders in improving marketing strategies and infrastructure to enhance Kinnow sales efficiency and farmer profitability.

Kumar et al. (2017) conducted an economic analysis of Kinnow production in the context of district Sirsa, Haryana. In the year 2015-16, they selected two blocks of Sirsa district were according to share in production. Similarly, 3 villages were selected from these blocks. Information was collected from a total of 60 farmers. The farmers were classified as small, medium, and large farmers based on Kinnow production. In conclusion, they found that the return of Kinnow orchards is ₹ 125478 per hectare /year. The internal rate of return was 15.57%, the net present value of ₹ 261258, and the benefit-cost ratio of 2.19%. They found that the marketing channel with the lowest intermediaries had the highest profitability for the producer.

Dhawan et al. (2018) It is clear from the study that during the period 1981-82 to 2010-11, the return on A1 and C2 costs increased by 10.82 and 12.45% in wheat crop, while it increased by 9.92 and 11.36% for paddy. There was an increase of 8.75 and 9.67% for the

cotton crop. In the 1990s, outbreaks of serious diseases in the cotton crop were recorded, which also affected the production of cotton. The cost also increased due to the additional cost of pesticides. With the introduction of the Bt cotton varieties, there was an increase in yield, and also a reduction in costs. Due to this cotton showed high returns. The study concludes that, relative to wheat and cotton crops, Profit increased more. However, there was no significant change in the paddy crop. The government needs to promote the availability of agricultural equipment on rent to further reduce the cost of cultivation, keeping in view the marginal and small farmers, and training of new techniques of agriculture for resource conservation, as a policy.

Singh et al. (2018) study examines the role of ancillary activities in the livelihoods of Kinnow growers in Punjab, India. The authors argue that ancillary activities can help Kinnow growers supplement their income and maximize the utilization of their resources. They found that Kinnow growers engaged in a variety of ancillary activities, including processing, packaging, and value-addition of Kinnow fruits, as well as setting up small-scale agro-industries and engaging in tourism-related services. The authors also highlight the challenges faced by Kinnow growers in engaging in ancillary activities, such as lack of technical knowledge, marketing facilities, and access to credit. Overall, Singh, Dhaka, and Goyal suggest that promoting ancillary activities can help improve the livelihoods of Kinnow growers and contribute to the overall economic development of the region.

Baswal et al. (2019) the main objective of the study conducted by the authors was to find out what is the effect of different concentration values of 1-methylcyclopropene on the quality and storage duration of Kinnow. In conclusion, they found that increasing the duration of Kinnow can be maintained in the cold storage when treated Kinnow Mandarin with [MeJa (0.001 μmol L-1), 1-MCP (1.5 μL L-1)] after crop harvesting. The quality of Kinnow also remained. This study suggests the constraints encountered in the marketing of Kinnow and the techniques used therein. Due to this farmers can get fair prices of Kinnow.

Kaur et al. (2019) conducted a study on the socio-economic profile of Kinnow growers in Punjab, India. They found that the majority of Kinnow growers belonged to the age

group of 31-50 years, with an average farming experience of 19 years. They also found that most Kinnow growers had small landholdings and low levels of education. Additionally, they observed that Kinnow growers faced several challenges such as price volatility, market uncertainties, and lack of access to credit and modern technology. The authors suggest that government policies and programs should be implemented to improve the socio-economic conditions of Kinnow growers, such as providing them with access to credit, modern technology, and market information. This, in turn, can lead to the growth and development of the Kinnow industry and the improvement of the livelihoods of Kinnow growers. The study had a sample size of 120 Kinnow growers from three districts in Punjab, India. The authors collected data through structured interviews and analyzed it using statistical software. The sample was selected using a purposive sampling technique, where Kinnow growers were selected based on their willingness to participate in the study and their availability during the data collection period.

Kumar et al. (2021) the economic analysis of Kinnow production presented in this study offers valuable insights into the financial viability and potential benefits of cultivating this citrus fruit. Conducted in the Sirsa district of Haryana during the 2017-18 period, the study provides a detailed examination of costs, returns, and various economic indicators associated with Kinnow orchards. By sampling 30 Kinnow growers purposively from different villages in the Mandi Dabwali block, the study captures a representative picture of Kinnow cultivation practices in the region. The findings reveal significant figures regarding the financial aspects of Kinnow cultivation, with the average first-year establishment costs per hectare calculated at ₹127,979, and per hectare per year returns amounting to ₹272,845. Furthermore, the economic viability of Kinnow cultivation is assessed through crucial indicators such as net present value, internal rate of return, benefit-cost ratio, and payback period. These metrics provide a comprehensive understanding of the profitability and investment attractiveness of Kinnow orchards. With a net present value of ₹783,243.67, an internal rate of return of 26.24%, a benefit-cost ratio of 1:3.76, and a payback period of 7 years, the study underscores the economic

feasibility and potential returns associated with Kinnow cultivation. Importantly, the study highlights the role of Kinnow cultivation in promoting agricultural diversification and commercialization in the state of Haryana. By demonstrating the potential for income generation and livelihood improvement among farmers, Kinnow cultivation emerges as a viable strategy for enhancing rural prosperity and contributing to the goal of doubling farmers' income. The implications of the study extend beyond its immediate findings, emphasizing the importance of continued research and development efforts aimed at enhancing the profitability and sustainability of Kinnow cultivation. Suggestions for the development of early fruit-bearing varieties and ensuring timely supply of necessary inputs underscore the need for targeted interventions to further optimize Kinnow production practices and maximize returns for farmers. In conclusion, the study provides valuable insights into the economic dynamics of Kinnow cultivation, offering policymakers, researchers, and practitioners a nuanced understanding of the opportunities and challenges inherent in citrus fruit production. By leveraging the findings of this study, stakeholders can formulate evidence-based strategies to promote the growth and resilience of Kinnow orchards, thereby fostering agricultural development and rural prosperity in the region.

Singh et al. (2021) the cutting and removal of certain fruit tree sections is known as fruit tree pruning. It crosses a wide range of horticulture practices. Pruning involves cutting back branches, occasionally getting rid of smaller limbs totally, and most importantly, getting rid of immature shoots, buds, and leaves. Pruning is a common orchard practice, both in organic and nonorganic varieties. Pruning can be used to manage growth, get rid of unhealthy or dead wood, and promote the development of fruit and flower buds. When young trees are pruned and trained, they become more resilient and productive over time. They also live longer and are less likely to suffer damage from weak crotches or forks (where a tree trunk divides into two or more branches) that break under the weight of fruit, snow, or ice on the branches. The effectiveness of pruning techniques is crucial, though. The limitations of manual pruning include a smaller field capacity and incomplete pruning for towering trees. For Kinnow Mandarin and Guava orchards, a

tractor-operated 1-row frontal pre-pruner with electro-hydraulic control was tested. Top and side pruning required 23.30 and 46.80 minutes per acre, respectively, and saved 99.32 to 99.38% of the time required for manual pruning.

Soni et al. (2021) to investigate the productivity and economic performance of intercropping Kinnow with vegetable crops, experiments were conducted. There were five different treatment regimens: I Kinnow + Onion (ii) Kinnow + Radish (iii) Sole Onion (iv) Sole Radish and (v) Sole Kinnow. The height, girth, and canopy spread of Kinnow over its single plantation were all positively impacted by intercropping. When compared to a single Kinnow, intercrops greatly increased the fruit output. However, compared to mono farming, Kinnow produced fewer crops during the rabi and kharif seasons. In terms of crop production equivalents compared to single Kinnow, the onion in the Rabi season and the Indian squash in the kharif season were superior candidates for intercropping systems. In Kinnow + radish and Kinnow + onion, the yearly system productivity in terms of onion equivalent yield (OEY) was 2.81 and 7.58 times higher than in solitary Kinnow, respectively. In intercropping systems of Kinnow + onion and Kinnow + radish, respectively, water productivity in terms of economic yield (WPEY) was increased from solitary Kinnow (0.62 kg/m3) to 4.23 and 1.86 kg/m3, respectively. Similar to this, the water productivity in terms of gross return (WPGR) increased from 4.98 Rs/m3 in solitary Kinnow to 22.73 and 9.51 Rs/m3 in Kinnow + onion and Kinnow + radish, respectively. In comparison to solitary Kinnow, the B: C ratios of (Kinnow + onion) and (Kinnow + radish) were increased to 3.65 and 2.06, respectively (B: C ratio of 1.50).

Yogi et al. (2021) the study used weekly Kinnow price series from six markets from 2010 to 2016 to analyze the spatial pricing behavior of Kinnow market pairs in the Punjab state of India. The paper used a time series model to examine how marketplaces integrate. The study has demonstrated that there is significant market cointegration. Numerous causal connections between several marketplaces have been discovered. According to the application of the vector error correction model (VECM), all of the error correction terms (ECTs) are negative and the majority of these terms are statistically

significant, suggesting that the system, once it is out of equilibrium, strives to return to the state of equilibrium. The study also employed impulse response analysis, which demonstrates how changes in one market's price will result in changes in the pricing of other markets. The study's findings suggest that price signals travel across geographical boundaries, showing that changes in one market's pricing are reliably related to those in another market's price and have the power to affect prices in the latter. The dynamic relationships between the supply and demand of Kinnow, however, may have an impact on the direction and magnitude of price variations. For improving the information precision to forecast price movements used by marketing operators for their plans and by policymakers for establishing the most effective marketing strategies to increase market efficiency, the study has offered intriguing insights for decision-makers.

Agarwal et al. (2022) the research was done to undertake an economic analysis of Punjab's mentha farming. The main information was gathered from 50 farmer respondents who were categorized according to their operating landholding. The Cobb-Douglas production function was fitted to find the factors affecting the mentha crop's yield. The projected benefit-cost ratio of 2.87 demonstrates the profitability of the mentha crop. Human labor was determined to be the most expensive part of growing mentha (39.04%), followed by fertilizers (20.65%) and suckers (11.82 percent). Most farmers were cultivating mentha, peppermint, and koshi types, with the former taking up the most space. Large farms (139852 per ha) saw the highest profits relative to variable costs, followed by medium farms (106083 per ha), and small farms (57371 per ha). In the current study, it was discovered that the factors of area (ha), irrigation (hours), and pesticide sprays (numbers) had an 82 percent significant impact on the mentha crop's production.

Bordoloi & Bhuyan (2022) one of the significant commercial crops grown in Assam is ginger. Using the OLS model, the study calculated the effect of socioeconomic variables on the money made from the sales of ginger items. The results showed that household size, level of education, and productivity (t) all contributed to the farmers' net income growth. Additionally, the disconnection between direct communication and market

accessibility promotes neighborhood traders to take the lead in price regulation. To promote a healthy marketing system, infrastructure support and proper connectivity among the actors are essential. To strengthen the ginger marketing structure, the government or NGOs must also put in place an effective support system. The opportunity cost of unsustainable land usage in walnut production is discussed in the paper. The anticipated buy price, would-sell, and would-rent calculations for the ultimate opportunity cost were based on flow and rental factors with the CPI index. In August 2021, the data were gathered using a stratified random sample technique. The dependent and linear characteristics of the crop were determined using Spearmen's estimation. According to the findings, the longer walnut tree gestation periods and greater opportunity costs led to poorer productivity, which in turn reduced the crop's adaptability. The government should give farmers with high-density, lower gestation-period walnut trees in light of the results' significant opportunity

Devi & Bhoi (2022) using primary data from the years 2017–18 and 2018–19, a study was conducted to analyze the economic factors affecting turmeric farmers in middle Gujarat who produce both processed and unprocessed turmeric. The findings showed that processed farmers' total costs per hectare, including processing fees, were higher (210887 per ha) than those of non-processed farmers (170922 per ha). However, the farmers who were selling the product in powder form as opposed to fresh realized a considerable difference in price per unit, gross return, net return, and benefit-cost ratio, making a significantly bigger profit in processed than non-processed. Both categories' combined elasticity coefficients were more than one, which indicates operating in the first zone of production and growing returns.

Kour & Malhotra (2022) the purpose of the study was to assess the socioeconomic position of rural families concerning MGNREGS. Results showed that the MGNREGS, whose work was either intended for poor or scheduled caste homes, were well known to the recipients. Most recipients thought the assets produced by the plan were beneficial. Most of the time, beneficiaries abide by verbal instructions and don't pay for the creation of job cards. Most of the responders had possession of their employment cards. The

findings showed that the sample households' income and spending had significantly increased. After enrolling in MGNREGS, the beneficiaries' expenses for food and non-food grew. MGNREGS had made it easier for their socioeconomic situation to improve.

Kumar et al. (2022) the highest rate of increase in the area and productivity of grapes was recorded in the case of the Chikkaballapura district. The values of instability indices for the area (6.73), production (13.72), and productivity (7.49) were comparatively lower, indicating their stability in the state. Further, the instability analysis indicated that the area and productivity of grapes in the Mysuru division were more unstable than in other state divisions. The study sheds light on the growth trends of several grape cultivars across the districts and divisions of the state of Karnataka. The majority of grapes grown in the state are four types: Bengaluru Blue, Anab-e-Shahi, seedless kinds, and other varieties. Throughout the study period, there was positive and considerable growth in the area and production of all grape varieties. The findings showed that the expansion was significantly beneficial in terms of area (7.23%), production (7.96%), and productivity (0.67 percent per annum). The Belagavi division experienced the highest growth rate, followed by the Kalaburagi division.

Meena & Kumari (2022) The study aimed to comprehensively analyze various facets of agricultural dynamics, including socioeconomic status, land use patterns, cropping systems, technical efficiency of crops, and challenges encountered in production and marketing processes. The findings underscored disparities between villages located in ravine areas and those elsewhere, revealing poor agricultural infrastructure and diminished technical efficiency of major crops in ravine-affected regions. One notable revelation was the lower crop productivity observed in ravine areas compared to state and national averages. This disparity highlights the need for targeted interventions to address the specific challenges faced by farmers in ravine-affected villages. The absence or inadequacy of extension services further compounded the difficulties encountered by farmers, exacerbating production and marketing-related constraints. In response to these findings, the study offered actionable suggestions aimed at harnessing the productive potential of ravine land. By proposing strategies for optimizing land use and enhancing

agricultural productivity in ravine areas, the study sought to mitigate the challenges posed by geographical constraints and infrastructure deficiencies. Overall, the study provides valuable insights into the multifaceted nature of agricultural development, underscoring the importance of addressing socioeconomic, infrastructural, and technical factors to promote sustainable agricultural practices and improve livelihoods in ravine-affected regions. By identifying constraints and offering actionable recommendations, the study contributes to the body of knowledge aimed at fostering inclusive and resilient agricultural systems.

Niranjan et al. (2022) the study made the effort to examine the variables influencing students' willingness to pursue a profession in agriculture. Additionally, an attempt was made to research the difficulties of starting their farm right away after college. In September 2020, a random survey of 397 agricultural students in Tamil Nadu pursuing undergraduate, graduate, and doctoral degrees was conducted. According to the findings, around 25% of the students enrolled in the course to take advantage of higher employment prospects, and 19% learned about farming. Only 11% of students want to pursue a career in agriculture, and over 48% of students want to work in the public sector. The likelihood of students becoming farmers was significantly influenced by their ownership of farmland, residency, parents' principal occupation, age, gender, the types of crops they were growing, and their mother's career path. While the students' desires had been adversely impacted by the degree pursued and the total amount of farmland. The main reasons for delaying the involvement of agriculture were lack of remunerative prices, difficulty obtaining loans with low interest rates, and low societal acceptance. As a result, within ten years of their graduation, more than half of the respondents intended to work in farming. If agricultural graduates were among the young people involved in farming, public initiatives might shorten this period.

Rai & Kundu (2022) the study examined the socioeconomic attributes of homestay providers in West Bengal's Darjeeling Hills. A total of 100 operators were chosen from Darjeeling's ten primary ecotourism destinations. By the findings, 56% of operators were men and 44% were women. The majority of respondents (56%) or semi-respondents

(72%) owned pucca or semi-pucca homes, indicating a high level of life. About 87% of people cooked with a combination of LPG and firewood. They owned a variety of homestays, including semi-pucca (72%), pucca (23%), and wooden homestays (5 percent). About 60% of those who started this business did so lately and have less than five years of experience. About 56% of them utilized their savings for the original investment, 31% borrowed money from formal sources, 10% borrowed money from unofficial sources, and only 4% received financial aid from the government.

The Review of Literature critically examines various studies related to Kinnow production, focusing on its economic, technical, and marketing dimensions:

Economic Viability: Several studies, including those by Kumar et al. (2017) and Kaur & Singla (2016), assess the economic viability of Kinnow cultivation through benefit-cost analyses conducted in Haryana and Punjab, respectively. While these studies provide insights into Kinnow production's profitability, there is a notable absence of comparative research across different states.

Marketing Challenges: Research by Bannor & Sharma (2015) highlights significant inefficiencies in the marketing of Kinnow, such as price volatility, inadequate storage facilities, and the monopolistic influence of intermediaries, which considerably diminish farmers' profit margins. The role of intermediaries emerges as a crucial factor, with much of the profit being absorbed by them rather than the producers.

Ancillary Activities: Singh & Kumar (2016) explore the role of ancillary activities, such as processing and packaging, in enhancing the income and livelihoods of Kinnow growers. While these activities present opportunities for income diversification, challenges such as limited technical knowledge, market access, and credit availability persist, restricting the full realization of their potential.

Agrarian Crisis and Crop Diversification: Scholars such as Kaur & Gill (1990) underscore the potential of crop diversification, including the expansion of Kinnow cultivation, as a strategy to mitigate the agrarian crisis. However, the literature notes that the expansion of Kinnow production has been more pronounced in Punjab than in Rajasthan, indicating regional disparities in adoption and growth.

RESEARCH GAP:

Based on the literature reviewed, the following research gaps are identified:

Trends and Patterns of Kinnow Area Expansion

While Kaur (2013) and others highlight an increase in the Kinnow cultivation area, there is insufficient research on the specific drivers and constraints influencing regional patterns of area expansion, particularly in Rajasthan and Punjab. The focus has largely been on aggregate trends without examining local-level dynamics, such as climatic conditions and water availability.

Socio-Economic Status of Kinnow Growers

Studies like Kaur et al. (2016) and Bannor & Sharma (2015) provide socio-economic data on growers but lack comparative analyses between regions. The differential impact of landholding size, education, and market access on farmer incomes in Rajasthan and Punjab remains unexplored, leaving gaps in understanding regional disparities in outcomes.

Supportive Infrastructure for Kinnow Production

While Ghafoor et al. (2008) and Sharma & Ghuman (2009) emphasize the importance of storage and processing units, there is limited information on the adequacy of supportive infrastructure in Rajasthan and Punjab. The role of irrigation, road connectivity, and post-harvest facilities specific to these regions requires further investigation.

Constraints Faced by Kinnow Growers

Challenges such as market inefficiencies, monopolistic practices, and lack of access to credit are noted (Kaur & Singla, 2016; Ahmed et al., 2015). However, there is a lack of holistic studies capturing both systemic and region-specific constraints faced by growers in the study area, such as water scarcity in Rajasthan and price fluctuations in Punjab.

Policy Recommendations

Existing studies (Singh & Kumar, 2016; Kaur, 2013) propose broad suggestions for improving Kinnow production and marketing. However, actionable, region-specific policy frameworks tailored to address local issues, such as climate adaptation in Rajasthan or market stabilization in Punjab, are missing.

CHAPTER-3

STUDY AREA PROFILE

This chapter offers a holistic portrayal of the study area, encompassing various facets beyond Kinnow production. It delves into the geographical, climatic, socioeconomic, and cultural dimensions of the regions under scrutiny, providing a comprehensive understanding of the contextual backdrop for the research. Through an exploration of key features such as land use patterns, demographic trends, infrastructure development, and economic activities, this chapter lays the groundwork for comprehensively analyzing the dynamics at play within the study area. By elucidating the broader context in which the study is situated, it aims to offer valuable insights into the interplay of various factors shaping the landscape under investigation.

Rajasthan:-

The state of Rajasthan is located in the northwest of India. It is situated between 23 ° 3 'to 30 ° 11' north latitude and 69 ° 29 'to 78 ° 17' east longitude. The length of the state from north to south (Ganganagar to Banswara) is 826 km and from east to west (Jaisalmer to Dhaulpur) the width is 869 km. The entire periphery of the state is approximately 5920 km. It is long in 1070 km and is adjacent to Pakistan. The western border is also included. The north and northeastern border of the state is connected with Punjab and Haryana, the eastern border with Uttar Pradesh and Madhya Pradesh, the south-eastern border with Madhya Pradesh, and the south and south-western border with Madhya Pradesh and Gujarat respectively. The Tropic of Cancer passes through the south of Banswara city. Rajasthan has an area of 3.42 lakh square kilometers, making it the largest state in India. This area is 10.4 percent of the total area of India. Rajasthan is the eighth state of India whose population, according to the 2011 census, is 6.85 crore, which is 5.7 percent of India's population. In terms of population density, Rajasthan has 200 people per square kilometer which is 382 persons per square kilometer. Population density is low in the western part of the state, while the eastern part, especially the Jaipur

district, has the highest population density. From the ground point of view, Rajasthan can be divided into four main parts: 1. North West Desert Territory 2. Intermediate Aravalli mountain region 3. Eastern Plain Territory 4. Southern-Eastern Plateau Region

(1) North Western Desert Region: -

It consists of 12 districts of the state - Jaisalmer, Barmer, Bikaner, Ganganagar, Jodhpur, Jalore, Pali, Nagaur, Churu, Jhunjhunu, Hanumangarh and Sikar, which is inhabited by 61% of the state. About 40% of the population is inhabited here. It is an area west of Aravali which is a dry and semi-arid desert region. Here the dunes are like an extension of the sea. This region is known as the Great Desert of India or the Thar Desert. The expanse of this desert is about 1.75 lakh sq km. Receive 25 to 50 cm of rain in this area. Till there is annual rainfall which decreases from east to west and in Jaisalmer it remains on average 15 cm. It is hot in winter and extreme heat in summer. In winter, in many places like Phalodi, and Churu, the temperature drops below zero. Similarly, in summer, the temperature in some places of Jaisalmer and Barmer districts goes up to 50 ° C. The groundwater level is found very deep in this western region, so the depth of the wells is 20 to 100 meters. In many areas, groundwater is usually saline which is unusable for humans and animals. Due to very little rainfall, there is a lack of surface water. There are only two rivers in this region of which Luni is a seasonal river and Ghaggar river of Hanumangarh region is a dead river. The Luni River rises 320 km southwest from the Naga Hills of Aravalli near Pushkar near Ajmer and flows into the Rann of Kutch to disperse its waters. It is a seasonal river. On rainy days, it holds water which is saline in most areas and is neither useful for drinking nor irrigation. It is the only river flowing west of Aravali. Due to some irrigation from the canals in Ganganagar, Hanumangarh, Bikaner, and Jaisalmer regions, the environment of the western desert region is changing gradually due to the Rajasthan Canal reaching Mohangad of Jaisalmer. Due to intensive plantation along the banks of the Rajasthan Canal, the area has started receiving relatively more rainfall. Groundnut and mustard are being cultivated over a large area. But overall, the area still depends on rainwater for irrigation, from which millet, jowar, moong, moth,

guar, sesame, etc. are taken in the Kharif crop. Due to the availability of canal water in Ganganagar, Hanumangarh, and Bikaner area, the wheat crop is often sown extensively in Rabi crop. Sriganganagar has the highest wheat yield in the entire Rajasthan. Animal husbandry is an important occupation in the region with the main kharif crop. Cows, sheep, and goats are a major source of income for the rural people here. Animal husbandry is a profitable profession due to milk, wool, meat, leather, etc. The discovery of petroleum products in western Rajasthan, especially in Barmer-Sanchore (Jalore) and Jaisalmer region, has changed the map of this region. Oil production from the Barmer-Sanchore region is setting up a petroleum refinery in Pachpadra. Due to this employment will be provided to millions of people in this region. At present, the state government is earning about 5000–6000 crores per year by extracting petroleum products as royalty. This income is likely to increase further. Apart from this, a huge amount of timber harvesting and trade is done in this area. In this region, salt is also made from saltwater in Pachpadra (Barmer), Baap (Jodhpur) Pokaran (Jaisalmer), and Lunkaransar (Bikaner) regions. The Degana region of Nagaur is the only tungsten area in India. A small amount of lignite is also available in Bikaner, Nagaur, and Barmer regions. Bentonite, gypsum, and rock phosphate are also available in this area in sufficient quantities. Solar energy is nature's boon to this region. Preparations for setting up solar parks and projects of about 40000 MW capacity are in progress here.

(2) Aravalli Hills

Aravalli Range is the oldest mountain range in the world. It divides Rajasthan into two parts diagonally. It is about 697 km in length from Khedbrahma in Gujarat in the southwest to Delhi in the northeast. Its length in Rajasthan is about 550 km. Expansion of the Aravalli region of Rajasthan is spread over seven districts - Sirohi, Udaipur, Rajsamand, Ajmer, Jaipur, Dausa, and Alwar. The southern westerly monsoon, which is the source of 90 percent of the rainfall in Rajasthan, passes parallel to the Aravalli Mountains, so rainfall is less in this region, especially in the Aravalli. More than 9% of the total area of Rajasthan is covered by the Aravalli region. Guru Shikhar situated in

Abu Parvat in the Sirohi district of South Aravali is the highest peak in Rajasthan with a height of 1722 meters. The other peaks here are Ser (1997 m), Achalgarh (1380 m) and Delwara (1442 m). Other districts of South Aravali are Udaipur and Rajsamand. Udaipur - The highest peak in the Rajsamand region is the Jarga Mountain with a height of 1431 meters. The plateau between Kumbhalgarh and Gogunda in the north-west of Udaipur is called the "Bhorat-Plateau". Southern Aravalli is the most important region of the Aravalli mountain range as it is a beautiful forest covered with dense forests. The area around Ajmer district is central. This region is called Aravali. The average elevation of Aravalli in this part is 700 meters and the width is 30 meters. The main mountains of this region are Taragarh (870 meters), and Nag (795 meters). The four ghats (rates) near Beawar are the main ones - Bar, Parveria Shivpur, Sura, and Debari rates. North Aravali is spread in the districts of Jaipur, Dausa, and Alwar.

(3) Eastern Plains Region

This eastern part of the state which includes Bharatpur, Alwar, Dhaulpur, Sawai Madhopur Jaipur Tonk, and the plains part of Bhilwara and southern districts Banswara and Dungarpur are included in this area.) Is more fertile than being. Three important rivers - Chambal, Banas, and Mahi - contribute to irrigation. Rivers are also a source of fertile soil, so there is a good yield of wheat, barley, gram, millet, jowar, mustard, oilseeds, sugarcane etc. Due to the fertile area, people are relatively prosperous and the density of the population is also high. The most important and perennial river of the region is Chambal. It originates from the Mau situated on the northern slope of the Vindhyachal Mountain in Madhya Pradesh and joins the Yamuna River near Etawah in Uttar Pradesh, passing through Kota, Sawaimadhopur, Karauli, Dholpur in Rajasthan. The total length of the river is 965 km. Out of which only 135km in Rajasthan Flows Kali Sindh, Parvati Brahmani, Meja, Gambhiri and Chandrabhaga rivers are the tributaries of Chambal. Gandhi Sagar Dam, Jawahar Sagar, Rana Pratap Sagar and Kota Barrage built on the Chambal River are important sources of irrigation and hydropower. Due to excessive erosion in the flow of the Chambal River, many areas of Sawai Madhopur and

Dhaulpur districts have become rugged ravines. Banas is another important river in the same eastern region, whose origin is the Khamnore (Rajsamand) hills near Kumbhalgarh. The river joins the Chambal River in the Sawai Madhopur district passing through Udaipur, Chittorgarh, Bhilwara, Ajmer, Talk, and Bundi. This river is also called "Forest's Hope". Its major tributaries are the Badach, Kothari, Gambhori, Khari, Banganga, etc. The Banas and its tributaries rain. But in these valleys, underground water is easily available at low depths which is useful for irrigation. The Bisalpur Dam in Tonk district is an important dam on the Banas River. The Mahi River is the other important river of the eastern plains. The Mahi River originates from the Vindhya Mountains in the Dhar district of Madhya Pradesh and flows from Chittorgarh, Pratapgarh, Banswara, and Dungarpur in Rajasthan and falls in the Gulf of Khambhat in Gujarat. Thus its flow is from east to west. The traditional Chhappan villages are situated in the basin of Mahi between Pratapgarh and Banswara. For this reason, this area is called "Chappan Maidan". The two important tributaries of Mahi are the Erava and the Eran. The area of Banswara - Dungarpur is in the form of many small hills and narrow banks, in the local language it is called 'Vagad'. From this, the language here is also called 'Wagdi'. A dam has been built on this river near Banswara which is called Mahi-Bajaj Sagar Project. It is used for irrigation and hydropower.

(4) Southern-Eastern Plateau Region: -

This plateau region is located in the Kota, Bundi, Jhalawar, and Baran districts of the state. For this reason, this is also called the "plateau of Hadoti". In Kota-Bundi districts, the "hills of Mukundra" are also part of this plateau region. Many tributaries of Chambal such as Kali Sindh, Parvan, Paria, and Parvati rivers irrigate the land here. The soil of the plateau area is very fertile, which produces cotton, sugarcane, tobacco, and opium. Climate: The climate of the region affects the entire way of life of that region.

Punjab:-

Punjab is a state in the northwest region of India and is one of the most prosperous states. The name Punjab is made of two words Punj (Five) + Aab (Water) i.e. land of five rivers. These five rivers of Punjab are Sutlej, Beas, Ravi, Chenab, and Jhelum. Only the Sutlej, Ravi, and Beas rivers flow in today's Punjab. The other two rivers are now in the state of Punjab, situated in Pakistan. The Punjab State is divided into three regions: Majha, Doaba, and Malwa.

Location

Punjab extends from latitudes 29.30° north to 32.32° North and longitudes 73.55° east to 76.50° East. Punjab is bounded on the west by Pakistan, on the north by Jammu and Kashmir, on the northeast by Himachal Pradesh, and the south by Haryana and Rajasthan.

Agriculture is the mainstay of Punjab's economy. Other major industries include the manufacturing of scientific instruments, electrical goods, financial services, machine tools, textiles, sewing machines etc. Punjab has made considerable economic progress after Independence despite the setback it suffered in 1947. It contributes nearly two-thirds to the total production of food grains and a third of milk production in the country. It is the leading producer of wheat, thereby contributing to national food security.

The initiative of the Green Revolution (a major agricultural initiative) has been keenly taken forward by the people of Punjab. Even though Punjabis account for less than 2.5% of the Indian population, they are one of the most prosperous races in India. Their per capita income is twice the national average. Punjab is considered to have the best infrastructure in India; this includes road, rail, air, and river transport links that are extensive throughout the region. Punjab also has the lowest poverty rate in India and has won the best state performance award, based on statistical data compiled by the Indian Government. According to the 2011 Census of India, the total population of Punjab is 27743338. The decadal change i.e. increase in population from 2001 to 2011 is 13.89%.

Geographical area

The total area of the state is 50,362 square kilometers (19,445 square miles), with the cultivable area being under assured irrigation. Its average elevation is 300 meters (980 ft) above sea level, with a range from 180 meters (590 ft) in the southwest to more than 500 meters (1,600 ft) around the northeast border.

Climate

The state has a balanced amalgamation of heat in summer, rain in monsoon, and cold in winter. The three seasons are so distinctly distributed that you can enjoy each of them individually. Punjab experiences both summer and winter to its extreme. It even receives abundant rainfall, which makes the state a very fertile land. The region lying near the foothills of the Himalayas receives heavy rainfall whereas the region lying at a distance from the hills, the rainfall is scanty and the temperature is high. The summer months span from mid-April to the end of June. The rainy season in Punjab is from early July to the end of September. October marks the beginning of the winter season. From December onwards, the winter becomes chilly. Most of the major festivals of Punjab, like Lohri, Holla Mohalla, Diwali, and Dussehra, fall during this period. The best time to visit Punjab is from October to the end of March.

Language

Punjabi, the official language of the state, is the tenth most widely spoken language in the world. It is also the fourth most spoken language in Asia. It is the only living language among the Indo-European languages which is a fully tonal language. Punjabi is written in the Gurmukhi.

Socio-economic comparison of Punjab and Rajasthan:

Punjab and Rajasthan are two states in India with distinct cultures and economic profiles. Here are some key socio-economic differences between the two states:

Agriculture: Agriculture is the mainstay of Punjab's economy, with the state being one of the largest producers of wheat and rice in India. Rajasthan, on the other hand, has a more diversified agriculture sector, with crops such as oilseeds, pulses, and cotton being significant contributors to the state's economy.

Industry: Punjab has a well-developed industrial sector, with a focus on textiles, food processing, and light engineering. Rajasthan has a relatively smaller industrial sector, with the state's economy being primarily based on agriculture and tourism.

Literacy rate: According to the 2011 census, Punjab had a literacy rate of 76.7%, while Rajasthan had a literacy rate of 66.1%.

Human Development Index (HDI): According to the UNDP report of 2020, Punjab has a higher HDI than Rajasthan, with a rank of 13 and 21 respectively.

Per capita income: According to the Ministry of Statistics and Programme Implementation, in 2019-20, the per capita income of Punjab was Rs. 1,86,826, while that of Rajasthan was Rs. 1,44,567.

Poverty rate: According to the data from the National Sample Survey Office, in 2011-12, the poverty rate in Punjab was 16.9% and in Rajasthan, it was 21.8%.

Gender Development Index (GDI): According to the UNDP report of 2020, Rajasthan has a higher GDI than Punjab, with a rank of 17 and 19 respectively.

Urbanization rate: According to the 2011 census, Rajasthan has a higher urbanization rate than Punjab, with 30.5% of its population living in urban areas, compared to Punjab's 27.7%.

Tourist destinations: Rajasthan is known for its rich cultural heritage and is a popular tourist destination, with cities such as Jaipur, Jodhpur, and Udaipur being major tourist attractions. Punjab is also known for its rich cultural heritage, with Amritsar's Golden Temple and the Wagah Border being popular tourist destinations.

Overall, both states have their unique socio-economic characteristics, which have been shaped by their history, culture, and geography.

Comparison of important indicators between Rajasthan and Punjab:

The comparison of important indicators between the Rajasthan and Punjab states of India shows some interesting contrasts. In terms of geographical area, Rajasthan is larger than Punjab with 3.42 Lakh Sq. Km. as compared to 0.5 Lakh Sq. Km. of Punjab. However, as a percentage of the total area of the country, Punjab is slightly smaller with 1.53% as compared to 10.41% of Rajasthan.

Table 3.1: Comparison of Important Indicators

State	Rajasthan	Punjab
Geographical area (lakh sq. Km.) 2011	3.42	0.5
Percentage of state area to total area of the country 2011	10.41	1.53
Percentage of state population to all india population 2011	5.66	2.29
Density of population per sq. K.m. 2011	200	551
Percentage of urban population to total population 2011	24.9	37.5
Literacy rate (percentage)2011	66.1	75.8
(per thousand live birth) 2019	35	19
Average size of operational holding (in hect.) 2015-16	2.73	3.62
Estimated consumption of fertilizer per hectare (kg/hectare)2019-20	62.28	243.06
Per capita income at current prices(rs.) 2020-21	109386	151367
Per capita consumption of electricity (k.w.h.) 2018-19	1282	2046
Number of motor vehicles per lakh population 31.03.2019	23047	35483
Total road length per hundred sq.km. Of area (km) 2017-18	91.57	283.22
No. Of banking offices per lakh population (september 2021)	10	21
Per capita bank deposit (rs.) (september, 2021)	62227	158551
Per capita bank credit (rs.) (september, 2021)	47002	83512

(Source: Economic Review of Rajasthan 2022)

In terms of population, Punjab has a higher density of people per square kilometer with 551 people per sq. km. as compared to 200 people per sq. km. in Rajasthan. Additionally, Punjab has a higher percentage of urban population with 37.5% as compared to 24.9% in Rajasthan. When it comes to education, Punjab has a higher literacy rate with 75.8% as compared to 66.1% in Rajasthan. Also, Punjab has a lower infant mortality rate with 19 per thousand live births as compared to 35 per thousand live births in Rajasthan. In terms of agriculture, the average size of operational holding in Punjab is larger with 3.62 hectares per holding as compared to 2.73 hectares per holding in Rajasthan. Additionally, Punjab has a higher consumption of fertilizer per hectare with 243.06 kg/hectare as compared to 62.28 kg/hectare in Rajasthan.

In terms of economy, Punjab has a higher per capita income of Rs. 151367 as compared to Rs. 109386 in Rajasthan. Additionally, Punjab has a higher per capita consumption of electricity with 2046 k.w.h. as compared to 1282 k.w.h. in Rajasthan.

In terms of transportation, Punjab has a higher number of motor vehicles per lakh population with 35483 as compared to 23047 in Rajasthan. Additionally, Punjab has a higher total road length per hundred square kilometres of area with 283.22 km as compared to 91.57 km in Rajasthan.

In terms of banking, Punjab has a higher number of banking offices per lakh population with 21 as compared to 10 in Rajasthan. Additionally, Punjab has a higher per capita bank deposit with Rs. 158551 as compared to Rs. 62227 in Rajasthan, and a higher per capita bank credit with Rs. 83512 as compared to Rs. 47002 in Rajasthan.

In conclusion, both states have their unique strengths and challenges, with Punjab generally performing better in terms of education, agriculture, economy, transportation, and banking, while Rajasthan has a larger geographical area and a higher percentage of state area than the total area of the country.

Comparison of selected sample districts:-

Sriganganagar District (Rajasthan)

The Thar Desert is spread over 61% of the state's area out of Rajasthan's total area of 342239 sq km. The Thar extends to the Fazilka district of Punjab. Sriganganagar district is a part of this desert, but due to irrigation facilities, it has become green as a plain area. It is the most northerly frontier district among the 33 districts of Rajasthan. Being an agricultural district, it is also referred to as the 'food basket' in Rajasthan. It borders Punjab in the north and its international border with Pakistan in the west and northwest. The eastern boundary of the district is bordered by Hanumangarh and to the south by the Churu and Bikaner districts of Rajasthan. Before independence, the district headquarters of Sriganganagar was a village in Mirzewala tehsil of the princely state of Bikaner. After the arrival of Gangnahar in 1927, the town of Sriganganagar developed, as a result, Tehsil Mirjewala of that time is now a village under it, while Sriganganagar is now the district headquarters. Administratively, the district is divided into 9 subdivisions

and 9 tehsils. Sriganganagar district is situated between 28 ° 40 to 30° 06 North latitude and 72 ° 39 to 74 ° 21 East longitude. The elevation of the district is between 168 to 227 meters above sea level. The maximum temperature here in the summer goes up to 48.4 ° C. The winter temperature cools down to a minimum of 0. 6 ° C. Heat waves and dust storms also occur here in summer. There is also an outbreak of cold waves here in winter. The rainfall here is mostly between July to mid-September. The rains from western disturbances in December or January are also held here, which proves to be extremely useful for the Rabi crop. The average annual rainfall of the district is only 20.70 cm.

Area

The total area of the district is 11154.66 square kilometers. This constitutes 3.26 percent of the total area of Rajasthan. The total cultivable land in Sriganganagar is 1093221 hectares. Out of the total reporting area, the gross agricultural area is 912554 ha, of which the area sown more than once is 302870 ha.

Irrigation

Irrigation is done through canals and tubewells in the district. The area irrigated by canals is 600893 hectares and the area irrigated by tubewells is 7188 hectares. In this area, irrigation is being done from the Indira Gandhi Canal, Gangahar and Bhakra Canal. Ghaggar is the only river in the district, which also provides water during the rainy season. Most of the tubewell is in the Ghaggar area.

Fazilka District (Punjab)

Fazilka was a part of it before the partition of the Ferozepur district. On 27 July 2011, Fazilka was declared a new district, separated from Ferozepur district. It became the 22nd district of Punjab. Its geographical spread is between 29 ° 94 to 30 ° 80 North latitude and 73 ° 88 to 74 ° 46 East longitudes. The total area of the district is 3113 square kilometers. Administratively, the district has three subdivisions and 3 tehsils Fazilka, Abohar, and Jalalabad. It is the southernmost western district of Punjab. The water of Sutlej, the only river in the district, enters it and flows towards Pakistan. The district shares a western border with Pakistan. The southern border is from the Sriganganagar district of Rajasthan, Ferozepur district in the east, and Muktsar Sahib district in the

north. The total population of the district is 1180483. There are a total of 315 villages in the district. The climatic conditions of the district almost match the Sriganganagar district. However, the groundwater level is in better condition than in Sriganganagar district. Hence tube wells are available for irrigation in most of the area. The area is also irrigated by canals; Abohar Tehsil is a bigger town than Fazilka district headquarters.

Comparison of selected districts:

To conduct this study, we have chosen Sriganganagar district in Rajasthan and Fazilka district in Punjab due to their significant Kinnow cultivation areas. These districts are located on the border of their respective states and share a common border as well as with neighboring international borders. In terms of population, natural resources, and administrative structure, the following comparative details are relevant for the selected districts. Table 3.2 presents a comparison of population distribution between Sriganganagar district in Rajasthan and Fazilka district in Punjab, as per the census conducted in 2011.

The total population of Sriganganagar district is 1,969,168, which is higher than Fazilka district's population of 1,026,200. The male population of the Sriganganagar district is 1,043,340, which is again higher than the Fazilka district's male population of 541,819. Similarly, the female population of the Sriganganagar district is 925,828, which is also higher than the Fazilka district's female population of 484,309. In terms of the rural and urban population, Sriganganagar district has a higher total rural population of 1,433,736 compared to Fazilka district's rural population of 759,111. Similarly, the male and female rural populations of the Sriganganagar district are higher than Fazilka district's male and female rural populations. Regarding urban population, Sriganganagar district has a total urban population of 535,432, which is higher than Fazilka district's urban population of 267,089. Additionally, both male and female urban populations of the Sriganganagar district are higher than the Fazilka district's corresponding urban populations.

Figure 3.1 Comparison of Population Distribution

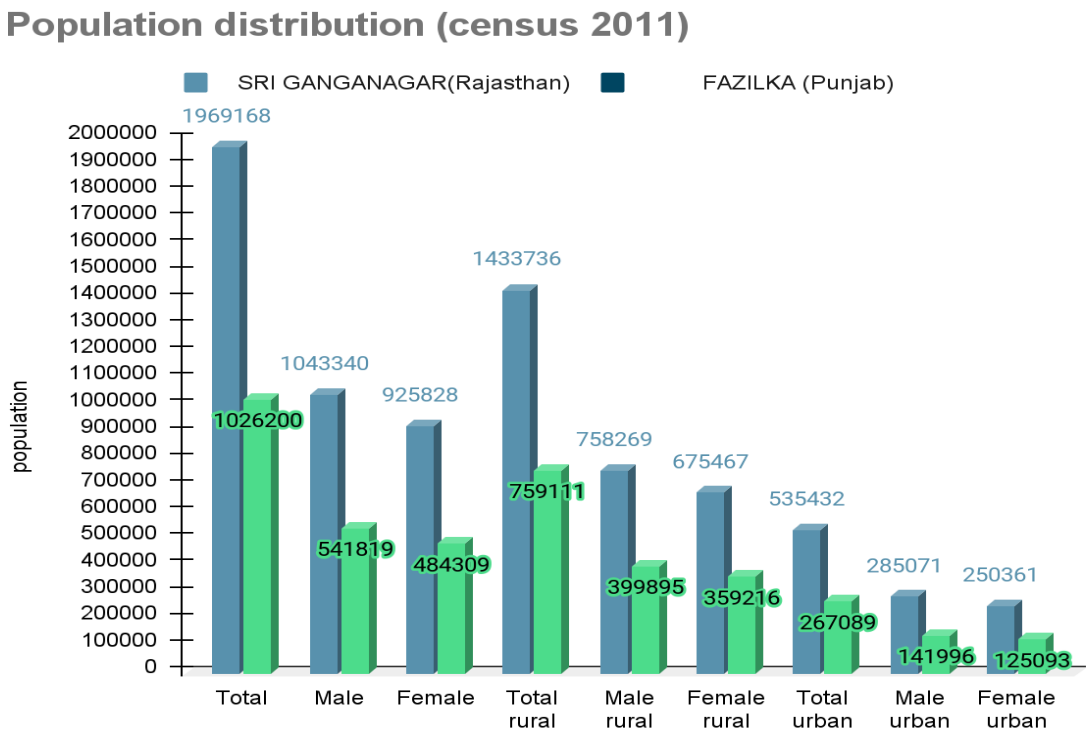


Table 3.2: Comparison of Population distribution

Population	Sriganganagar(Rajasthan)	Fazilka (Punjab)
Total	1969168	1026200
Male	1043340	541819
Female	925828	484309
Total rural	1433736	759111
Male rural	758269	399895
Female rural	675467	359216
Total urban	535432	267089
Male urban	285071	141996
Female urban	250361	125093

Source: Census of India 2011

Overall, the data suggests that the Sriganganagar district has a higher population compared to the Fazilka district, with a larger rural and urban population.

Comparison of percentage share in population:

The data represents the table 3.3 population distribution of two districts S in Rajasthan and Fazilka in Punjab - as recorded in the 2011 census. The total population of Sriganganagar is 1,969,168, while the total population of Fazilka is 1,026,200. The male population in Sriganganagar is 1,043,340, which accounts for 52.98% of the total population, while the male population in Fazilka is 541,819, which accounts for 52.80% of the total population.

The female population in Sriganganagar is 925,828, which accounts for 47.02% of the total population, while the female population in Fazilka is 484,309, which accounts for 47.19% of the total population. In terms of the rural-urban divide, the total rural population in Sriganganagar is 1,433,736, which accounts for 72.81% of the total population, while the total urban population is 535,432, which accounts for 27.19% of the total population. In comparison, the total rural population in Fazilka is 759,111, which accounts for 73.97% of the total population, while the total urban population is 267,089, which accounts for 26.03% of the total population. Therefore, it can be observed that both districts have a similar gender ratio with a slight majority of the male population. Additionally, both districts have a significant rural population with Fazilka having a slightly higher percentage of rural population than Sriganganagar.

Table 3.3: Comparison of percentage share in population

Population	Sriganganagar(Rajasthan)		Fazilka (Punjab)	
	Number	% share	Number	% share
Total	1969168	100	1026200	100
Male	1043340	52.98379823	541819	52.79857728
Female	925828	47.01620177	484309	47.19440655
Total rural	1433736	72.80922704	759111	73.97300721
Total urban	535432	27.19077296	267089	26.02699279

Source: Census of India 2011

Literacy:

The data represents in table-3.4 the literacy rates in two districts - Sriganganagar in Rajasthan and Fazilka in Punjab - as recorded in the 2011 census. The total literacy rate in Sriganganagar is 69.60%, while in Fazilka it is 68.90%. The male literacy rate in Sriganganagar is higher at 78.50%, while in Fazilka it is 76.30%. The female literacy rate in Sriganganagar is 59.70%, while in Fazilka it is slightly higher at 60.70%.

Table 3.4: Comparison of Literacy

Literacy rate	Sriganganagar(Rajasthan)	Fazilka(Punjab)
Total	69.60	68.90
Male	78.50	76.30
Female	59.70	60.70
Rural	66.20	65.20
Urban	78.70	79.30

Source: Census of India 2011

In terms of the rural-urban divide, the literacy rate in urban areas is higher than in rural areas in both districts. In Sriganganagar, the urban literacy rate is 78.70%, while the rural literacy rate is 66.20%. Similarly, in Fazilka, the urban literacy rate is 79.30%, while the rural literacy rate is 65.20%.

Figure-3.2: Comparison of Literacy

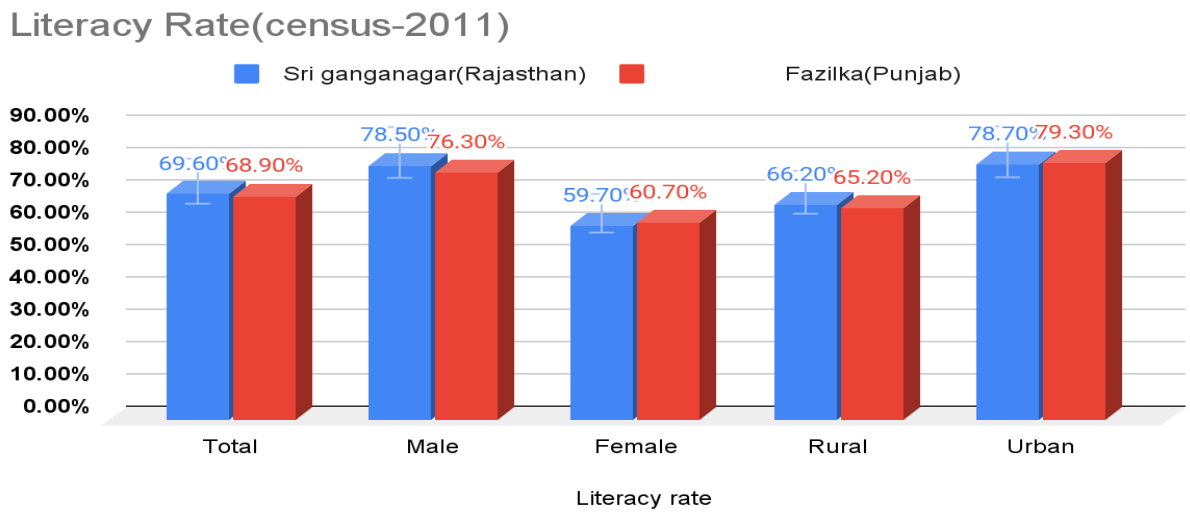
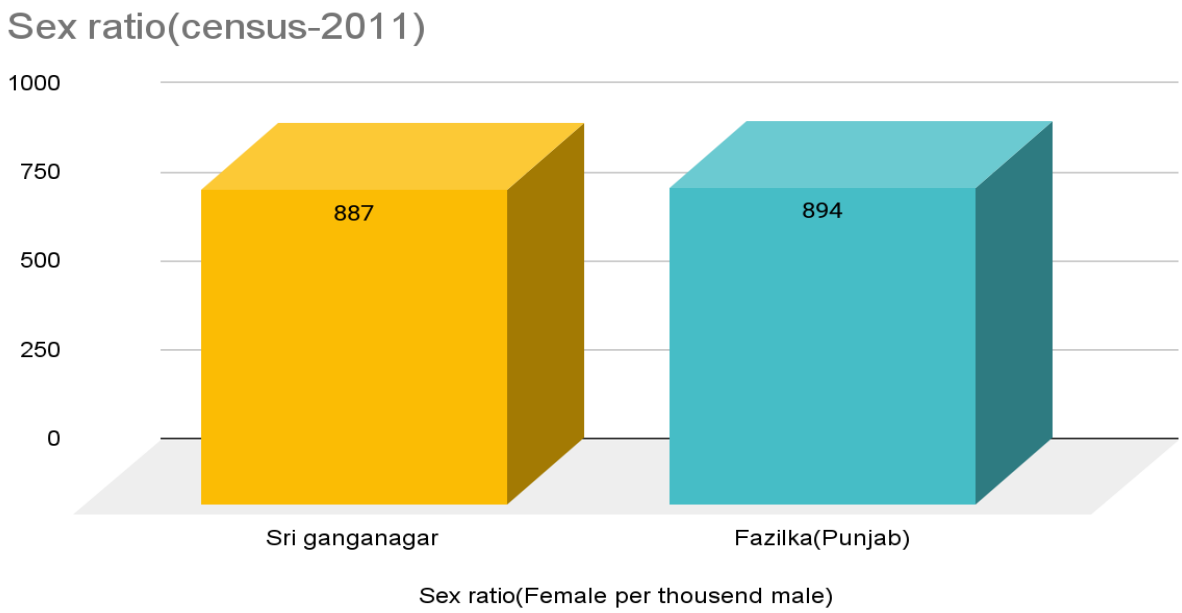


Figure-3.3 Comparison of Sex Ratio



It can be observed that there is a significant gender gap in literacy rates, with male literacy rates being higher than female literacy rates in both districts. Additionally, the overall literacy rates in both districts are below the national average of 74.04% as recorded in the 2011 census. Low literacy rates in a region can be indicative of poor socio-economic conditions, inadequate access to education, and limited employment opportunities. Therefore, the data on literacy rates is crucial for understanding the overall socio-economic status of the population in the respective districts.

The data represents in table-3.5 the number of agricultural holdings and their percentage share in two different districts, Sriganganagar and Fazilka. The agricultural holdings are classified into five categories based on their landholding size, namely marginal, small, semi-medium, medium, and large. In Sriganganagar, there are a total of 112,955 agricultural holdings, out of which 3278 (2.9%) are marginal, 9172 (8.12%) are small, 20,557 (18.2%) are semi-medium, 52,014 (46.05%) are medium, and 27,934 (24.73%) are large. On the other hand, in Fazilka, there are 47,685 agricultural holdings,

out of which 4199 (8.81%) are marginal, 7233 (15.17%) are small, 16,579 (34.77%) are semi-medium, 15,337 (32.16%) are medium, and 4337 (9.1%) are large.

Table 3.5: Comparison of Land Holding

Type of holding	No. of holdings		Percentage share	
	Sriganganagar	Fazilka	Sriganganagar	Fazilka
Marginal	3278	4199	2.9	8.81
Small	9172	7233	8.12	15.17
Semi medium	20557	16579	18.2	34.77
Medium	52014	15337	46.05	32.16
Large	27934	4337	24.73	9.1
All classes	112955	47685	100	100

Source: https://agcensus.dacnet.nic.in/DL/districtT1table2.aspx

The data indicates that the majority of agricultural holdings in both districts fall under the medium and semi-medium categories. In Sriganganagar, the medium category has the highest percentage share (46.05%), while in Fazilka, the semi-medium category has the highest percentage share (34.77%).

Figure-3.4: Size of Landholding (Sriganganagar)

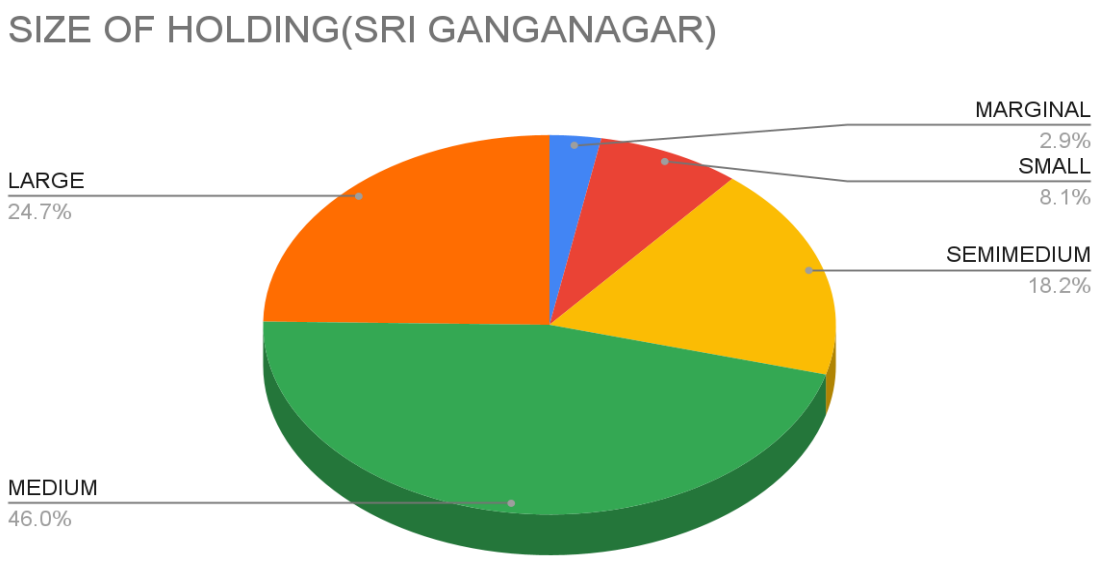
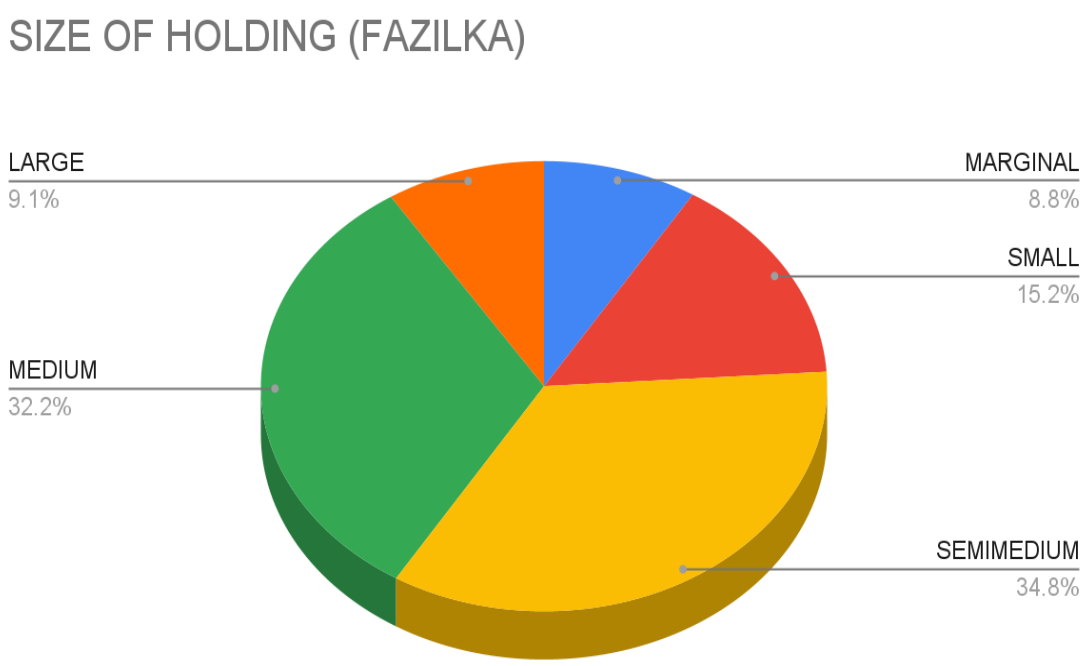


Figure-3.5: Size of Landholding (Fazilka)



The marginal and small categories have relatively low percentage shares in both districts. The large category has a higher percentage share in Sriganganagar (24.73%) compared to Fazilka (9.1%). This data can provide insights into the landholding patterns of farmers in these districts, which can have implications for their socio-economic conditions.

Comparison of the Number of Workers:-

According to the 2011 census, the total number of workers in Sriganganagar was 912672 and the total number of workers in Fazilka was 387817. The number of main workers was 680563 in Sriganganagar and 319058 in Fazilka. Similarly, the number of marginal workers was 232109 in Sriganganagar and 68759 in Fazilka. The percentage of main workers in the total population in Sriganganagar was 34.56 percent and in Fazilka it was 31.10 percent. The percentage of main workers in the total population is higher in Sriganganagar than in Fazilka.

Table 3.6: Number of Workers (Census-2011)

	Sriganganagar(Rajasthan)	Fazilka(Punjab)
Total workers	912672	387817
Main workers	680563	319058
Marginal workers	232109	68759
% Of the main workers in the population	34.56%	31.10%

Source;-District Census Handbook Ganganagar 2011, Punjab at a glance (district wise) 2019

Share of SC/ST Population:

The data provided in Table 3.7 represents the population of Scheduled Castes (SC) and Scheduled Tribes (ST) in two districts - Sriganganagar in Rajasthan and Fazilka in Punjab - as recorded in the 2011 census. In Sriganganagar, the SC population is 720,412, which accounts for 36.58% of the total population of the district. The ST population is 13,477, which accounts for 0.68% of the total population. In contrast, in Fazilka, the SC population is 226,255, which accounts for 42.03% of the total population of the district. However, there is no recorded ST population in Fazilka. The percentage of the SC population in Sriganganagar is lower than that of Fazilka, but it still constitutes a significant proportion of the total population. The ST population, on the other hand, is very low in both districts, with Sriganganagar having a slightly higher percentage than Fazilka.

Table 3.7: Scheduled Caste and Scheduled Tribes Population (Census-2011)

	SC	% of SC	ST	% of ST
Sriganganagar(Rajasthan)	720412	36.58%	13477	0.68%
Fazilka(Punjab)	226255	42.03%	Nil	Nil

Source:-District Census Handbook Ganganagar 2011, Punjab at a Glance (district wise) 2019

It is important to note that SC and ST are considered marginalized communities in India and are granted certain benefits and reservations in education and employment opportunities by the government to uplift their socio-economic status. Therefore, the data on the SC and ST population is crucial for understanding the socio-economic status of these communities in the respective districts.

Land use:

The data provided in Table 3.8 represents the land use in two districts - Sriganganagar in Rajasthan and Fazilka in Punjab - for the year 2015-16. In Sriganganagar, the total number of holdings is 112,955, while in Fazilka it is 47,685. The total area in Sriganganagar is 859,112 hectares, while in Fazilka it is 216,329 hectares. The net area sown in Sriganganagar is 805,345 hectares, while in Fazilka it is the same as the total area, which indicates that all the land in Fazilka is being cultivated. The area under current fallows in Sriganganagar is 43,431 hectares, while in Fazilka there is no current fallow land. The net cultivated area in Sriganganagar is 848,776 hectares, while in Fazilka it is 216,329 hectares.

The other uncultivated land, excluding fallow land, in Sriganganagar is 10,336 hectares, while in Fazilka it is 0. In terms of uncultivated land, Sriganganagar has 10,336 hectares of land not currently being used for cultivation, while in Fazilka there is no uncultivated land. However, it is important to note that this does not necessarily mean that all available land is being used productively. In both districts, there is no land categorized as fallow land other than current fallows or culturable wasteland.

Table 3.8: Comparison of Land Use (2015-16)

		Sriganganagar (rajasthan)	Fazilka (punjab)
Total holdings	Number	112955	47685
	Area (ha.)	859112	216329
Net area sown (ha.)		805345	216329
Area under current fallows (ha.)		43431	0
Net cultivated area (ha.)		848776	216329
Other uncultivated land excluding fallow land (ha.)		10336	0
Fallow land other than current fallows (ha.)		0	0
Cultivable waste land (ha.)		0	0
Total uncultivated land (ha.)		10336	0
Land not available for cultivation (ha.)		0	0

Source: https://agcensus.dacnet.nic.in/DL/districtT1table2.aspx

Additionally, no land is available for cultivation in either district. Overall, the data on land use is important for understanding the agricultural and economic activities of the respective regions. It can provide insights into the availability of land for cultivation, productivity, and utilization of land resources in the region.

Operational holdings in Sriganganagar and Fazilka:-

The size of the holding has a significant impact on agricultural production and farming practices. There should also be a suitable ratio of land with labor and other means for agricultural production, otherwise, agriculture will not be able to be done efficiently. Most of the farms in India are very small. It is not easy to increase production by cultivating these fragmented and small farms. It is said that as long as most of the holdings are small, equipment is inadequate and unbalanced, and technology is backward, it is very difficult to increase production and remove poverty in agriculture. Many words are used to indicate the appropriate unit of agriculture, such as economic holding, family holding, optimum holding, basic holding maximum holding, etc. But before understanding the meaning of these words, it is necessary to understand the difference between landowner's holding and farmer's holding. Owner's Holding refers to the size of the land which is owned by a person. This ownership can be in the form of a landowner, tenant, or lessee. The landlord doesn't need to cultivate all his land on his own.

Table 3.9: Comparison of Operational Holding by Size Groups (2015-16)

	No. of Holdings		Percentage	
	Sriganganagar	Fazilka	Sriganganagar	Fazilka
Marginal	3278	4199	2.9	8.81
Small	9172	7233	8.12	15.17
Semimedium	20557	16579	18.2	34.77
Medium	52014	15337	46.05	32.16
Large	27934	4337	24.73	9.1

Source: https://agcensus.dacnet.nic.in/DL/districtT1table2.aspx

He/she cultivates some part himself and gives the remaining part to someone else on rent that part of the land which is cultivated by the farmer is called 'Cultivator's holding'. Both the landowner's holding and the cultivator's holding can be the same, whereas the landowner himself cultivates all his land. Conversely, if a landlord gives

some of his land on rent to someone else for cultivation and retains the rest of the land for cultivation, then the landowner's holding and cultivator's holding may be different. In the present chapter, the meaning of agricultural holding is from the agricultural holding itself. This is also called Operational Holding.

The data provided in Table 3.9 represents the comparison of operational holdings by size groups in two districts - Sriganganagar in Rajasthan and Fazilka in Punjab - for the year 2015-16. In Sriganganagar, there are a total of 112,955 holdings, while in Fazilka there are 47,685 holdings. The data is categorized into five size groups, namely marginal, small, semi-medium, medium, and large. In Sriganganagar, there are 3,278 marginal holdings, which constitute 2.9% of the total holdings, while in Fazilka, there are 4,199 marginal holdings, which constitute 8.81% of the total holdings. Smallholdings in Sriganganagar are 9,172, which is 8.12% of the total, while in Fazilka, there are 7,233 small holdings, which constitute 15.17% of the total. Semi-medium holdings in Sriganganagar are 20,557, which is 18.2% of the total holdings, while in Fazilka, there are 16,579 semi-medium holdings, which constitute 34.77% of the total. Medium holdings in Sriganganagar are 52,014, which is 46.05% of the total holdings, while in Fazilka, there are 15,337 medium holdings, which constitute 32.16% of the total. Large holdings in Sriganganagar are 27,934, which is 24.73% of the total holdings, while in Fazilka, there are 4,337 large holdings, which constitute 9.1% of the total. Overall, the data on operational holdings by size groups is important for understanding the distribution of land among different categories of farmers in the respective regions. It can provide insights into the distribution of land resources, agricultural productivity, and the economic activities of different groups of farmers in the region.

Comparison of Operational Holding by Size Groups (2015-16)-Scheduled Caste:

Data provided in table 3.10 is a comparison of operational holdings by size groups in two different districts - Sriganganagar in Rajasthan and Fazilka in Punjab, for the year 2015-16. The focus of this particular comparison is on the number and percentage of holdings owned by individuals belonging to the Scheduled Caste community.

Table 3.10: Comparison of Operational Holding by Size Groups (2015-16)-Scheduled Caste

	No. of holdings		Percentage	
	Sriganganagar	Fazilka	Sriganganagar	Fazilka
Marginal	644	1172	2.79	11.56
Small	2119	1845	9.18	18.2
Semi medium	4453	4700	19.29	46.37
Medium	11598	2287	50.25	22.56
Large	4268	132	18.49	1.3
Total	23082	10136	100	100

Source: https://agcensus.dacnet.nic.in/DL/districtT1table2.aspx

The data shows that in Sriganganagar, there were a total of 23,082 operational holdings owned by individuals belonging to the Scheduled Caste community, while in Fazilka, the number was 10,136. Across all size groups, Sriganganagar had a higher number of holdings than Fazilka, except for the Marginal size group. In terms of percentages, the data shows that in Sriganganagar, the majority of holdings owned by Scheduled Caste individuals were in the Medium and Semi Medium size groups, with a combined percentage of 68.54%. In contrast, in Fazilka, the majority of holdings were in the semi-medium and small size groups, with a combined percentage of 64.37%. Overall, the data suggests that there are differences in the distribution of operational holdings across different size groups in these two districts, with Sriganganagar having a higher percentage of holdings in the larger size groups. Additionally, the data highlights the number of operational holdings owned by individuals belonging to the Scheduled Caste community in each district.

Comparison of Operational holding by size groups (2015-16)-Scheduled tribes:

The data represented in table-3.11 the number of operational holdings and their percentage distribution by size groups for Scheduled Tribes in the Sriganganagar district of Rajasthan and Fazilka district of Punjab. In the Sriganganagar district, there were a total of 4 operational holdings owned by Scheduled Tribes, out of which 1 holding belonged to the semi-medium size group, 2 to the medium size group, and 1 to the large

size group. In the Fazilka district, there were no operational holdings owned by Scheduled Tribes in any of the size groups.

Table 3.11: Comparison of Operational Holding by Size Groups (2015-16)-S.T.

	No. of holdings		Percentage	
	Sriganganagar	Fazilka	Sriganganagar	Fazilka
Marginal	0	0	0	0
Small	0	0	0	0
Semimedium	1	0	25	0
Medium	2	0	50	0
Large	1	0	25	0
Total	4	0	100	0

Source: https://agcensus.dacnet.nic.in/DL/districtT1table2.aspx

The data indicates that the presence of Scheduled Tribes in these districts is very low, and they have limited land ownership in the agricultural sector.

Female holdings:

The percentage of female land ownership is a significant indicator of gender equality and women's socioeconomic status. Access to land empowers women to generate income, contribute to household decision-making, and improve their overall well-being. This data shows in table-3.12 the comparison of operational holding by size groups in two districts, Sriganganagar and Fazilka, based on the gender of the holders, as of 2015-16. The number of holdings and the percentage for each size group are given for both districts. In Sriganganagar, there were a total of 3,612 holdings by female holders, with the largest number being in the medium-size group with 1,664 holdings (46.07% of the total female holdings). The smallest number of female holdings was in the large size group with 828 holdings (22.92% of the total female holdings).

In Fazilka, there were a total of 1,254 holdings by female holders, with the largest number being in the small size group with 299 holdings (23.84% of the total female holdings). The smallest number of female holdings was in the large-size group with 100 holdings (7.97% of the total female holdings). Overall, in both districts, the medium-sized group had the largest percentage of female holdings, with Sriganganagar having a

higher percentage than Fazilka. The small-size group had the second-largest percentage of female holdings in both districts.

Table 3.12: Comparison of Operational Holding By Size Groups (2015-16)-Female

	No. of holdings		Percentage	
	Sriganganagar	Fazilka	Sriganganagar	Fazilka
Marginal	199	255	5.51	20.33
Small	301	299	8.33	23.84
Semimedium	620	362	17.29	28.87
Medium	1664	238	46.07	18.98
Large	828	100	22.92	7.97
Total	3612	1254	100	100

Source: https://agcensus.dacnet.nic.in/DL/districtT1table2.aspx

Irrigation status of the operational holdings:

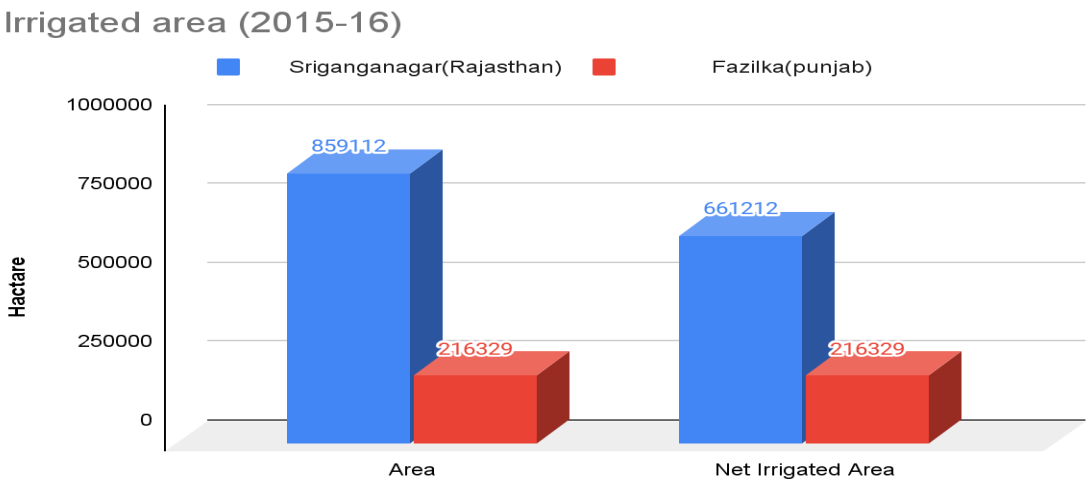
The given data in table-3.13 provides information on the irrigation status of the operational holdings in Sriganganagar (Rajasthan) and Fazilka (Punjab) during the year 2015-16. The data includes the number of holdings and the total area of holdings in hectares. According to the data, the total number of operational holdings in Sriganganagar is 112,955, and the total area is 859,112 hectares, while in Fazilka, the number of operational holdings is 47,685, and the total area is 216,329 hectares.

Table 3.13: Irrigation Status (2015-16)

	Size class(ha)	Sriganganagar (rajasthan)	Fazilka (punjab)
Total holdings	Number	112955	47685
	Area	859112	216329
Wholly irrigated holdings	Number	88659	47685
	Area	588467	216329
Wholly un-irrigated holdings	Number	11234	0
	Area	90793	0
Partly irrigated holdings	Number	12087	0
	Total area	126085	0
	Irrigated area	72745	0
Holdings receiving irrigation	Number	100746	47685
	Net irrigated area	661212	216329

Source of data: Agriculture census (2015-16)

Figure-3.6: Comparison of Irrigated Area



Source of data: Agriculture census (2015-16)

The data also reveals that in Sriganganagar, out of the total operational holdings, 88,659 holdings, covering an area of 588,467 hectares, were wholly irrigated, and 11,234 holdings, covering an area of 90,793 hectares, were wholly un-irrigated. On the other hand, in Fazilka, all the holdings received irrigation, and there were no wholly unirrigated holdings. The data further shows that there were 12,087 partly irrigated holdings in Sriganganagar, covering a total area of 126,085 hectares, out of which 72,745 hectares were irrigated. In Fazilka, there were no partly irrigated holdings

The data also provides information on the net irrigated area, which is 661,212 hectares in Sriganganagar and 216,329 hectares in Fazilka. Additionally, the data reveals that in Sriganganagar, 100,746 holdings received irrigation, while in Fazilka, all the holdings received irrigation.

This chapter exclusively utilizes secondary data to conduct a comprehensive socio-economic comparison between Kinnow growers in Rajasthan and Punjab. The analysis is based on various published sources, including government reports, census data, agricultural surveys, and economic reviews. By relying solely on secondary data, the chapter aims to offer an in-depth understanding of the disparities and trends in socio-

economic characteristics, focusing on critical variables such as landholding patterns, irrigation infrastructure, literacy rates, and agricultural productivity.

1. Geographical Context:

The chapter draws on geographical and demographic data from official sources to describe the contrasting landscapes of Rajasthan and Punjab. Rajasthan, with its arid and semi-arid zones, is heavily dependent on canal irrigation, while Punjab is characterized by fertile alluvial soils and advanced irrigation networks that support its highly productive agriculture.

2. Socio-Economic Indicators:

Secondary data from government censuses and economic surveys reveal significant differences in socio-economic development between the two states. Punjab demonstrates higher levels of infrastructure development, literacy, and per capita income compared to Rajasthan. Data from the 2011 Census and Economic Review Reports underscore these contrasts, showing that Punjab has a literacy rate of 75.8%, while Rajasthan lags behind at 66.1%. Per capita income is similarly higher in Punjab, reflecting its stronger agricultural productivity and industrial growth.

3. Agricultural and Landholding Patterns:

Data from agricultural censuses provides a detailed comparison of landholding structures. In Punjab, the average operational holding is smaller but more productive due to better irrigation and farming techniques, whereas Rajasthan has larger landholdings but faces challenges with irrigation and productivity. Fazilka (Punjab) is noted for its smaller, more efficiently irrigated farms, while Sriganganagar (Rajasthan) features larger but less uniformly irrigated landholdings.

4. Demographic and Economic Data:

Population data from the Census of India highlights the demographic differences between the two states. Sriganganagar has a higher population density, while Fazilka shows better indicators for urbanization and literacy. This section also examines workforce distribution, showing a higher proportion of agricultural workers in Rajasthan, whereas Punjab benefits from a more diversified economy.

5. Social Representation:

Secondary data sources also shed light on the caste composition of Kinnow growers. In both regions, the majority of farmers belong to the General and OBC categories, with SC populations also playing a significant role. However, the representation of ST populations is negligible in both areas, reflecting broader regional demographics.

6. Education and Literacy:

Education data from government sources, such as the District Census Handbooks, reveal that Kinnow farmers in both states generally have higher education levels compared to the national average for rural areas. The data shows a substantial portion of farmers in both Fazilka and Sriganganagar having completed secondary or higher education, which is expected to positively impact farm management practices.

7. Land Use and Irrigation:

Secondary data on land use and irrigation from the Agriculture Census demonstrates the disparity between the two regions in terms of irrigation coverage. While Fazilka has almost complete irrigation coverage, Sriganganagar still has significant areas dependent on rainfall, despite the availability of canal irrigation.

Through the exclusive use of secondary data, this chapter highlights the socio-economic contrasts between Kinnow growers in Punjab and Rajasthan. Punjab's Fazilka district is characterized by better irrigation, higher literacy, and smaller but more productive landholdings, while Rajasthan's Sriganganagar district faces challenges related to irrigation, larger landholdings, and lower socio-economic indicators. The secondary data effectively illuminates these disparities, providing a foundation for policy recommendations aimed at improving the socio-economic conditions of Kinnow farmers, particularly in Rajasthan.

CHAPTER-4

TRENDS AND PATTERNS OF KINNOW PRODUCTION

This chapter serves as a foundational framework for the comprehensive exploration of Kinnow production trends and patterns in Rajasthan and Punjab. The least-squares method, using both linear and exponential models, was employed to determine trends in area, production and productivity of kinnow. In particular, the exponential function facilitated the calculation of compound growth rates (CGR) for these variables. Variability, production and productivity of kinnow field were assessed through coefficient of variation (CV). The resulting CV values provided insight into the variability of these factors, shedding light on stability or fluctuations within the kinnow production landscape.

Comparison of area:

Table 4.1 provides a detailed comparison of the Kinnow cultivation area in two major Kinnow growing states of India, namely Fazilka in Punjab and Sriganganagar in Rajasthan, over ten years. The data shows that Fazilka has consistently seen an increase in the Kinnow cultivation area, with a total increase of 11,790 hectares in the ten years, while Sriganganagar has seen only a minimal increase of 9 hectares. The year-wise analysis of the data suggests that the Kinnow cultivation area in Fazilka has grown steadily, with a few exceptions, over the years. The highest increase in the Kinnow cultivation area in Fazilka was observed in 2012-13, with a growth of 2627 hectares, representing an 11.8% increase from the previous year.

The area under Kinnow cultivation in Fazilka has seen a gradual increase since then, with the smallest increase being 805 hectares in 2020-21. On the other hand, the Kinnow cultivation area in Sriganganagar has been inconsistent over the ten years, with a decline in the area observed in 2015-16. The decrease in the area under cultivation was significant, at 15.7%, and the reasons for this decrease are unclear. However, since then, the area has seen some recovery, with a slight increase in the area under cultivation observed in 2016-17.

Table 4.1: Comparison of Year Wise Area under Kinnow

Year	Fazilka(Punjab)			Sriganganagar(Rajasthan)		
	Area (Hectare)	Change in area (Hectare)	% change in area (YOY)	Area (Hectare)	Change in area (Hectare)	% change in area (YOY)
2011-12	22228	-	-	11062	-	-
2012-13	24855	2627	11.81843	11341.59	279.59	2.527481
2013-14	25831	976	3.926775	11585.12	243.53	2.14723
2014-15	26926	1095	4.239093	11890	304.88	2.631652
2015-16	28384	1458	5.414841	10028	-1862	-15.6602
2016-17	29539	1155	4.069194	10228	200	1.994416
2017-18	30758	1219	4.126748	10430	202	1.974971
2018-19	32026	1268	4.122505	10781	351	3.365292
2019-20	33213	1187	3.706364	10981	200	1.855115
2020-21	34018	805	2.42375	11071	90	0.819597
Total		11790			9	

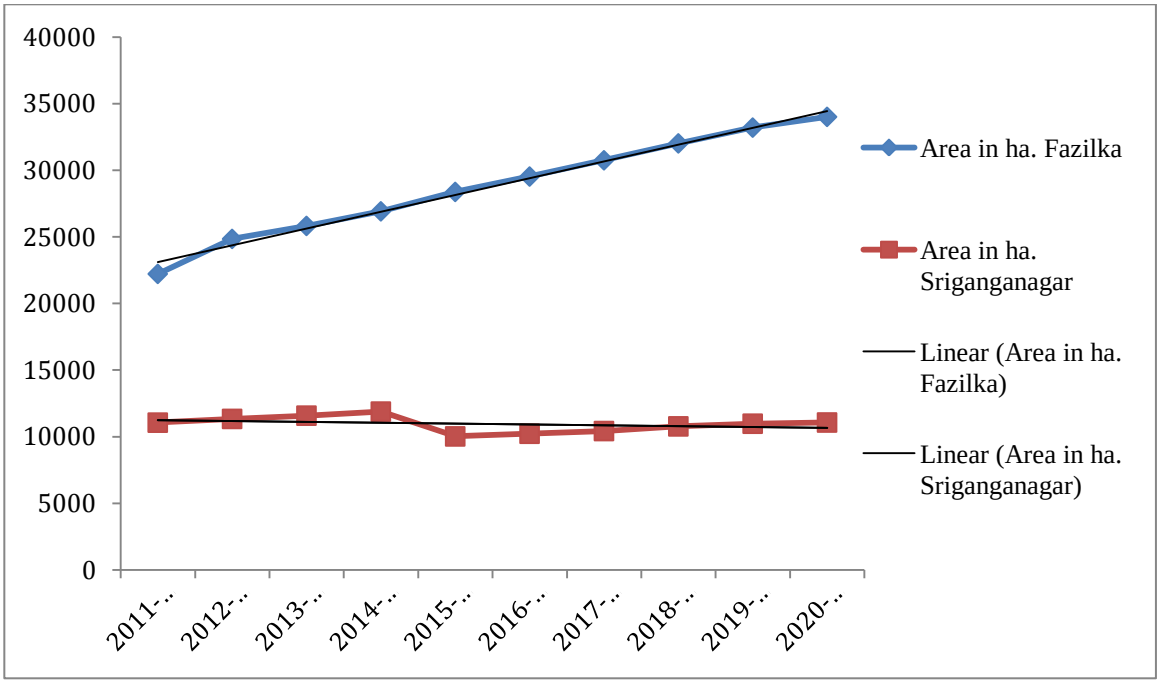
Sources: Office of assistant director horticulture Sriganganagar, department of horticulture Punjab.

Overall, the data suggests that Fazilka has emerged as a major Kinnow cultivation region in India, while Sriganganagar has seen a relatively smaller growth in the area under cultivation. However, the data provides valuable insights for policymakers and stakeholders in the Kinnow cultivation industry in India.

Table 4.2 shows the regression analysis results for the area under Kinnow cultivation in two districts, Fazilka and Sriganganagar, in India. The data includes the intercept, slope, R^2, Compound Annual Growth Rate (C.A.G.R.), standard error (S.E.), trend equation, and type of trend for both districts. The regression analysis for Fazilka shows a strong positive trend. The trend line equation is Y=1262.1x+21836, where Y represents the area under Kinnow cultivation, and x represents the year. The slope value of 1262.1 suggests that the area under Kinnow cultivation has increased by an average of 1262.1 hectares per year. The C.A.G.R. value of 4.57% indicates that the area has been decreasing at an average annual rate of -0.57% over the analysis period. In the case of Sriganganagar, the regression analysis shows a weak trend. The trend line equation is Y=-64.507x+11295, where Y represents the area under Kinnow cultivation, and x represents the year. The slope value of -64.507 suggests that the area under Kinnow

cultivation has decreased by an average of -64.507 hectares per year. However, the small slope values indicate that the trend is not very strong. The C.A.G.R. of -0.57% suggests that the area has been decreasing at an average annual rate of -0.57% over the analysis period.

Figure 4.1: Comparison of Area under Kinnow



Additionally, the exponential regression analysis results for both districts provide a different type of trend analysis. The exponential regression analysis shows that the area under Kinnow cultivation in Fazilka and Sriganganagar has been growing exponentially. The trend equation for Fazilka is Y=22321e0.0447x, where Y represents the area under Kinnow cultivation, and x represents the year. The trend equation for Sriganganagar is Y=11278 e-0.006x. The exponential regression analysis shows a higher growth rate for Fazilka, with an annual growth rate of 4.47%, while Sriganganagar has a much lower growth rate of 0.6%.

Table 4.2: Regression Results of Area under Kinnow for Study Area

Item	District	Slope	Intercept	C.A. G.R.	S.E.	Trend equation	Type of trend
Area under Kinnow	Fazilka	1262.1	21836		407.73	Y=1262.1x+21836	(L)
	Sriganganagar	-64.507	11295		591.02	Y=-64.507x+11295	(L)
	Fazilka			4.57		$Y=22321e^{0.0447x}$	(E)
	Sriganganagar			-0.57		$Y=11278\ e^{-0.006x}$	(E)

Sources: calculated data

In conclusion, the regression analysis provides valuable insights into the trend of the Kinnow cultivation area in the two districts of India. The analysis suggests that Fazilka has a much stronger positive trend than Sriganganagar, with a much higher annual growth rate. This study compares the infrastructure and ancillary support for kinnow cultivation in Fazilka (Punjab) and Sriganganagar (Rajasthan) to explain the differences in the area, production, and productivity of kinnow. Fazilka's orchards are significantly closer to essential services, including bank branches (6.104 km vs. 8.5 km), nurseries (7.81 km vs. 18 km), processing units (4.375 km vs. 17.625 km), and extension services (14.02 km vs. 23.19 km), which facilitates easier access to credit, quality plant material, and agricultural support. These factors enable Fazilka farmers to invest more quickly in inputs and adopt better practices, leading to greater expansion and productivity. While both regions have similar access to cold storage, Fazilka's overall infrastructure ensures more efficient utilization. Proximity to custom hiring centers and fruit markets further boosts Fazilka's production logistics. The study concludes that Fazilka's superior infrastructure supports its faster growth in kinnow cultivation, while Sriganganagar's relative remoteness from key services poses a challenge, emphasizing the need for infrastructure improvements in the region.

Comparison of production:

Table 4.3 compares the production of Kinnow oranges in two districts, Fazilka in Punjab and Sriganganagar in Rajasthan, over ten years from 2011-12 to 2020-21. In 2011-12, Fazilka produced 491,238 MT of Kinnow oranges while Sriganganagar produced 132,275 MT. Over the next few years, both districts showed an increase in

production. In 2012-13, Fazilka's production increased by 59,027 MT or 12.02% while Sriganganagar's production increased by 10,835 MT or 8.19%. The trend continued in the following years, and Fazilka's production increased consistently. However, in 2015-16, Sriganganagar's production decreased by 30,000 MT or 10.34%. This decline continued in the following year, with a decrease of 49,500 MT or 19.04% in 2017-18. On the other hand, Fazilka's production continued to increase at an average annual growth rate of 8.04%. In 2020-21, Fazilka produced 915,623 MT of Kinnow oranges, which is a significant increase of 424,385 MT or 85.98% compared to the production in 2011-12. In terms of overall production, Fazilka produced 2.94 times more Kinnow oranges than Sriganganagar in 2020-21. The data also shows that Sriganganagar's production is more volatile than Fazilka's, with larger fluctuations in the production from year to year. Overall, the data suggests that Fazilka has been more successful in increasing Kinnow orange production consistently over the past decade compared to Sriganganagar.

Table 4.3: Comparison of Year-Wise Production of Kinnow

Year	Fazilka(Punjab)			Sriganganagar(Rajasthan)		
	Production (MT)	Change in production (MT)	% change in production (YOY)	Production (MT)	Change in production (MT)	% change in production (YOY)
2011-12	491238	-	-	132275	-	-
2012-13	550265	59027	12.01597	143110	10835	8.191268
2013-14	583161	32896	5.97821	247947	104837	73.25624
2014-15	635669	52508	9.004031	251200	3253	1.311974
2015-16	670345	34676	5.45504	290000	38800	15.44586
2016-17	699927	29582	4.412952	260000	-30000	-10.3448
2017-18	734962	35035	5.005522	210500	-49500	-19.0385
2018-19	768496	33534	4.562685	280000	69500	33.01663
2019-20	830871	62375	8.116503	180000	-100000	-35.7143
2020-21	915623	84752	10.20038	280000	100000	55.55556
Total		424385			147725	

Sources: Office of assistant director horticulture Sriganganagar, department of horticulture Punjab.

Table 4.4 shows the regression analysis results for the production of Kinnow in the Fazilka and Sriganganagar districts. For Fazilka, the intercept value is 453461, indicating that the expected value of Kinnow production when the year is zero is 453461

MT. The slope of the regression line is 42654, meaning that for every year, the production of Kinnow in Fazilka increases by 42654 MT. The CAGR of 6.47% indicates an average annual growth rate of Kinnow production in Fazilka over the given period. The standard error (SE) value of 18318.79207 is relatively high, indicating some variability in the data. The trend equation for Fazilka is Y = 42654x + 453461, which represents a positive linear trend. For Sriganganagar, the intercept value is 9672.2, indicating that the expected value of Kinnow production when the year is zero is 9672.2 MT. The slope of the regression line is 174306, meaning that for every year, the production of Kinnow in Sriganganagar increases by 174306 MT. The CAGR of 5.17% indicates an average annual growth rate of Kinnow production in Sriganganagar over the given period. The SE value of 52999.3276 is relatively high, indicating some variability in the data. The trend equation for Sriganganagar is Y = 9672.2x + 174306, which represents a positive linear trend.

Figure 4.2: Comparison of Kinnow Production

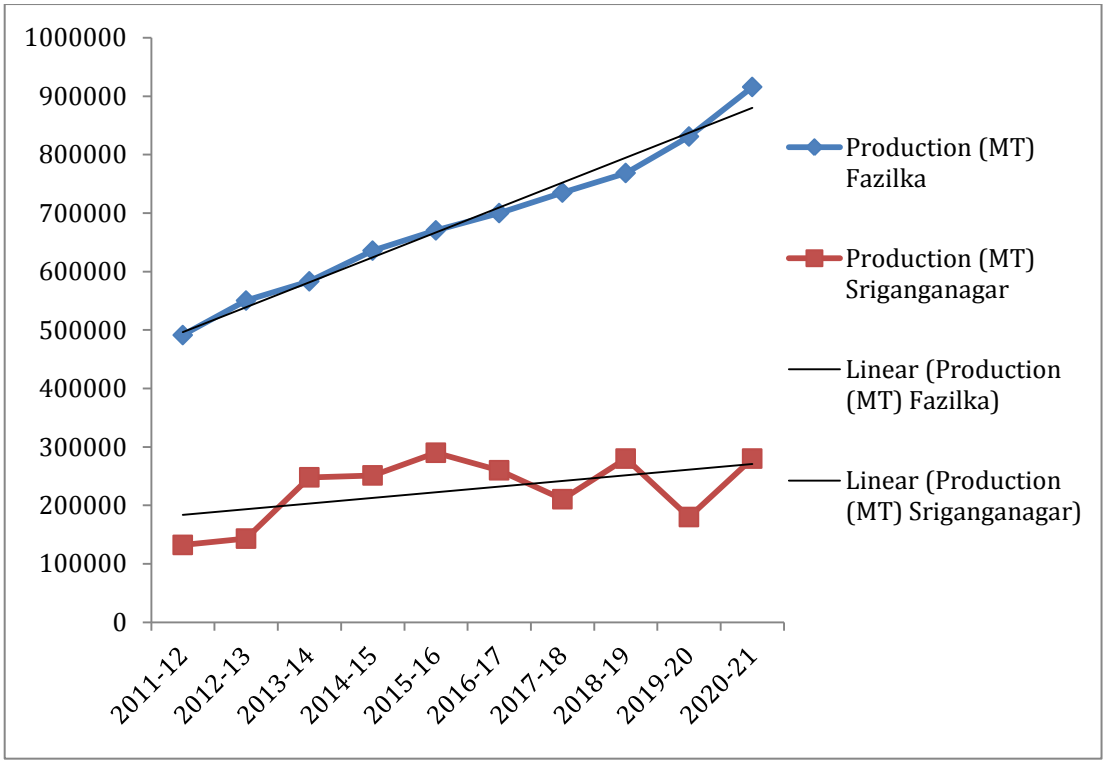


Table 4.4: Regression Results of Kinnow Production for Study Area

Item	District	Slope	Intercept	C.A. G.R.	S.E.	Trend equation	Type of trend
Production of Kinnow	Fazilka	42654	453461		18318.7	Y = 42654x + 453461	(L)
	Sriganganagar	9672.2	174306		52999.3	Y = 9672.2x + 174306	(L)
	Fazilka			6.47		$Y = 479457e^{0.0627x}$	(E)
	Sriganganagar			5.17		$Y = 166605e^{0.0504x}$	(E)

Sources: calculated from data

In addition to the linear trends, the exponential trends for Fazilka and Sriganganagar are also provided. The exponential trend equation for Fazilka is Y = 479457e0.0627x, and for Sriganganagar, it is Y = 166605e0.0504x. Both equations show an increasing trend in Kinnow production over time, and the growth rate is higher for Fazilka than Sriganganagar. Overall, the data indicates that the production of Kinnow has been increasing over time in both districts, but the rate of growth has been higher in Fazilka than in Sriganganagar. The linear regression lines provide a good fit for the data in both districts, but the R^2 value is relatively low for Sriganganagar, indicating that there is more variability in the data. The exponential trend equations show that the growth rate of Kinnow production is increasing over time in both districts. Rajasthan should consider adopting the Citrus Estate model of Punjab to enhance kinnow production and improve the overall quality of citrus crops. The Citrus Estates, strategically established in major citrus-growing regions like Hoshiarpur, Hariana, Abohar, Badal, and Tahliwal Jattan, provide a comprehensive support system for farmers within a 20 km radius. Equipped with scientific centers, disease diagnostic and prevention units, knowledge dissemination hubs, and citrus nurseries, these facilities ensure that farmers have access to the latest technologies and best practices. Furthermore, the Estates supply modern farm implements which are essential for efficient cultivation. By focusing on horticulture, particularly kinnow, Punjab's government aims to diversify its agricultural base, reducing dependence on traditional crops like wheat and paddy, while maximizing the potential of the state's agricultural resources. Implementing a similar model in Rajasthan could significantly

boost the citrus industry, improve fruit quality, and enhance farmers' incomes, ultimately contributing to the region's economic development.

Comparison of Kinnow productivity:

Table 4.5 compares the productivity of Kinnow oranges between two different locations, Fazilka in Punjab and Sriganganagar in Rajasthan, over ten years, from 2011-12 to 2020-21. The productivity is measured in Metric Tons (MT). From the data, it is observed that Fazilka consistently outperformed Sriganganagar in terms of Kinnow productivity over ten years. In 2011-12, the productivity in Fazilka was 22.1 MT, while it was only 11.957 MT in Sriganganagar. By 2020-21, the productivity had increased to 26.915 MT in Fazilka, while it had only reached 25.291 MT in Sriganganagar. The percentage change in productivity is another parameter that can be used to analyze the data.

Table 4.5: Comparison of Kinnow Productivity

Year	Fazilka(Punjab)			Sriganganagar(Rajasthan)		
	Productivity (MT)	Change in productivity (MT)	Percent change in productivity (YOY)	Productivity (MT)	Change in productivity (MT)	Percent change in productivity (YOY)
2011-12	22.1	-	-	11.957	-	-
2012-13	22.139	0.039	0.176471	12.618	0.661	5.528143
2013-14	22.576	0.437	1.973892	21.402	8.784	69.61484
2014-15	23.607	1.031	4.566797	21.126	-0.276	-1.2896
2015-16	23.617	0.01	0.04236	28.919	7.793	36.88819
2016-17	23.695	0.078	0.330271	25.42	-3.499	-12.0993
2017-18	23.894	0.199	0.83984	20.182	-5.238	-20.6058
2018-19	23.996	0.102	0.426885	25.971	5.789	28.68398
2019-20	25.016	1.02	4.250708	16.391	-9.58	-36.8873
2020-21	26.915	1.899	7.591142	25.291	8.9	54.29809
Total		4.815			13.334	

Sources: Office of assistant director horticulture Sriganganagar, department of horticulture Punjab.

In Fazilka, productivity saw a fluctuating but overall positive trend with a total increase of 4.815 MT over ten years. In Sriganganagar, productivity increased sharply in 2013-14 but then saw a downward trend until 2019-20, after which it saw a significant

increase in 2020-21, resulting in a total increase of 13.334 MT over ten years. The year-on-year percentage change in productivity is another important factor. Fazilka saw a minimal increase in productivity in most years, with a maximum increase of 7.59% in 2020-21. On the other hand, Sriganganagar had a few years with significant increases in productivity, such as 69.61% in 2013-14 and 54.29% in 2020-21. However, it also had years with a significant decrease in productivity, such as -36.88% in 2019-20. In conclusion, the data indicates that Fazilka is more productive than Sriganganagar when it comes to Kinnow oranges. However, the data also shows that there is considerable year-to-year variation in productivity, and both locations have seen significant changes in productivity over the ten years.

The data presented in table 4.6 provides information on the productivity of Kinnow oranges in two districts, Fazilka and Sriganganagar. The table presents intercept, slope, Compound Annual Growth Rate (CAGR), standard error (S.E.), trend equation, and the type of trend for each district.

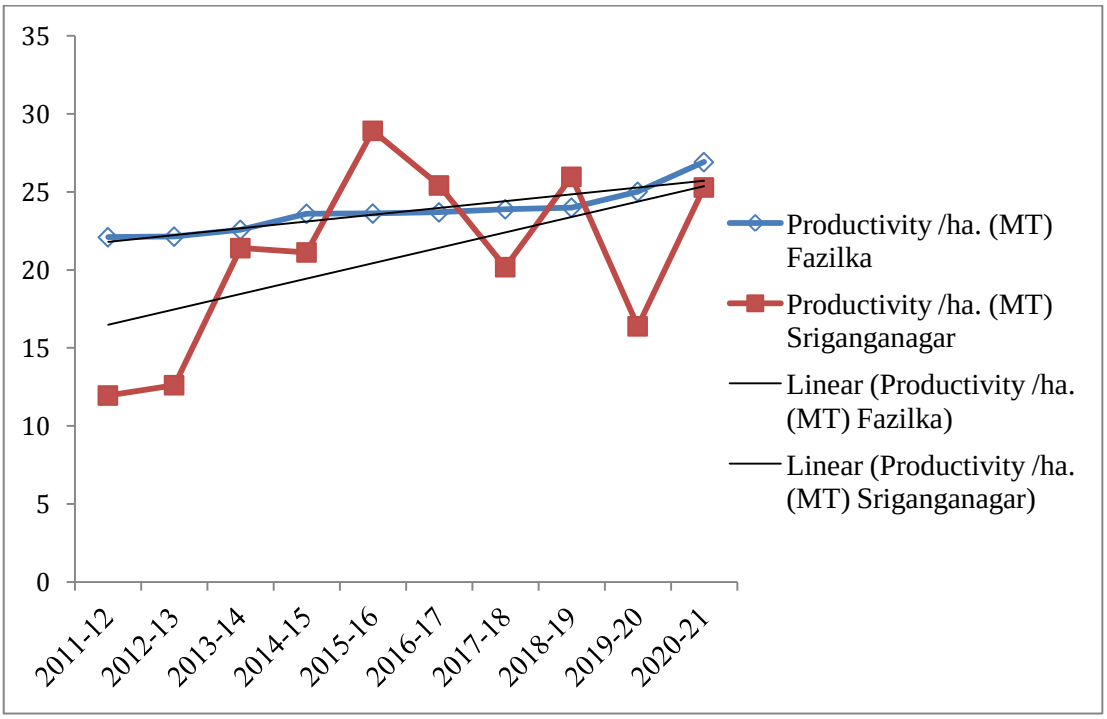
Table 4.6: Regression Results of Productivity of Kinnow for Study Area

Item	District	Slope	Intercept	C.A.G.R.	S.E.	Trend equation	Type of trend
Productivity of Kinnow	Fazilka	0.4334	21.372		0.6031	Y = 0.4334x + 21.372	(L)
	Sriganganagar	0.9875	15.497		5.23208	Y = 0.9875x + 15.497	(L)
	Fazilka			1.82		$Y = 21.48e^{0.018x}$	(E)
	Sriganganagar			5.78		$Y = 14.773e^{0.0562x}$	(E)

Sources: calculated from data

The intercept and slope represent the values of the y-intercept and slope of the linear regression line that is fitted to the data for each district. The intercept for Fazilka is 21.372, which means that if the value of x (year) is zero, the expected productivity of Kinnow oranges in Fazilka is 21.372 MT. The slope for Fazilka is 0.4334 which means that the expected increase in productivity for each year is 0.4334 MT. Similarly, for Sriganganagar, the intercept is 15.497, and the slope is 0.9875.

Figure 4.03: Comparison of Kinnow Productivity



The CAGR value represents the Compound Annual Growth Rate, which is the rate at which productivity has increased or decreased over the years. For Fazilka, the CAGR value is 1.82, which means that the productivity of Kinnow oranges has increased by 1.82 MT per year. For Sriganganagar, the CAGR value is 5.78, which indicates that the productivity has increased by 5.78 MT per year. The standard error (S.E.) represents the standard deviation of the residuals from the regression line. The S.E. value for Fazilka is 0.6031, and for Sriganganagar, it is 5.23208.

The trend equation represents the equation of the regression line. For Fazilka, the trend equation is Y = 0.4334x + 21.372, which means that the expected productivity in Fazilka can be calculated by multiplying the year by 0.4334 and adding 21.372. Similarly, for Sriganganagar, the trend equation is Y = 0.9875x + 15.497. The type of trend indicates whether the trend is linear (L) or exponential (E). For Fazilka and Sriganganagar, the type of trend is linear.

The instability index, which is the ratio of the standard deviation to the mean, is high for production and productivity in both districts, indicating a high degree of

instability in these variables. The instability index is higher in Sriganganagar than in Fazilka, indicating a higher degree of instability in Sriganganagar. The instability index for the area under Kinnow cultivation is low for both districts, indicating a relatively stable area under cultivation. In summary, the data suggest that while the area under Kinnow cultivation has been relatively stable over the years, the production and productivity of Kinnow have been highly unstable, especially in Sriganganagar. This could be due to various factors such as climate variability, pest and disease outbreaks, fluctuation of irrigation water supply in canals, and market fluctuations. Irregular water supply in canals has been identified as a significant issue affecting the fluctuating productivity of kinnow in Ganganagar, Rajasthan. This inconsistency in irrigation hampers the growth and yield of kinnow orchards, making it difficult for farmers to maintain stable production levels. Adequate and reliable water supply is crucial for the efficient management of orchards, particularly in a water-intensive crop like kinnow, and the lack of it exacerbates the challenges farmers face in ensuring consistent productivity. Addressing this problem through improved irrigation infrastructure and water management practices would be essential for stabilizing and enhancing kinnow production in the region.

The given regression results show the trends in area, production, and productivity of Kinnow in two districts of India, Fazilka, and Sriganganagar, from 2011-12 to 2020-2021. The analysis includes the intercept, slope, R^2 value, compound annual growth rate (CAGR), standard error (S.E.), trend equation, and type of trend. The data reveal that the area under Kinnow and its production have increased steadily over the years in Fazilka, while in Sriganganagar; the trend is not as significant. The productivity of Kinnow also shows a positive trend in both districts. The exponential trend equations suggest that the growth rate of area, production, and productivity has slowed down in recent years in both districts. Overall, these results can aid in decision-making processes related to agricultural planning and production in these regions.

The data presented in the table 4.7 shows the mean, standard deviation, coefficient of variation, adjusted R square, and instability index for area, production, and

productivity of Kinnow in Fazilka and Sriganganagar from 2011-12 to 2020-2021. The mean area of Kinnow in Fazilka is much higher than that in Sriganganagar, indicating that Fazilka has more Kinnow orchards. The standard deviation for the area is relatively low for Fazilka, which means that the area under Kinnow cultivation has been relatively stable over the years. In contrast, the standard deviation for the area in Sriganganagar is much higher, indicating a higher degree of variability in the area under Kinnow cultivation. The mean production of Kinnow in Fazilka is also higher than that in Sriganganagar. The standard deviation for the production of Kinnow is relatively high for both districts, indicating that the production has been unstable over the years.

Table 4.7: Instability in Area, Production, and Productivity of Kinnow

	Area Of Kinnow		Production Of Kinnow		Productivity /Hectare	
	Fazilka	Sriganganagar	Fazilka	Sriganganagar	Fazilka	Sriganganagar
Mean	28777.8	10939.771	688055.7	227503.2	23.7555	20.9277
Standard Deviation	3840.40	590.45	130289.96	57917.07	1.431	5.768
C.V.	13.345	5.397	18.93	25.45	6.025	27.56
Adjusted R Square	0.989	-0.002	0.98	0.163	0.821	0.177
Instability Index	1.3996	5.4027	2.678	23.29	2.55	25

Sources: calculated from data

The coefficient of variation (CV) for the production is higher in Sriganganagar than in Fazilka, which indicates greater variability in the production of Kinnow in Sriganganagar. The mean area of Kinnow in Fazilka was 28777.8 hectares, which was much higher than Sriganganagar's mean area of 10939.771 hectares. However, the standard deviation of Fazilka was also higher; indicating greater variation in area over the years. The mean production of Kinnow in Fazilka was 688055.7 metric tonnes, which was much higher than Sriganganagar's mean production of 227503.2 metric tonnes. Again, the standard deviation of Fazilka was higher, indicating greater variation in production over the years. The mean productivity per hectare of Kinnow in Fazilka was 23.7555, while in Sriganganagar, it was 20.9277. The coefficient of variation for productivity in Sriganganagar was much higher; indicating more significant fluctuations

in productivity over the years. The adjusted R square shows a high correlation between area and production in both districts. However, productivity has a weaker correlation with production in Sriganganagar than in Fazilka. Finally, the instability index shows that Sriganganagar has a higher degree of instability in all three measures than Fazilka.

- The mean productivity of Kinnow per hectare is higher in Fazilka than in Sriganganagar. The standard deviation for the productivity of Kinnow per hectare is relatively low for Fazilka, which indicates that the productivity has been relatively stable over the years. However, the standard deviation for the productivity in Sriganganagar is much higher, indicating a higher degree of variability in the productivity of Kinnow per hectare. In the Fazilka district:
- For the "Area of Kinnow," the coefficient for "Time" is highly significant ($p<0.001$), with a t-value of 28.115.
- For the "Production of Kinnow," the coefficient for "Time" is also highly significant ($p<0.001$), with a t-value of 21.149.
- For the "Productivity of Kinnow," the coefficient for "Time" is highly significant ($p<0.001$), with a t-value of 6.493.
- In the Sriganganagar district:
- For the "Area of Kinnow," the coefficient for "Time" is not significant (NS), with a t-value of -0.991.
- For the "Production of Kinnow," the coefficient for "Time" is not highly significant ($p=0.136$), with a t-value of 1.658.
- For the "Productivity of Kinnow," the coefficient for "Time" is not significant (NS), with a t-value of 1.714.

These results indicate that the effect of time on the dependent variables varies by district and the specific dependent variable being examined. In Fazilka, time has a highly significant effect on the "Area of Kinnow," "Production of Kinnow," and "Productivity of Kinnow." In Sriganganagar, the effect of time is not significant for the "Area of Kinnow" and "Productivity of Kinnow," but it is somewhat significant ($p=0.136$) for the "Production of Kinnow."

In Fazilka, all coefficients for different combinations of dependent and independent variables were statistically significant at all significance levels (1%, 5%, and 10%). However, in Sriganganagar, none of the coefficients were statistically significant at any common significance level. The impact of the "Time" variable on the dependent variable varied between districts, with Fazilka generally stronger and statistically significant relationships, while Sriganganagar exhibited weaker and often non-significant relationships.

Chapter 4 focuses on the trends and patterns of Kinnow production in Fazilka (Punjab) and Sriganganagar (Rajasthan). It combines agricultural economics, horticultural science, and socio-economic analysis to examine the growth of Kinnow cultivation in these regions. Key sections include:

Cultivation Area Comparison:

Fazilka saw consistent growth in Kinnow cultivation, with a total increase of 11,790 hectares over ten years. The area under cultivation peaked in 2012-13 with an 11.8% increase.

Sriganganagar had minimal growth, with only a 9-hectare increase over the same period, experiencing significant fluctuations, particularly a 15.7% decline in 2015-16.

Production Comparison:

Fazilka showed a steady increase in Kinnow production, growing from 491,238 MT in 2011-12 to 915,623 MT in 2020-21. The average annual growth rate was 8.04%.

Sriganganagar's production fluctuated more dramatically, with significant declines in some years, notably a 19.04% drop in 2017-18.

Productivity Comparison:

Fazilka consistently outperformed Sriganganagar in terms of productivity, with the former growing from 22.1 MT/hectare in 2011-12 to 26.91 MT/hectare in 2020-21.

Sriganganagar's productivity fluctuated significantly, with years of sharp increases (e.g., 69.61% in 2013-14) followed by steep declines.

Regression Analysis:

Fazilka demonstrated a strong positive trend in area, production, and productivity with high R^2 values and steady growth, indicating consistent expansion of Kinnow cultivation.

Sriganganagar showed weaker trends, with lower R^2 values and greater variability, reflecting less stable growth.

In conclusion, Fazilka has emerged as a leading region for Kinnow production, while Sriganganagar's performance has been more volatile, influenced by factors such as climate and irrigation variability.

CHAPTER-5

SOCIO-ECONOMIC CHARACTERISTICS

This chapter sets the stage for a comprehensive comparison of socio-economic conditions among Kinnow growers in Rajasthan and Punjab. Through empirical analysis and interpretation, the study seeks to identify patterns, trends, and disparities that can inform targeted interventions to enhance the socio-economic well-being of citrus growers and contribute to the overall development of citrus-growing regions. In this chapter, a comparative analysis of the socioeconomic status of Rajasthan and Punjab has been conducted using primary data sources. Socioeconomic conditions of sampled Kinnow growers have been meticulously identified through the study of primary data.

Comparison of Socio-Economic Conditions between Sampled Kinnow Growers

Landholding:

Landholding refers to the ownership or possession of land by individuals or organizations. It is an important socio-economic indicator because it can have a significant impact on the distribution of wealth and resources within a society. In many societies, access to land is closely linked to economic and social status. Individuals and families who own or control significant amounts of land may have more economic opportunities and political power than those who do not. Additionally, land ownership can impact access to resources such as water and minerals, as well as cultural and spiritual practices that are tied to the land.

Land holding of respondent Kinnow farmer:

The table 5.1 represents the landholding of selected Kinnow farmers from two different districts of India: Fazilka in Punjab and Sriganganagar in Rajasthan. The data is categorized based on the size of the farm, and the number and percentage share of farmers in each category are given for both districts. Looking at the data, we can see that the majority of Kinnow farmers in both districts fall under the categories of medium and semi-medium farmers. In Fazilka, 50.42% of the Kinnow farmers fall under the medium

category, while in Sriganganagar, it is even higher at 72.92%. Similarly, in Fazilka, 37.08% of the Kinnow farmers are semi-medium, while in Sriganganagar, it is 13.75%. This suggests that Kinnow farming in these regions is dominated by medium-sized farms.

Table 5.1: Land Holding of Respondent Kinnow Farmer

Type of farmer	Fazilka (Punjab)		Sriganganagar (Rajasthan)	
	Number	Percentage share	Number	Percentage share
Marginal	3	1.25	1	0.417
Small	15	6.25	5	2.083
Semi medium	89	37.083	33	13.75
Medium	121	50.417	175	72.917
Large	12	5	26	10.833
Total	240	100	240	100
Gini coefficient value	0.626		0.51	
Total land of respondents	1282 ha.		1644 ha.	
Mean	5.34 ha.		6.85 ha.	
S.D.	2.617		2.69	

Source: Primary data

Marginal farmers make up a very small proportion of the Kinnow farmers in both districts, with only 1.25% in Fazilka and 0.42% in Sriganganagar. The small and large farm categories also have a relatively low percentage share, with the majority of Kinnow farmers falling under the medium and semi-medium categories. When comparing the two districts, we can see that Fazilka has a higher percentage of small and marginal Kinnow farmers compared to Sriganganagar. This could be due to various factors such as differences in land availability, government policies, or agricultural practices. Additionally, Sriganganagar has a significantly higher percentage of medium-sized Kinnow farms compared to Fazilka.

Figure-5.1: Landholding of Respondent Kinnow Growers of Fazilka

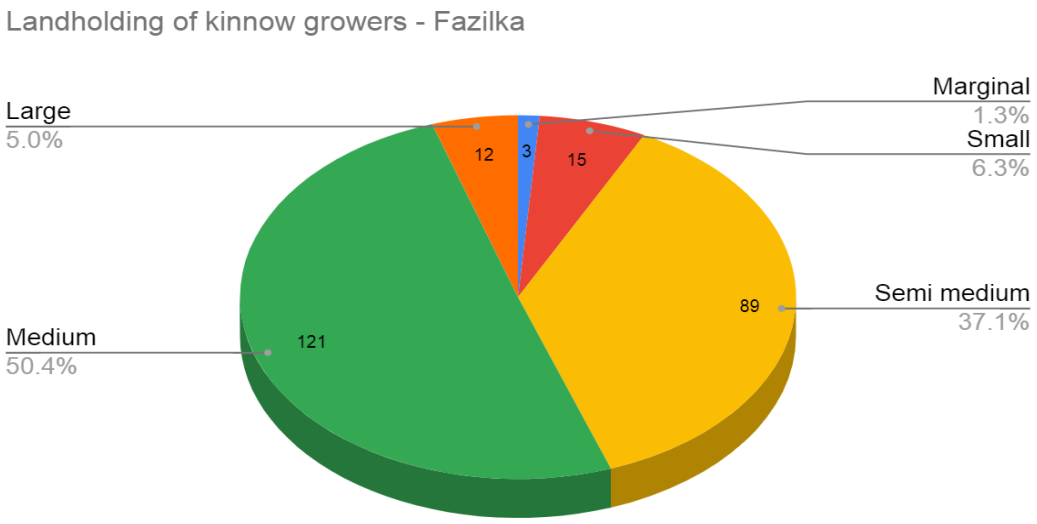
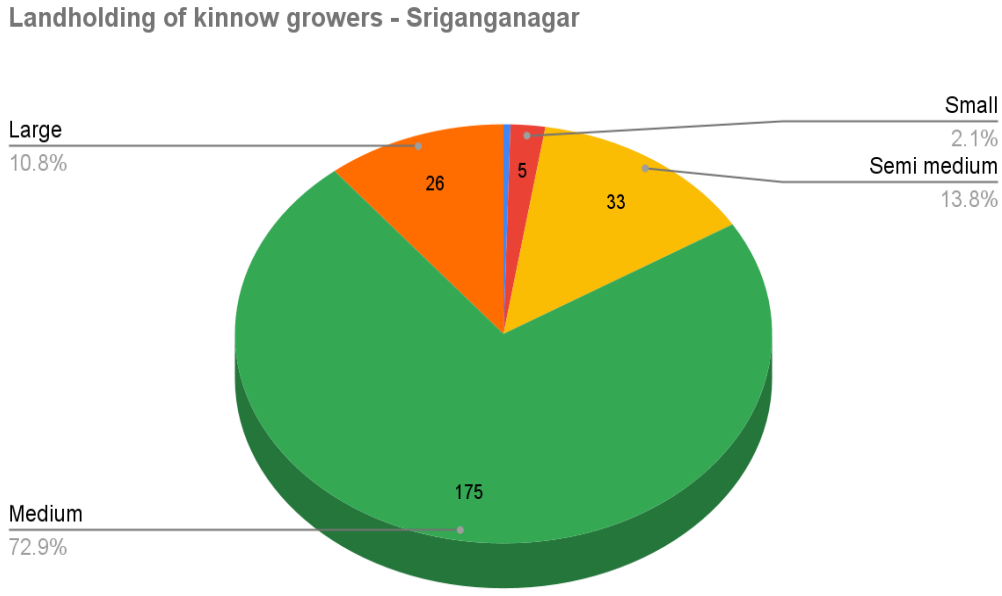


Figure-5.2: Landholding of Respondent Kinnow Growers of Sriganganagar



Overall, this data provides insights into the distribution of landholding among Kinnow farmers in Fazilka and Sriganganagar. It suggests that medium-sized farms dominate the Kinnow farming landscape in these regions, and the distribution of farmers across different farm categories varies between the two districts. In Fazilka, a higher proportion of farmers are in the larger categories of semi-medium and medium, while in Sriganganagar, a larger proportion of farmers are in the smaller categories of marginal and small. In Fazilka, out of 240 farmers, 3 (1.25%) are categorized as marginal, 15 (6.25%) as small, 89 (37.083%) as semi-medium, 121 (50.417%) as medium, and 12 (5%) as large. Similarly, in Sriganganagar, out of 240 farmers, 1 (0.417%) are categorized as marginal, 5 (2.083%) as small, 33 (13.75%) as semi-medium, 175 (72.917%) as medium, and 26 (10.833%) as large.

The total land of respondents in Fazilka is 1282 hectares, with a mean land holding of 5.34 hectares and a standard deviation of 2.617 hectares. In Sriganganagar, the total land of respondents is 1644 hectares, with a mean land holding of 6.85 hectares and a standard deviation of 2.69 hectares. The Gini coefficient measures the degree of inequality in the distribution of landholding among farmers. A value of 0 indicates perfect equality, where each farmer holds an equal share of land. A value of 1 indicates perfect inequality, where one farmer holds all the land. In Fazilka, the Gini coefficient is 0.626, while in Sriganganagar, it is 0.51. The Gini coefficient value for Fazilka indicates a lower degree of inequality in the distribution of landholding among Kinnow farmers as compared to Sriganganagar. In Fazilka, a large proportion of farmers (50.417%) fall in the medium category, indicating a concentration of landholding among a relatively small group of farmers. In contrast, in Sriganganagar, a relatively higher percentage of farmers (72.917%) fall in the medium category, indicating a more equal distribution of landholding among farmers. The Gini coefficient values also confirm that there is a significant difference in the levels of inequality in land ownership between the two regions.

Figure-5.3: Lorenz curve of Landholding for Fazilka

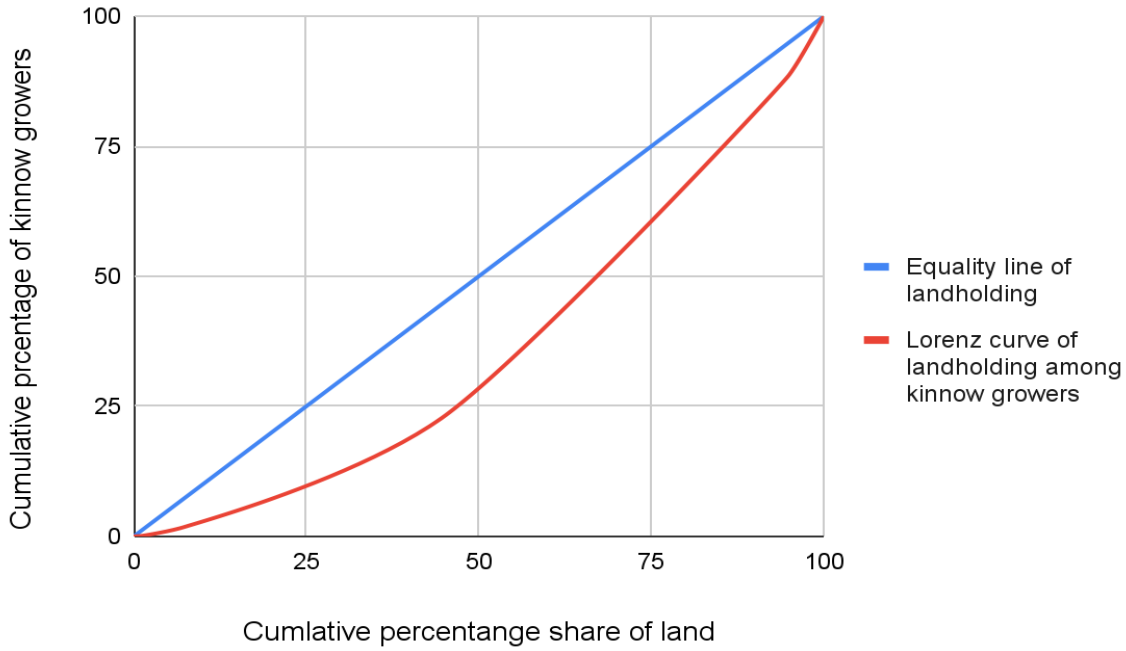
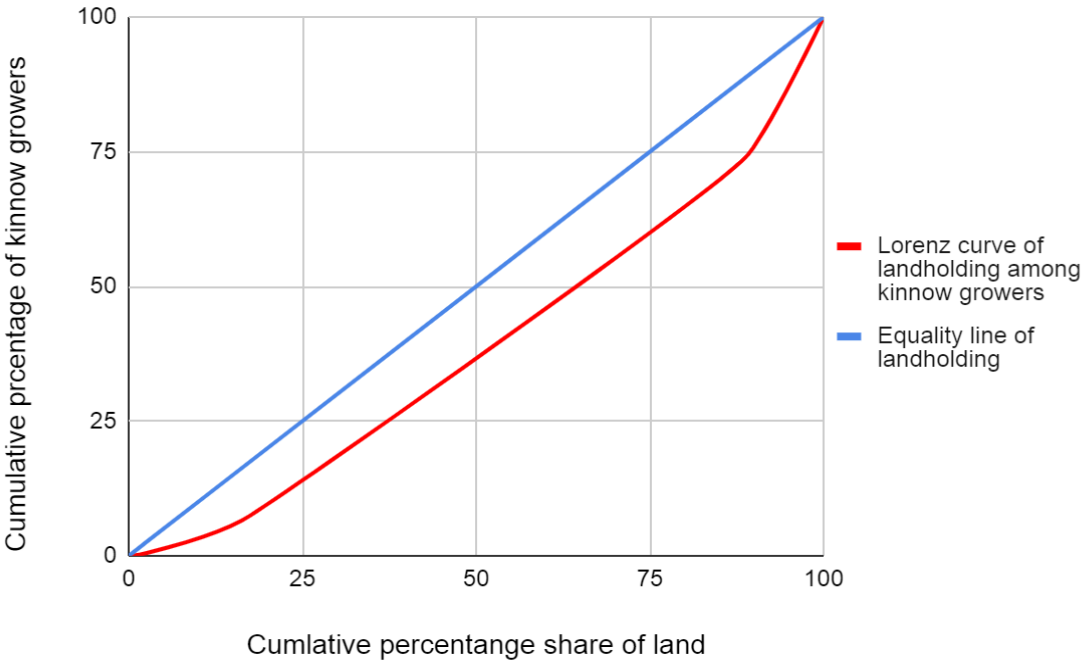


Figure-5.4: Lorenz curve of Landholding for Sriganganagar



Fazilka has a Gini coefficient of 0.626, indicating high levels of inequality, while Sriganganagar has a much lower Gini coefficient of 0.51, indicating a more equal distribution of land ownership. Melkamu & Singh (2016) also revealed a Gini coefficient of 0.499 for agricultural land, 0.476 for livestock holdings, 0.670 for irrigated land, and 0.425 for income distribution. These values indicate a significant level of inequality among the households sampled in Northern Rajasthan.

Landholding block-wise of selected respondent Kinnow farmers for study

Table 5.2 presents data on the selected Kinnow farmers for study, categorized by the type of farmer and district/block in which their orchards are located. The two districts included in the study are Fazilka and Sriganganagar, and the four blocks included are Khuian Sarwar, Abohar, Srikaranpur, and Sriganganagar.

The types of farmers included in the study are marginal, small, semi-medium, medium, and large, based on their landholding size. In Fazilka, the study includes 120 Kinnow farmers, with 2 marginal farmers, 9 small farmers, 43 semi-medium farmers, 59 medium farmers, and 7 large farmers. In Sriganganagar, the study also includes 120 Kinnow farmers, with 1 marginal farmer, 6 small farmers, 46 semi-medium farmers, 62 medium farmers, and 5 large farmers.

Table 5.2: Land Holding Block-Wise Of Selected Respondent Kinnow Farmers for Study

Type of farmer	Fazilka		Sriganganagar		
	Khuian Sarwar	Abohar	Srikaranpur	Sriganganagar	Total
Marginal	2	1	0	1	4
Small	9	6	2	3	20
Semi medium	43	46	17	16	122
Medium	59	62	88	87	296
Large	7	5	13	13	38
Total	120	120	120	120	480

Source: primary data

The data is further categorized by the block in which the farmers are located. In the Khuian Sarwar block, the study includes no marginal farmers, 2 small farmers, 17 semi-medium farmers, 88 medium farmers, and 13 large farmers. In Abohar block, the study includes 1 marginal farmer, 3 small farmers, 16 semi-medium farmers, 87 medium farmers, and 13 large farmers. In Srikaranpur block, the study includes no marginal farmers, 2 small farmers, 3 semi-medium farmers, 46 medium farmers, and no large farmers. In Sriganganagar block, the study includes 1 marginal farmer, 3 small farmers, 16 semi-medium farmers, 62 medium farmers, and 5 large farmers.

- The majority of farmers in all locations fall into the 'Medium' category, with the highest number of Kinnow farmers in Fazilka (59) and Sriganganagar (87).
- The 'Semi-medium' category also has a substantial number of farmers in all locations, with the highest in Sriganganagar (17).
- 'Small' farmers are the third most common category in all locations, with 20 in total.
- 'Marginal' and 'Large' farmers have the smallest representation in all locations.

The data provides insights into the distribution of Kinnow farmers across different categories and blocks in Fazilka and Sriganganagar. Due to limited land availability, small farmers have restricted access to canal water. Since Kinnow is sensitive to saline water, its cultivation depends on the use of canal water.This can help in understanding the diversity of Kinnow growers in the region and their socio-economic conditions.

Age of respondent Kinnow growers:

Age can be used as a socio-economic indicator to understand how various factors impact people differently at different stages of their lives. For example, individuals of different ages may face different employment opportunities and earnings potential, have varying levels of education and health, and may have different access to resources such as housing, healthcare, and retirement benefits. The age structure of a population can also impact economic and social outcomes at the national level. For instance, an aging population may face challenges related to increased healthcare costs and a shrinking workforce, while a younger population may require more investment in education and job training to ensure future economic growth.

Table 5.3: Age-Wise Distribution of Respondent Kinnow Growers

Age	Fazilka			Sriganganagar		
	Khuian Sarwar	Abohar	District total	Srikaranpur	Sriganganagar	District total
20-25	1	0	1	0	2	2
25-30	7	9	16	10	9	19
30-35	18	19	37	21	20	41
35-40	41	39	80	40	38	78
40-45	29	31	60	32	29	61
45-50	15	13	28	12	16	28
Above 50	9	9	18	5	6	11
Total	120	120	240	120	120	240

Source: primary data

Table 5.4: Comparison of Age-Wise Distribution of Respondent Kinnow Growers

Age	Fazilka	Sriganganagar
20-25	1	2
25-30	16	19
30-35	37	41
35-40	80	78
40-45	60	61
45-50	28	28
50-55	18	11
Total	240	240
Mean	39.54	38.85
Standard deviation	6.49	6.21
Minimum	24	25
Maximum	55	55
Range	31	30

Source: primary data

Tables 5.3 and 5.4, compare the age-wise distribution of respondent Kinnow growers from two regions: Fazilka and Sriganganagar. The table displays the number of

respondents in each age group for each region, the total number of respondents, the mean and standard deviation of the age distribution, and the minimum and maximum ages of the respondents. Overall, there were an equal number of respondents from both regions, with 240 respondents from each region. The mean age of respondents from Fazilka was 39.54, and from Sriganganagar were 38.85. The standard deviation of the age distribution was 6.49 for Fazilka and 6.21 for Sriganganagar. Looking at the age-wise distribution, we can see that the majority of respondents in both regions were between the ages of 35-40, with 80 respondents from Fazilka and 78 respondents from Sriganganagar in this age group. The age distribution for both regions is quite similar, with no significant differences between the two regions. According to Tauer (1995), this pertains to farmers in the middle age group who can exert substantial effort to enhance agricultural productivity. Tauer's argument suggests that as farmers reach their midlife, typically around 35-40 years of age, they tend to experience an upturn in productivity due to the accumulation of both experience and equity.

The minimum age of the respondents was 24 in Fazilka and 25 in Sriganganagar, while the maximum age was 55 in both regions. The range of age in Fazilka was slightly higher than that in Sriganganagar, with a range of 31 and 30, respectively. In conclusion, the data shows that the age-wise distribution of respondent Kinnow growers is similar in both regions, with the majority of respondents falling in the age group of 35-40 years. The mean age and standard deviation of the age distribution were also quite similar between the two regions.

Gender:

Gender is an important socio-economic indicator because it helps to highlight how gender inequalities impact individuals and society as a whole. By paying attention to gender-based disparities and taking steps to address them, we can work towards a more equitable and just society for all. The table 5.5 compares the gender distribution of respondent Kinnow growers from four regions: Khuian Sarwar, Abohar, Sriganganagar, and Srikaranpur. The table displays the number and percentage of male and female respondents in each region.

Table 5.5: Comparison of Gender Distribution of Respondent Kinnow Growers

Gender	Fazilka		Sriganganagar	
	Khuian Sarwar	Abohar	Srikaranpur	Sriganganagar
Male	(117) 97.5%	(116) 96.67%	(118) 98.33%	(117) 97.50%
Female	(03) 2.5%	(04) 3.33%	(02) 1.67%	(03) 2.50%
Other	0	0	0	0

Source: primary data

The data shows that the vast majority of respondents in all regions are male, with only a small percentage of female respondents. In human Sarwar, for example, 117 respondents (97.5%) were male, while only three (2.5%) were female. Similarly, in Abohar, 116 respondents (96.67%) were male, while only four (3.33%) were female. This trend is consistent across all regions. In Srikaranpur block, 118 respondents (98.33%) were male, while only two (1.67%) were female. In Sriganganagar, 117 respondents (97.50%) were male, while only three (2.50%) were female. Overall, the data suggests that the Kinnow-growing industry is predominantly male-dominated, with very few female growers. This information can be used to inform policies and programs aimed at promoting gender equity in the industry, including measures to encourage and support women's participation in Kinnow cultivation and related activities.

Marital status:

Marital status is a socio-economic indicator that refers to the legal and social status of individuals in their marital relationships. This indicator provides valuable information about the social and economic conditions of individuals in a particular society. Table 5.6 shows the marital status of respondent Kinnow growers from the Fazilka district of Punjab and Sriganganagar district of Rajasthan. In Fazilka, out of 240 respondents, 235 (97.9%) were married and 5 (2.1%) were single. In Sriganganagar, out of 240 respondents, 234 (97.5%) were married and 6 (2.5%) were single.

Table 5.6: Marital Status of Respondent Kinnow Growers

Marital status	Fazilka (Punjab)		Sriganganagar (Rajasthan)	
	No. of responses	Percentage	No. of responses	Percentage
Married	235	97.92	234	97.5
Single	5	2.083	6	2.5
Total	240	100	240	100

Source: primary data

From the data, it can be inferred that the majority of Kinnow growers in both districts are married. The difference in percentage between the two districts is negligible. Bannor and Madhu (2015) conducted a study on the socioeconomic characteristics of kinnow producers in the Rajasthan state of India and found 97% of Kinnow growers were married.

Caste category-wise distribution of respondent Kinnow growers:

The caste category is a socio-economic indicator that refers to the hierarchical social and occupational groups in a particular society. This indicator provides valuable information about the distribution of social and economic power and resources among different groups. Caste categories can vary significantly across different regions and countries, depending on cultural and historical factors. In general, societies with a caste system are characterized by rigid social hierarchies, where individuals are assigned a particular status and occupation based on their birth and family background. Table 5.7 compares the caste category-wise distribution of respondent Kinnow growers from four regions: Saharanpur, Sriganganagar, Khuian Sarwar, and Abohar. The table displays the number of respondents from each caste category, including general, OBC (Other Backward Classes), SC (Scheduled Caste), and ST (Scheduled Tribe). Overall, the majority of respondents in all regions belonged to the general caste category, with a smaller percentage belonging to the OBC and SC categories. No respondents belonged to the ST category in any of the regions. In the Fazilka block the highest number of respondents was from the general category with 78 respondents, followed by 25

respondents from the OBC category and 17 respondents from the SC category. In Khuian Sarwar and Abohar, the majority of respondents belonged to the OBC category with 90 and 89 respondents respectively, followed by a smaller number of respondents from the general and SC categories.

Table 5.7: Comparison of Caste Category Wise Distribution of Respondent

Cast category	Fazilka		Sriganganagar	
	Khuian Sarwar	Abohar	Srikaranpur	Sriganganagar
General	78	81	12	14
OBC	25	23	90	89
SC	17	16	18	17
ST	0	0	0	0

Source: primary data

Similarly, in Sriganganagar, the highest number of respondents was from the general category with 81 respondents, followed by 23 respondents from the OBC category and 16 respondents from the SC category. In Srikaranpur, the majority of respondents belonged to the OBC category (73 respondents, 61%), followed by the General category (44 respondents, 37%) and the SC category (2 respondents, 2%). No respondents belonged to the ST category in Srikaranpur.

The data shows that the majority of Kinnow growers in all regions belong to the general caste category. However, there are also significant numbers of OBC and SC category respondents in some regions. The absence of any respondents from the ST category because of less population in the study area.

In conclusion, the data suggests that there may be caste-based disparities in the Kinnow-growing industry, with certain caste categories being overrepresented or underrepresented in different regions. Further research may be necessary to understand the reasons behind these disparities and to explore strategies for promoting greater diversity and inclusivity in the industry.

Education among respondent Kinnow growers:

Education is a socio-economic indicator that refers to the level of formal education attained by individuals in a given population. This indicator provides valuable information about the level of human capital and potential for social and economic development.

Table 5.8: Education among Respondent Kinnow Growers Block-Wise

	Education	Informal	Primary	Upper Primary	Secondary	Senior Secondary	Graduation	Post Graduation	Total
Fazilka (Punjab)	Khuian Sarwar	2	3	8	22	30	45	10	120
	Abohar	1	3	9	21	34	44	8	120
	District total	3	6	17	43	64	89	18	240
Sriganganagar (Rajasthan)	Srikaranpur	1	1	8	18	32	47	13	120
	Sriganganagar	0	1	7	20	32	42	18	120
	District total	1	2	15	38	64	89	31	240

Source: primary data

Based on the table 5.9, we can analyze the education level of Kinnow growers as follows: Majority of the Kinnow growers have completed higher education: 89 out of 240 respondents (or 37.08%) in both Fazilka and Sriganganagar have completed graduation, while 18 out of 240 respondents (or 7.5%) have completed post-graduation. This indicates that the Kinnow growers in these regions have a relatively high level of education, which could be an advantage in managing their farms and adapting to changes in the agricultural industry. Secondary and senior secondary education is also popular among Kinnow growers: 43 out of 240 respondents (or 17.92%) in Fazilka and 38 out of 240 respondents (or 15.83%) in Sriganganagar have completed secondary education. 64 out of 240 respondents (or 26.67%) in both regions have completed senior secondary education. This suggests that a significant number of Kinnow growers have completed secondary and senior secondary education, which could have a positive impact on the

overall development of the agricultural sector in these regions. A small proportion of Kinnow growers have only completed informal or primary education: Only 3 out of 240 respondents (or 1.25%) in Fazilka and 1 out of 240 respondents (or 0.42%) in Sriganganagar have completed informal education.

Table 5.9: Education among Respondent Kinnow Growers

Education	Fazilka (Punjab)	Sriganganagar (Rajasthan)
Informal	3	1
Primary	6	2
Upper Primary	17	15
Secondary	43	38
Senior Secondary	64	64
Graduation	89	89
Post Graduation	18	31
Total	240	240

Source: primary data

6 out of 240 respondents (or 2.5%) in Fazilka and 2 out of 240 respondents (or 0.83%) in Sriganganagar have completed primary education. This indicates that the vast majority of Kinnow growers have at least completed upper primary education, which is a positive sign for the overall education level of the population. Overall, the education level of Kinnow growers appears to be relatively high, with a significant number of respondents having completed graduation or post-graduation. However, there are still a few respondents who have only completed informal or primary education. It is important to continue promoting education and training programs for the farming community to ensure sustainable growth and development in the agricultural sector. In Fazilka, the majority of the respondents have completed either graduation (37.08%) or senior secondary (26.67%) education. In comparison, in Sriganganagar, the majority of the respondents have completed either graduation (37.08%) or senior secondary (26.67%) education, but there is a higher percentage of respondents with postgraduate education (12.92%) compared to Fazilka (7.5%).

Figure-5.5: Education Qualifications of Respondent (Fazilka)

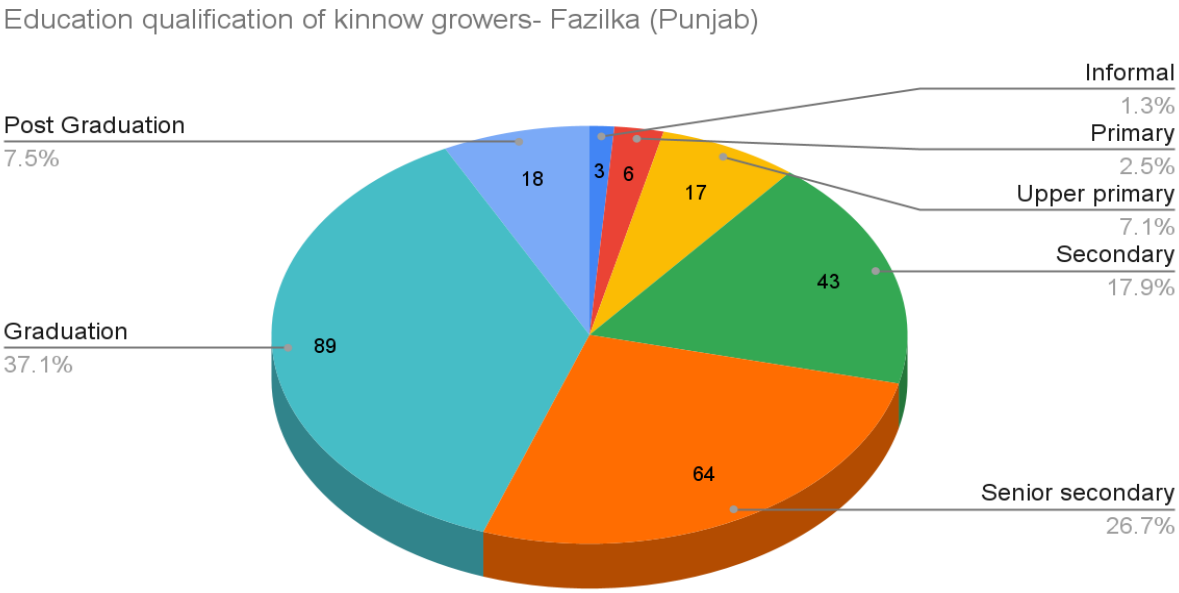
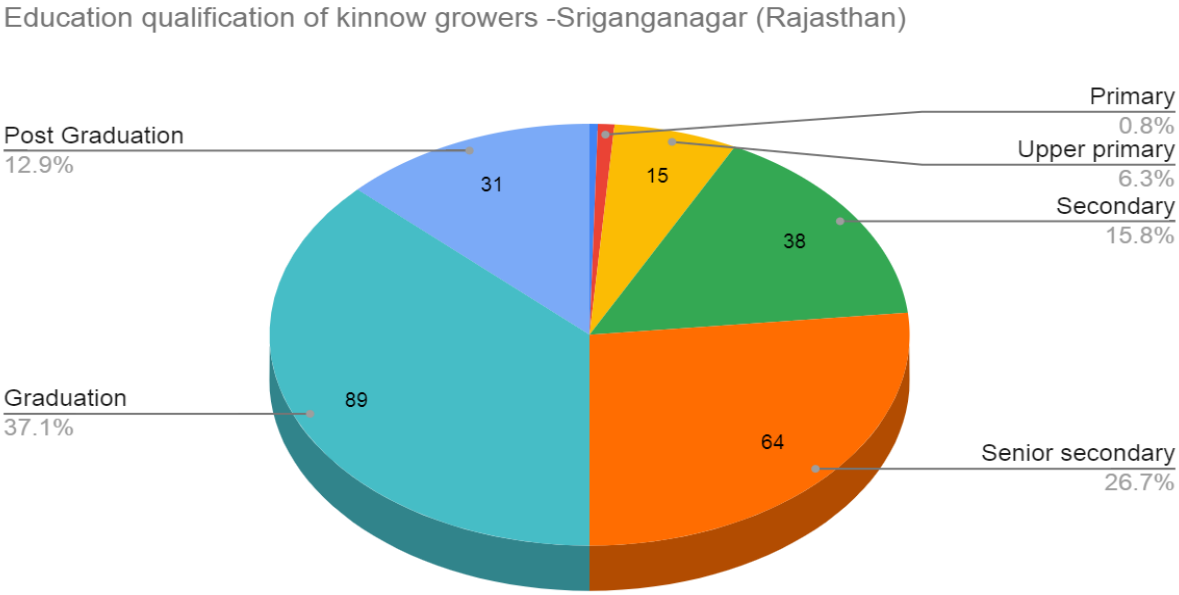


Figure-5.6: Education Qualifications of Respondent (Sriganganagar)



The percentage of respondents with informal education or only primary education is low in both locations, indicating that the majority of the respondents have completed at least upper primary or secondary education.

Overall, the distribution of education levels among respondents is quite similar in both locations, with minor variations in the percentages of respondents with different levels of education.

Level of educational institutions near the respondent Kinnow growers:

The level of educational institutions nearby is a socio-economic indicator that refers to the availability and quality of educational institutions in a particular geographic area. This indicator provides valuable information about the level of educational access and opportunities for individuals in a given region or community.

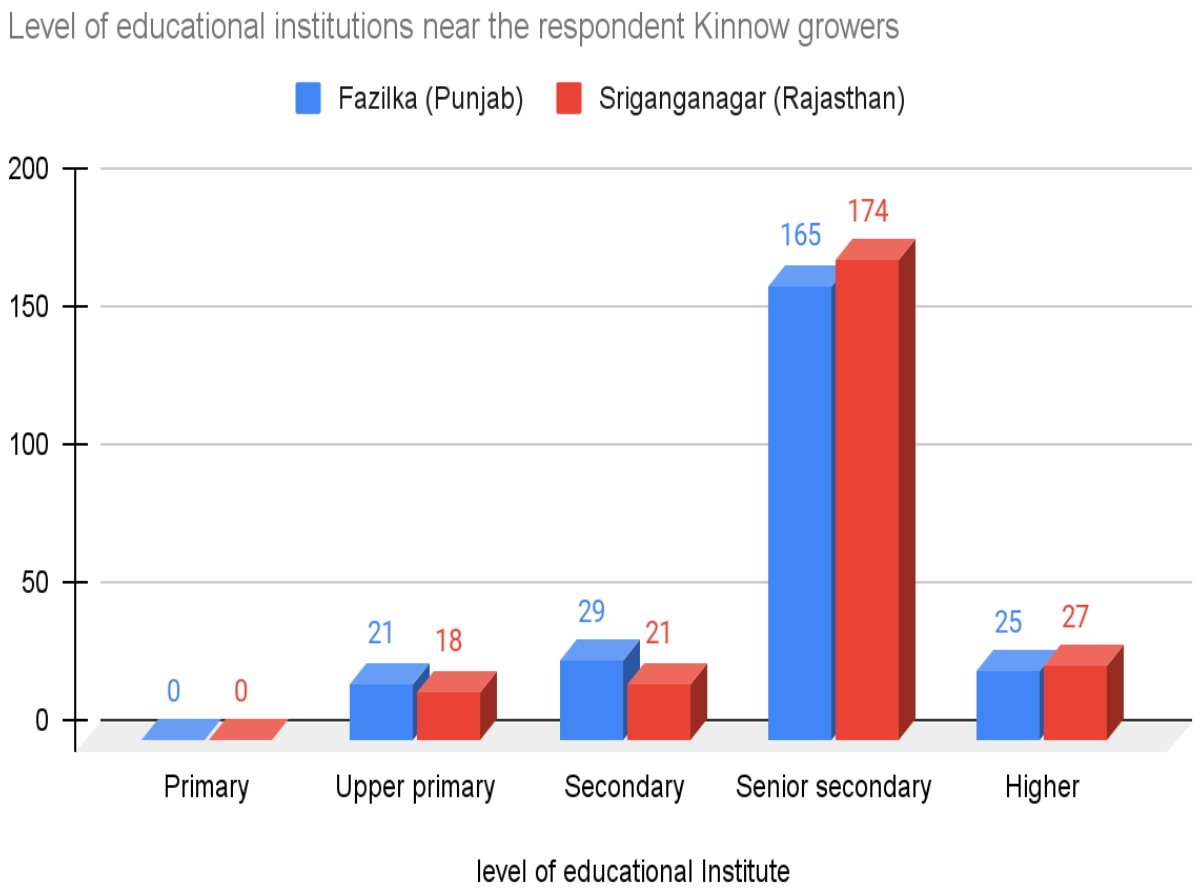
The level of educational institutions nearby can vary significantly across different regions and countries, depending on factors such as population size, urbanization, government investment in education, and cultural and social norms around education. In general, regions with a greater density of educational institutions are likely to have higher levels of educational attainment and greater opportunities for educational advancement. Table 5.10 shows the level of educational institutions near Kinnow growers in two locations: Fazilka in Punjab and Sriganganagar in Rajasthan. The educational institutions are classified into five categories: Primary, Upper Primary, Secondary, Senior Secondary, and Higher. The table also shows the number of responses received for each category in each location. It is important to note that the table does not show the actual number of educational institutions, but rather the number of responses received from Kinnow growers regarding the presence of such institutions in their area. Based on the data presented, it appears that there are more senior secondary-level educational institutions near the Kinnow growers in both Fazilka (Punjab) and Sriganganagar (Rajasthan), with 165 and 174 responses respectively. This is followed by secondary-level institutions, with 29 and 21 responses in Fazilka and Sriganganagar respectively. There are also some higher-level institutions with 25 and 27 responses in Fazilka and Sriganganagar respectively.

Table 5.10: Level of Educational Institutions near the Respondent Kinnow Growers

Level of Educational Institute	Fazilka (Punjab)	Sriganganagar (Rajasthan)
	No. of responses	No. of responses
Primary	0	0
Upper Primary	21	18
Secondary	29	21
Senior Secondary	165	174
Higher	25	27
Total	240	240

Source: primary data

Figure-5.7: Level of Educational Institutions near Respondents' Residence



However, it is important to note that there are no primary or upper primary-level institutions near the Kinnow growers in either Fazilka or Sriganganagar, as there are no responses in these categories. Overall, the data suggests that there are more options for senior secondary education near the Kinnow growers in both Fazilka and Sriganganagar. This could have implications for the quality and accessibility of education for young children in these areas.

Size and type of family:

The size of the family is a socio-economic indicator that refers to the number of individuals living in a household. This indicator provides valuable information about household demographics, living standards, and social and economic characteristics.

The size of a family can vary significantly across different regions and countries depending on cultural, economic, and social factors. Larger families are often associated with lower levels of development, poverty, and limited access to education and healthcare. Smaller families, on the other hand, are often associated with higher levels of development, greater access to education and healthcare, and more opportunities for women.

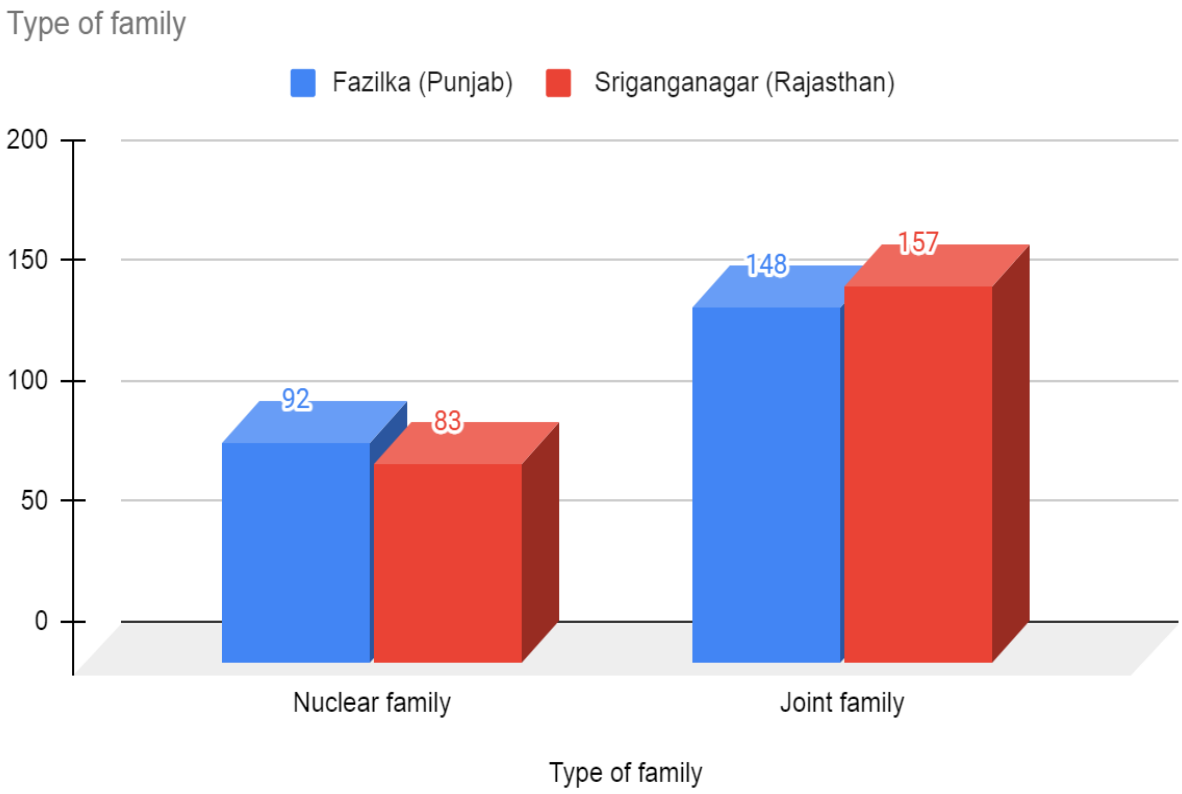
The size of a family can impact a wide range of social and economic outcomes, including household income, employment, health, and education. Larger families may face greater financial constraints due to the need to support a larger number of individuals with limited resources. This can limit opportunities for education, healthcare, and employment, particularly for women and children.

Table 5.11: Family Type of Respondent Kinnow Growers

Type of family	Fazilka (Punjab)		Sriganganagar (Rajasthan)	
	No. of responses	Percentage	No. of responses	Percentage
Nuclear family	92	38.33	83	34.58
Joint family	148	61.67	157	65.42

Source: primary data

Figure-5.8: Family Type of Respondents



The table 5.11 shows the type of family structure among Kinnow growers in two locations: Fazilka in Punjab and Sriganganagar in Rajasthan. The two types of family structures are the Nuclear family and the Joint family. The table also shows the number of responses received and the percentage of respondents in each category. Overall, the data suggests that the majority of Kinnow growers in both locations live in Joint families. In Fazilka, 61.67% of respondents reported living in a Joint family, while 38.33% reported living in a Nuclear family. In Sriganganagar, 65.42% of respondents reported living in a Joint family, while 34.58% reported living in a Nuclear family. However, the data does suggest that the traditional joint family structure is still prevalent among Kinnow growers in these areas. Understanding family structures is important for understanding the social dynamics and support systems available to Kinnow growers. For example, joint families may provide a built-in support system for agricultural activities,

with multiple generations contributing to the labor and knowledge required for successful cultivation. In contrast, nuclear families may have less support available and may be more reliant on hired labor or technology to manage the orchards.

Table 5.12: Family Size of Respondent Kinnow Growers

No. of members	Fazilka (Punjab)	Sriganganagar (Rajasthan)
2	1	1
3	7	5
4	26	23
5	58	54
6	45	48
7	28	31
8	26	26
9	19	21
10	15	14
11	11	12
12	4	5
Mean	6.5875	6.7208
Standard deviation	4.67	4.63
Minimum	2	2
Maximum	12	12
Range	10	10

Source: primary data

The table 5.12 shows the number of family members ranging from 2 to 12, and the data shows that the average family size for Kinnow growers is similar in both locations, with Fazilka having an average of 6.5875 members per family and Sriganganagar having an average of 6.7208 members per family. The standard deviation is also similar in both locations, indicating a similar level of variation in family size. The range of family size is the same in both locations, with the smallest family having 2

members and the largest family having 12 members. The data shows that the majority of Kinnow growers in both locations have families with 4 to 8 members, with the largest number of responses in the 5 and 6-member categories.

Understanding family size is important for understanding the labor and resource needs of Kinnow cultivation. Larger families may have more available labor for managing orchards, while smaller families may need to rely more on hired labor or technology. Additionally, larger families may have different resource needs and consumption patterns than smaller families, which can impact the economic and environmental sustainability of Kinnow cultivation.

Overall, the data suggests that the family size of Kinnow growers in Fazilka and Sriganganagar is similar, with the majority of families having 4 to 8 members. However, further research may be needed to fully understand the impact of family size on Kinnow cultivation and the broader social and economic dynamics of these communities.

Consumption of electricity:

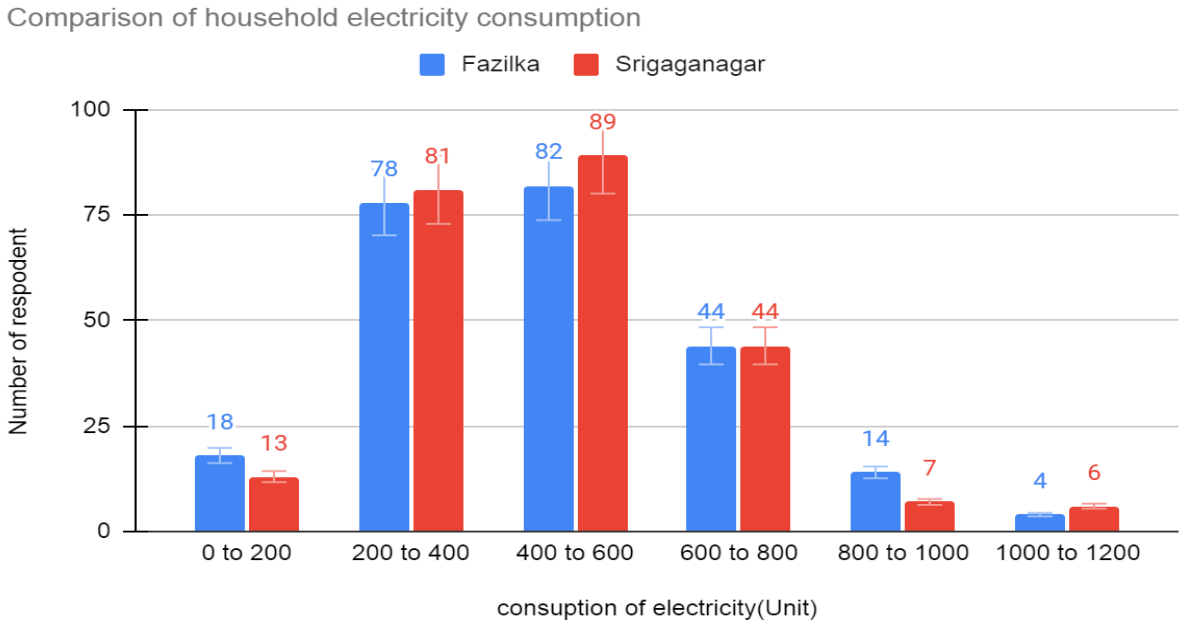
Household electricity consumption is a socio-economic indicator that refers to the amount of electricity used by households for various activities such as lighting, cooking, heating, cooling, and other appliances. This indicator provides valuable information about the level of energy use, living standards, and affordability of energy services in a region or country. Household electricity consumption can vary significantly across different regions and countries depending on factors such as income, household size, housing type, and climatic conditions. Higher levels of household electricity consumption are typically associated with higher income levels, larger households, and greater access to energy-efficient appliances and housing. Household electricity consumption can have significant impacts on energy security, affordability, and environmental sustainability. Energy security refers to the availability of reliable and affordable energy sources to meet the needs of households and businesses. The affordability of energy services is important to ensure that households can access and afford basic energy services.

Table 5.13: Household Electricity Consumption of Respondents per Month

Consumption of electricity(Unit)	Fazilka (Punjab)		Sriganganagar (Rajasthan)	
	No. of farmers	Percentage	No. of farmers	Percentage
0 to 200	18	7.5	13	5.42
200 to 400	78	32.5	81	33.75
400 to 600	82	34.17	89	37.08
600 to 800	44	18.33	44	18.33
800 to 1000	14	5.83	7	2.92
1000 to 1200	4	1.67	6	2.5
Total	240	100	240	100
Mean Consumption	475		474.16	
S.D.	216.89		206.15	

Source: primary data

Figure 5.9: Comparison of Household Electricity Consumption



The table 5.13 shows the electricity consumption of respondent Kinnow growers per month in two different regions of India, Fazilka (Punjab) and Sriganganagar (Rajasthan). The data is divided into six consumption categories, ranging from 0 to 200 units per month to 1000 to 1200 units per month. Looking at the data, we can see that in Fazilka, the highest number of farmers (82) fall under the 400 to 600 units per month consumption category, whereas in Sriganganagar, the highest number of farmers (89) fall under the 400 to 600 units per month consumption category. Comparing the data in both regions, we can see that the percentage of farmers in each consumption category is relatively similar, except for the 800 to 1000 and 1000 to 1200 units per month categories. In Fazilka, 5.83% of farmers fall under the 800 to 1000 units per month category, while in Sriganganagar, only 2.92% of farmers fall under this category. Similarly, in Fazilka, only 1.67% of farmers fall under the 1000 to 1200 units per month category, while in Sriganganagar, 2.5% of farmers fall under this category. Furthermore, we can see that the number of farmers decreases as we move towards higher consumption categories in both regions. For example, in Fazilka, only 4 farmers fall under the 1000 to 1200 units per month consumption category, while in Sriganganagar, only 6 farmers fall under this category. Overall, the data suggests that the majority of Kinnow growers in both regions consume electricity in the range of 200 to 600 units per month. Tiwari et al., (2020) discovered that, at the sectoral level, a one-way causal relationship exists, with electricity consumption positively influencing growth in both the agricultural and domestic sectors.

Source of drinking water of respondent Kinnow growers:

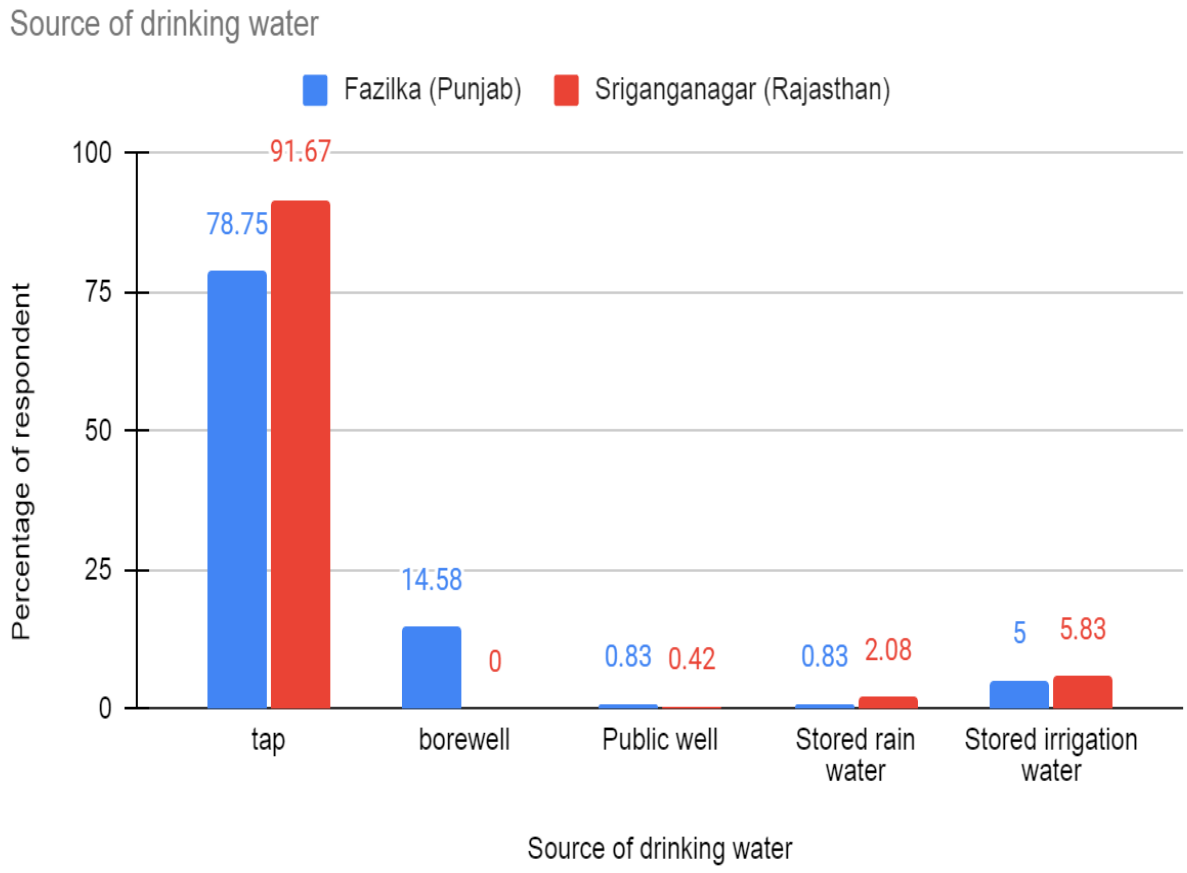
The source of drinking water is a socio-economic indicator that refers to how households obtain water for drinking and other domestic uses. The source of drinking water can provide insights into the level of development, health, and well-being of a region or country. Traditionally, households obtained water from natural sources such as rivers, lakes, and wells. However, in recent years, many households have transitioned to using piped water systems or other modern water supply technologies. The source of drinking water can impact health, the environment, and economic outcomes.

Table 5.14: Source of Drinking Water

Source of drinking water	Fazilka (Punjab)		Sriganganagar (Rajasthan)	
	No. of responses	percentage	No. of responses	Percentage
Tap	189	78.75	220	91.67
Bore well	35	14.58	0	0
Public well	2	0.833	1	0.417
Stored rainwater	2	0.833	5	2.083
Stored irrigation water	12	5	14	5.833
Total	240	100	240	100

Source: primary data

Figure-5.10: Respondents Source of Drinking Water



Using contaminated water for drinking can have adverse effects on health due to the transmission of waterborne diseases such as cholera, typhoid, and diarrheal. This can

result in high rates of mortality and morbidity, particularly among vulnerable populations such as children and the elderly. In addition to the health effects, the use of contaminated water can also lead to environmental degradation and economic losses due to reduced productivity and increased healthcare costs. Although many countries have made advancements toward achieving universal access to improved drinking water and sanitation, this progress falls short of its maximum potential, and it doesn't seem to be associated with the social and economic characteristics of a given country (Luh & Bartram, 2015).

The transition to using clean drinking water sources has the potential to improve health outcomes, reduce environmental degradation, and stimulate economic development. It can also increase productivity, reduce healthcare costs, and promote gender equity by reducing the time spent collecting water. In summary, the source of drinking water is an important socio-economic indicator that provides insights into the level of development, health, and environmental outcomes of a region or country. The use of clean drinking water sources can lead to significant improvements in health, the environment, and economic outcomes. Table 5.14 presents the source of drinking water of Kinnow growers in Fazilka, Punjab Sriganganagar, Rajasthan, as well as the number of responses and the percentage of each source. In Fazilka, the majority of respondents (78.75%) rely on tap water as their source of drinking water, followed by borewell water (14.58%), stored irrigation water (5%), stored rainwater (0.83%), and public well water (0.83%). In Sriganganagar, an even higher percentage (91.67%) of respondents use tap water for drinking, while a small percentage reported using stored rainwater (2.08%), stored irrigation water (5.83%), and public well water (0.42%). No respondents reported using borewell water for drinking in Sriganganagar. As groundwater availability varies depending on several factors such as the geological characteristics of the region, rainfall patterns, and human activities, groundwater may be less available or less accessible in Sriganganagar compared to Fazilka. This may have resulted in a higher reliance on other sources of water such as tap water in Sriganganagar.

Residence area of respondent Kinnow grower:

Residence area, whether urban or rural, is a socio-economic indicator that refers to the geographic location of a household or community. This indicator provides valuable information about the economic, social, and environmental conditions in a particular area. Urban areas are typically characterized by high population density, diverse economic activities, and access to social services and infrastructure. Rural areas, on the other hand, are typically characterized by lower population density, agricultural or natural resource-based economies, and more limited access to social services and infrastructure.

The residence area can have significant impacts on socio-economic outcomes such as income, employment, education, health, and access to basic services. For example, urban residents may have greater access to job opportunities, education, and healthcare, while rural residents may have greater access to natural resources and agricultural livelihoods. The table 5.15 shows the distribution of respondents based on their residence area type, i.e., whether they live in a village or a city, in two regions where Kinnow growers operate, Fazilka in Punjab and Sriganganagar in Rajasthan. The data indicates that a higher percentage of Kinnow growers in both regions live in villages compared to cities. In Fazilka, 205 respondents participated in the survey, out of which 85.42% lived in villages, while only 14.58% lived in cities. This suggests that a significant majority of Kinnow growers in Fazilka are from rural areas, which could be attributed to various factors. For instance, agriculture is the primary occupation in rural areas, and owning land for cultivation may be more feasible in rural areas than in urban areas. Additionally, rural areas may provide a more conducive environment for cultivating Kinnow, which require specific soil and climatic conditions.

Table 5.15: Residence area of respondent Kinnow Grower

	Fazilka (Punjab)		Sriganganagar (Rajasthan)	
	No. of responses	Percentage	No. of responses	percentage
Village	205	85.42	203	84.58
City	35	14.58	37	15.42

Source: primary data

Figure 5.11: Residence Area of Respondent Kinnow Grower (Fazilka)

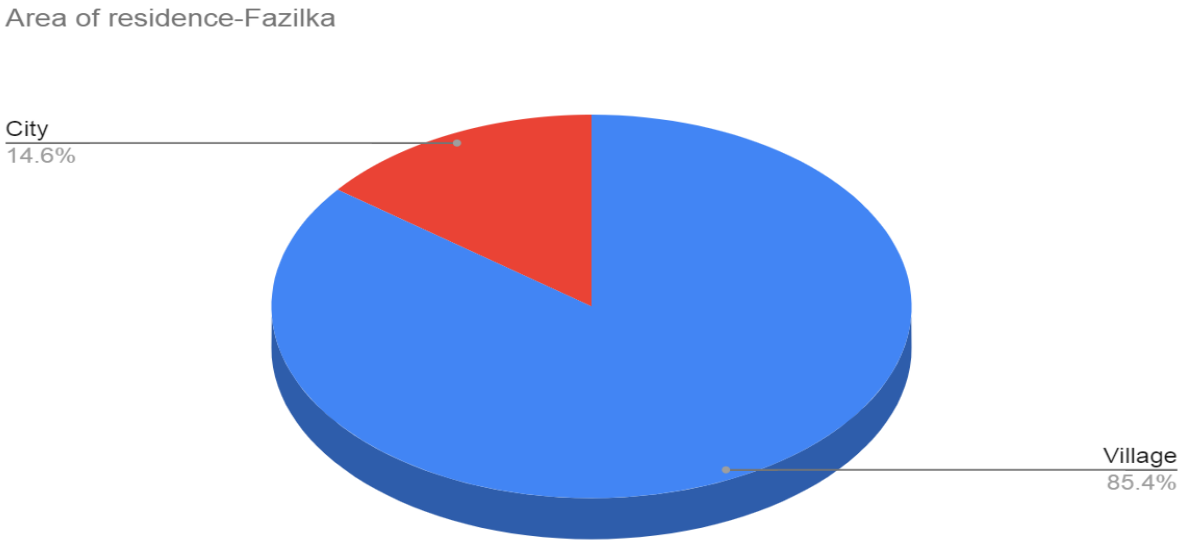
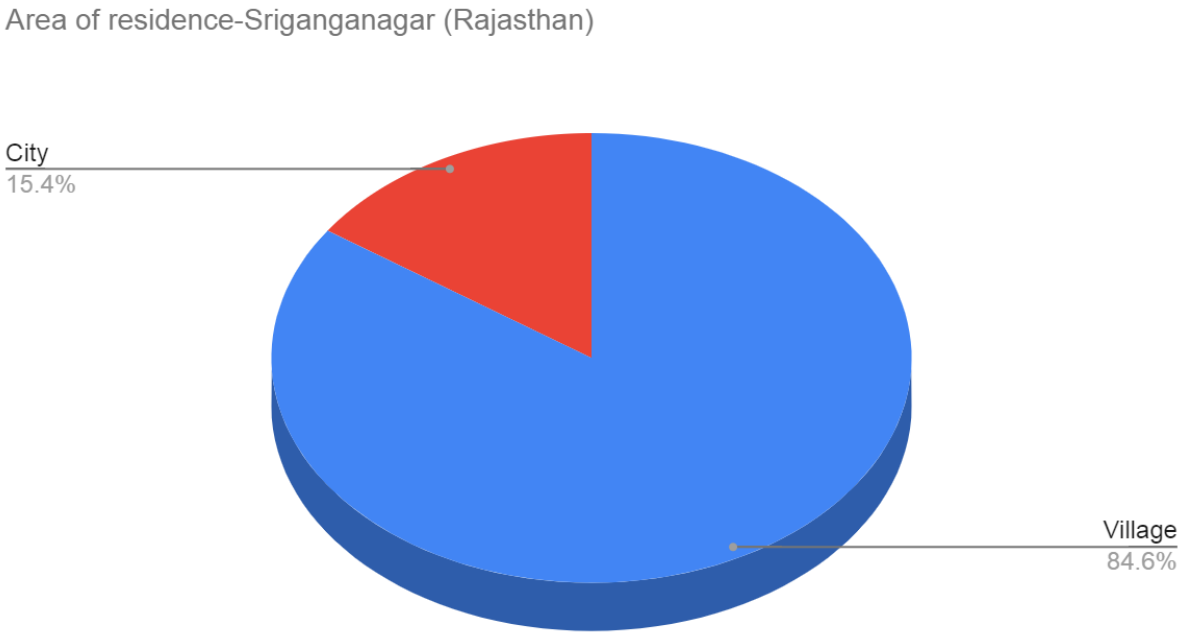


Figure 5.12: Residence Area of Respondent Kinnow Grower (Sriganganagar)



In Sriganganagar, 240 respondents participated in the survey, out of which 84.58% lived in villages, while 15.42% lived in cities. This again indicates a higher percentage of Kinnow growers residing in rural areas. Sriganganagar is known for its extensive canal system, which makes irrigation possible and enables agriculture to thrive. Therefore, the majority of Kinnow growers in this region may prefer living in villages as it provides them with easy access to canal water for irrigation and other agricultural inputs. Overall, the data suggests that the majority of Kinnow growers in both regions live in villages rather than cities. This could be due to several reasons such as the availability of land for farming, lower cost of living, and a preference for a rural lifestyle.

House Type of Respondent Kinnow Growers:

The type of house is an important socio-economic indicator that provides valuable information about the living conditions and economic status of households and communities. It can also provide insights into the broader social and economic conditions of a region or country and can be used to develop policies and programs that aim to improve housing quality and support economic development. The table 5.16 presents data on the type of houses owned by respondent Kinnow growers in two different regions of India, Fazilka in Punjab and Sriganganagar in Rajasthan. The data is presented in terms of the number of responses and the percentage of respondents in each category. The three types of houses listed in the table are Cutcha, Semi-Pucca, and Pucca. Kutcha houses are those made of mud and thatch, Semi Pucca houses are partially made of bricks and cement, and Pucca houses are fully made of bricks and cement. In Fazilka, out of 240 responses, only one respondent had a Kutcha house, representing 0.42% of the respondents, while 25 respondents had Semi Pucca houses, representing 10.42% of the respondents.

The majority of the respondents in Fazilka, 214 out of 240 or 89.16%, had Pucca houses. In Sriganganagar, out of 240 responses, two respondents had Kutcha houses, representing 0.83% of the respondents, while 35 respondents had Semi Pucca houses, representing 14.59% of the respondents. The majority of the respondents in Sriganganagar, 203 out of 240 or 84.58%, had Pucca houses. Thomson et al., (2013)

introduced both a six-item and a three-item comparative scale for housing characteristics, which are recommended by the U.N. and are commonly featured in housing censuses. These scales are highly related to each other and exhibit similar valuations. Notably, these scales exhibit wide variation among Latin American countries in terms of people's distribution along them, making them applicable globally. Additionally, they have proven to be useful in research and show significant correlations with a country's infant mortality rate at the aggregate level, as well as with educational attainment among various age groups and genders.

Overall, the data shows that Pucca houses are the most common type of house owned by Kinnow growers in both regions, with a combined percentage of 86.87%. Semi-Pucca houses are the second most common type of house, with a combined percentage of 12.5%. Kutcha houses are the least common, with a combined percentage of 1.25%. The data also suggests that the percentage of Kinnow growers owning Pucca houses is slightly higher in Fazilka than in Sriganganagar, while the percentage of Kinnow growers owning semi-pucca and Kutcha houses is slightly higher in Sriganganagar than in Fazilka. However, it is important to note that the differences in percentages are relatively small and may not be statistically significant.

Table 5.16: House Type of Respondent Kinnow Growers

Type of house	Fazilka (Punjab)		Sriganganagar (Rajasthan)	
	No. of responses	percentage	No. of responses	Percentage
Cutcha	1	0.42	2	0.83
Semi pucca	25	10.42	35	14.59
Pucca	214	89.16	203	84.58
Total	240	100	240	100

Source: primary data

Figure 5.13: House Type of Respondents (Fazilka)

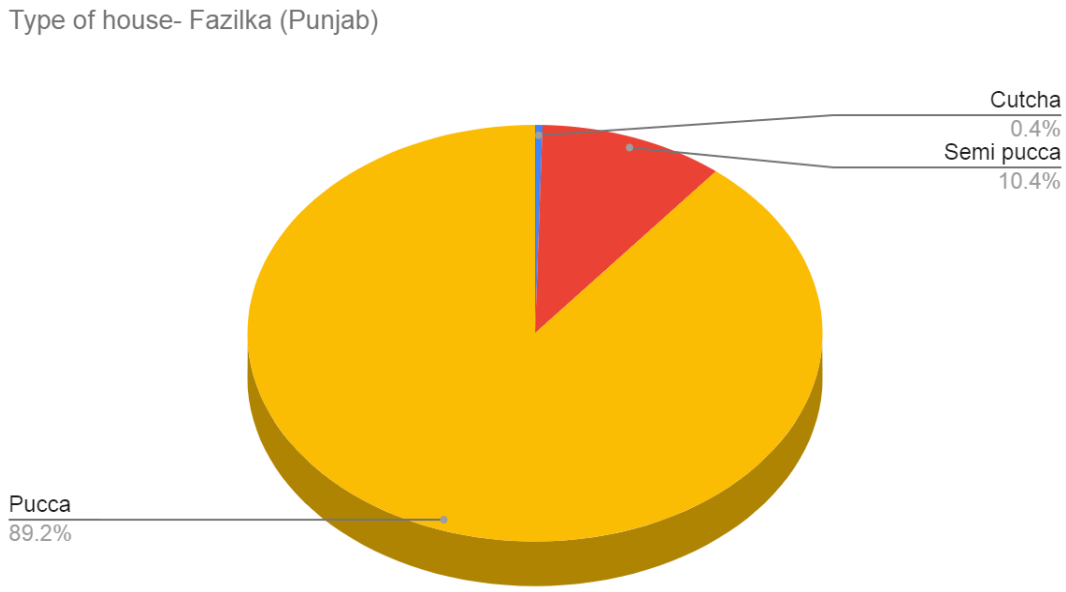
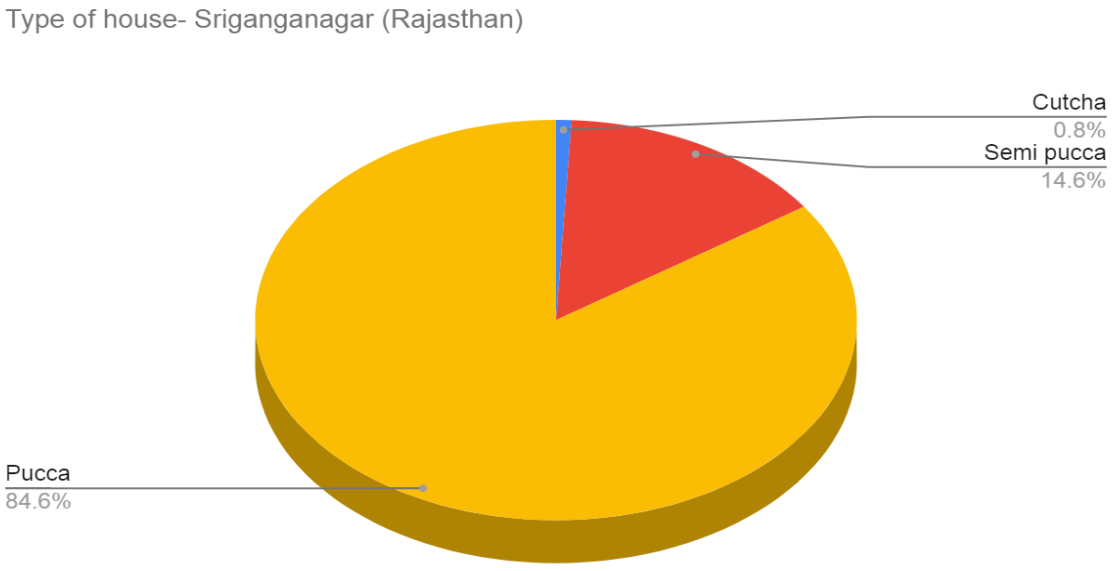


Figure 5.14: House Type of Respondents (Sriganganagar)



Connectivity of all-weather roads to respondent Kinnow grower's houses:

Access to all-weather roads is critical for the development of rural areas and the agriculture sector. A study in India found that the construction of all-weather roads improved the accessibility and connectivity of villages, reduced transportation costs, and facilitated the transportation of agricultural inputs and products. This, in turn, had positive effects on the income and livelihoods of farmers and contributed to the overall economic development of the region. However, the construction and maintenance of roads can be expensive and require significant investment from the government and other stakeholders. Therefore, there is a need for policies and initiatives that prioritize the development of infrastructure in rural areas and support the adoption of sustainable and cost-effective transportation solutions (Khandker et al., 2006)

Table 5.17 provides information on the connectivity of all-weather roads to the houses of Kinnow growers in two different locations: Fazilka (Punjab) and Sriganganagar (Rajasthan). In Fazilka, out of 240 respondents, a large majority of the respondents (235, 97.92%) reported having all-weather roads connecting to their houses, while only 5 (2.08%) reported not having such roads.

Table 5.17: Connectivity of All-Weather Roads to Respondent Kinnow Grower's Houses

	No. of responses		
	Yes	No	Total
Fazilka (Punjab)	235 (97.92%)	5 (2.08%)	240 (100%)
Sriganganagar (Rajasthan)	173 (72.08%)	67 (27.92%)	240 (100%)

Source: primary data

In Sriganganagar, out of 240 respondents, 173 (72.08%) reported having all-weather roads connecting to their houses, while 67 (27.92%) reported not having such roads. The data suggests that a significantly higher proportion of Kinnow growers in Fazilka, Punjab have access to all-weather roads connecting to their houses compared to Sriganganagar, Rajasthan. This difference may have implications for the transportation and accessibility of produce and other resources in the two regions. Overall, the data highlights the importance of infrastructure development and accessibility in the

agricultural sector. Access to all-weather roads can improve the transportation of agricultural products and inputs, increase market access, and potentially enhance rural livelihoods.

Drainage system:

The table 5.18 shows information on the drainage system of respondent Kinnow grower's houses in two different locations: Fazilka (Punjab) and Sriganganagar (Rajasthan). In Fazilka, out of 240 respondents, a significant majority of the respondents (185, 77.08%) reported having paved drains, while 53 (22.08%) reported having raw drains, and only 2 (0.84%) reported having a sewerage system. In Sriganganagar, out of 240 respondents, 168 (70%) reported having paved drains, while 71 (29.58%) reported having raw drains, and only 1 (0.42%) reported having a sewerage system. The data suggests that a higher proportion of respondents in Fazilka, Punjab have access to paved drains compared to Sriganganagar, Rajasthan. Paved drains can improve drainage efficiency, reduce health hazards, and minimize the spread of water-borne diseases.

Table 5.18: Drainage system of Respondent Kinnow Grower's Houses

	No. of responses			
	Paved drain	Raw drain	Sewerage	Total
Fazilka (Punjab)	185(77.08%)	53(22.08%)	2(0.84%)	240(100%)
Sriganganagar (Rajasthan)	168(70%)	71(29.58%)	1(0.42%)	240(100%)

Source: primary data

The data also highlights the need for improved sanitation infrastructure in the two regions. While the majority of respondents in both regions reported having access to some form of drainage system, the lack of proper sewerage systems in both regions suggests a need for investment in infrastructure to improve public health and sanitation. Overall, the data underscores the importance of adequate infrastructure development, including drainage and sanitation systems, in the agricultural sector and rural livelihoods.

Source of cooking among respondent Kinnow growers:

The source of cooking is an important socio-economic indicator that provides insights into the level of development, health, and environmental outcomes of a region or country. The use of cleaner cooking fuels can lead to significant improvements in health,

the environment, and economic outcomes. Traditionally, households used solid fuels such as wood, charcoal, or animal dung for cooking. However, in recent years, many households have transitioned to using cleaner cooking fuels such as liquefied petroleum gas (LPG), biogas, or electricity. The source of cooking can impact health, the environment, and economic outcomes. The transition to cleaner cooking fuels has the potential to improve health outcomes, reduce environmental degradation, and stimulate economic development. It can also increase energy access and reduce the time spent collecting firewood, allowing for more time for other activities such as education or income-generating work. The utilization of sustainable, clean energy is essential for enhancing public health and reducing the environmental impact (Pangaribowo et al., 2023).

Table 5.19: Source of Cooking

Source of cooking	Fazilka (Punjab)		Sriganganagar (Rajasthan)	
	No. of responses	Percentage	No. of responses	Percentage
Cooking gas	120	50	111	46.25
Wood	2	0.83	10	41.67
Dung-cake	1	0.42	5	2.08
Electricity	1	0.42	1	0.42
All of these	116	48.83	113	47.08
Total	240	100	240	100

Source: primary data

Table 5.19 presents data on the sources of cooking used by respondent Kinnow growers in two different regions of India, Fazilka in Punjab and Sriganganagar in Rajasthan. The data is presented in terms of the number of responses and the percentage of respondents in each category. The sources of cooking listed in the table are Cooking Gas, Wood, Dung-cake, Electricity, and All of these. In Fazilka, out of 240 responses, the majority of the respondents, 120 or 50%, used Cooking Gas as their source of cooking. A significant percentage of respondents, 116 or 48.83%, reported using All of these sources for cooking. The remaining respondents used Wood, Dung-cake, or Electricity as their source of cooking, with percentages of 0.83%, 0.42%, and 0.42%, respectively.

Figure 5.15: Source of Cooking (Fazilka)

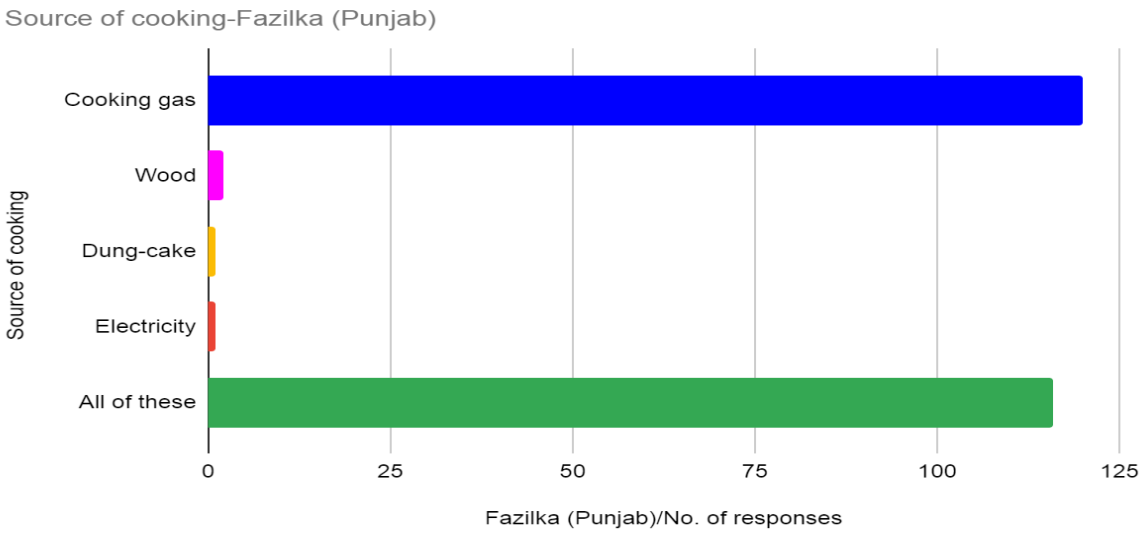
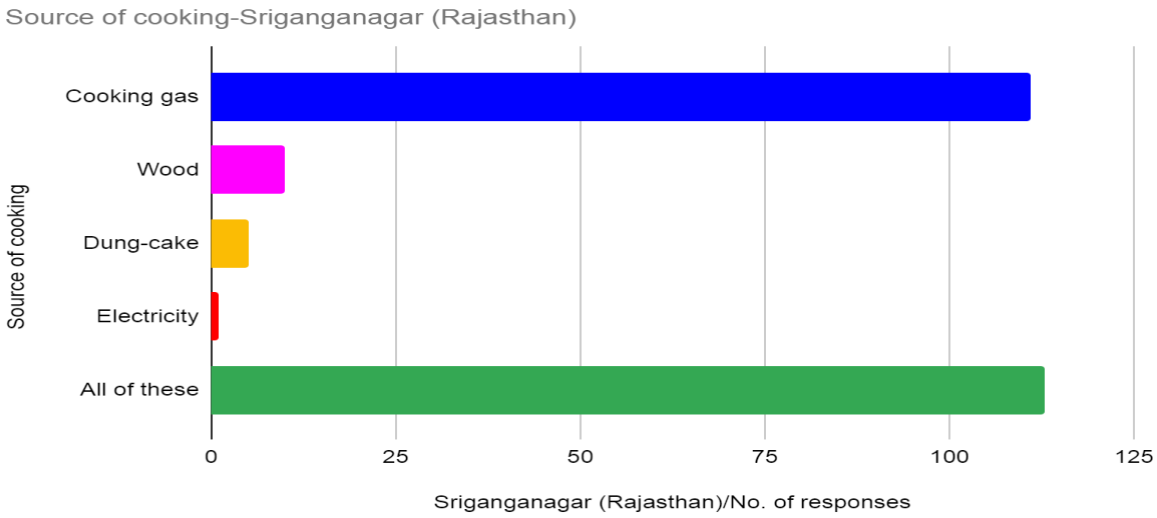


Figure 5.16: Source of Cooking (Sriganganagar)



In Sriganganagar, out of 240 responses, the majority of the respondents, 111 or 46.25%, used Cooking Gas as their source of cooking. A significant percentage of respondents, 113 or 47.08%, reported using all of these sources for cooking. A smaller percentage of respondents used Wood or Dung-cake as their source of cooking, with percentages of 41.67% and 2.08%, respectively. Only one respondent reported using Electricity as their source of cooking. Overall, the data shows that Cooking Gas is the

most common source of cooking used by Kinnow growers in both regions, with a combined percentage of 48.13%. All of these sources are the second most common source of cooking, with a combined percentage of 48.46%. Wood, Dung-cake, and Electricity are much less commonly used, with combined percentages of only 2.41%.

The data also suggests that the percentage of Kinnow growers using Cooking Gas is slightly higher in Fazilka than in Sriganganagar, while the percentage of Kinnow growers using Wood and Dung-cake is slightly higher in Sriganganagar than in Fazilka. However, it is important to note that the differences in percentages are relatively small and may not be statistically significant.

Secondary source of income other than the farming of respondent Kinnow grower:

A secondary source of income other than farming refers to the additional income earned by individuals or households from activities other than farming. This can include income generated from employment in non-farm sectors, self-employment in small businesses, or through investments.

The importance of a secondary source of income other than farming as a socio-economic indicator lies in its potential to increase the economic stability and resilience of rural households. In many rural areas, agriculture is often the primary source of income for families, and its dependence can make them vulnerable to economic shocks such as crop failures or price fluctuations. A secondary source of income can help to reduce this vulnerability by diversifying the sources of income and providing a more stable financial footing.

The presence or absence of a secondary source of income other than farming can also be an indicator of social and economic development. In areas where non-farm employment opportunities are limited, households may have no choice but to rely solely on farming, which can hinder their economic growth and development. Conversely, regions with a more diversified economy, including non-farm employment opportunities, are often associated with higher levels of economic development and greater prosperity.

Overall, a secondary source of income other than farming is an important socio-economic indicator that can provide insights into the economic well-being and resilience of rural households and the broader economy of a region or country.

The table 5.20 provides information on the secondary sources of income other than farming for Kinnow growers in Fazilka (Punjab) and Sriganganagar (Rajasthan) regions. The data shows the number of responses and percentage for each type of secondary income source.

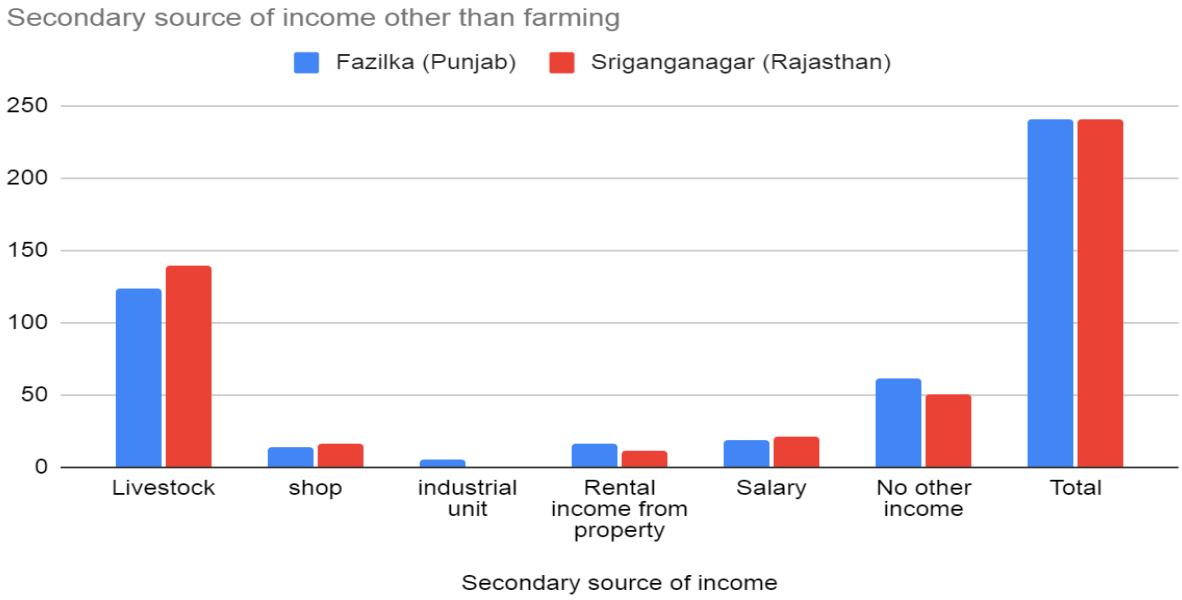
Table 5.20: Secondary Source of Income Other Than Farming of Respondent

Secondary source of income	Fazilka (Punjab)		Sriganganagar (Rajasthan)	
	No. of responses	percentage	No. of responses	Percentage
Livestock	124	51.67	140	58.33
Shop	14	5.83	16	6.67
industrial unit	5	2.08	1	0.42
Rental income from property	16	6.67	11	4.58
Salary	19	7.92	21	8.75
No other income	62	25.83	51	21.25
Total	240	100	240	100

Source: primary data

In Fazilka, livestock is the most common secondary source of income, reported by 124 (51.67%) of the respondents, followed by rental income from property reported by 16 (6.67%) of the respondents. 19 (7.92%) of the respondents reported having a salary as their secondary income source. Shop and industrial units were reported as secondary income sources by a small number of respondents. On the other hand, in Sriganganagar, livestock is again the most common secondary income source, reported by 140 (58.33%) of the respondents, followed by salary reported by 21 (8.75%) of the respondents. Shop and rental income from the property were reported as secondary income sources by a small number of respondents, and only one respondent reported having an industrial unit as their secondary income source. It is interesting to note that in both regions, livestock is the most common secondary income source. This could be because livestock rearing is an integral part of the rural economy and provides a steady source of income throughout the year.

Figure 5.17: Secondary Source of Income



Additionally, rental income from property and salary were also reported as secondary income sources in both regions, indicating diversification of income sources among Kinnow growers. Overall, the data suggests that Kinnow growers in both regions rely on a variety of secondary income sources to supplement their farming income. This could be an indication of the need to diversify income sources and reduce dependence on a single source of income.

The annual income of respondent Kinnow growers:

Annual income is a commonly used socio-economic indicator that measures the amount of money earned by an individual, household, or group in a year. It is a crucial factor in determining one's financial well-being and can significantly influence their standard of living. Annual income is typically used to calculate taxes, access credit, and make important financial decisions. It can also be used to compare the economic status of different groups or regions.

Table 5.21: Annual Income of Respondent Kinnow Growers

Annual income	Fazilka (Punjab)		Sriganganagar (Rajasthan)	
(In lakh Rupees)	No. of responses	Percentage	No. of responses	Percentage
0 to 3	20	8.33	24	10
3 to 6	116	48.33	127	52.92
6 to 9	90	37.5	78	32.5
9 to 12	7	2.92	5	2.08
12 and above	7	2.92	6	2.5
Total	**240**	**100**	**240**	**100**
Chi-square value	338.5		92.3	
Mean income	5.8125		5.525	
S.D.	15.5		14.85	
Gini coefficient	0.352		0.202	

Source: primary data

The table 5.21 provides information on the annual income of respondent Kinnow growers in Fazilka (Punjab) and Sriganganagar (Rajasthan). The total number of respondents in both regions is 240. In Fazilka, 20 respondents (8.33%) reported an annual income between 0 to 3 lakh rupees, 116 respondents (48.33%) reported an income between 3 to 6 lakh rupees, 90 respondents (37.5%) reported an income between 6 to 9 lakh rupees, 7 respondents (2.92%) reported an income between 9 to 12 lakh rupees, and 7 respondents (2.92%) reported an income of 12 lakh rupees and above. In Sriganganagar, 24 respondents (10%) reported an annual income between 0 to 3 lakh rupees, 127 respondents (52.92%) reported an income between 3 to 6 lakh rupees, 78 respondents (32.5%) reported an income between 6 to 9 lakh rupees, 5 respondents (2.08%) reported an income between 9 to 12 lakh rupees, and 6 respondents (2.5%) reported an income of 12 lakh rupees and above. In a study conducted by Poudel et al. (2022) it was observed that a significant proportion of the participants involved in mandarin cultivation were male, of middle age, had medium-sized families, operated farms of moderate size, possessed literacy, and primarily relied on agriculture as their source of income. The study suggested that Kinnow cultivation had the potential to improve the socio-economic status of smallholder farmers in the Fazilka district of Punjab.

Figure 5.18: Annual Income of Respondent Kinnow Growers

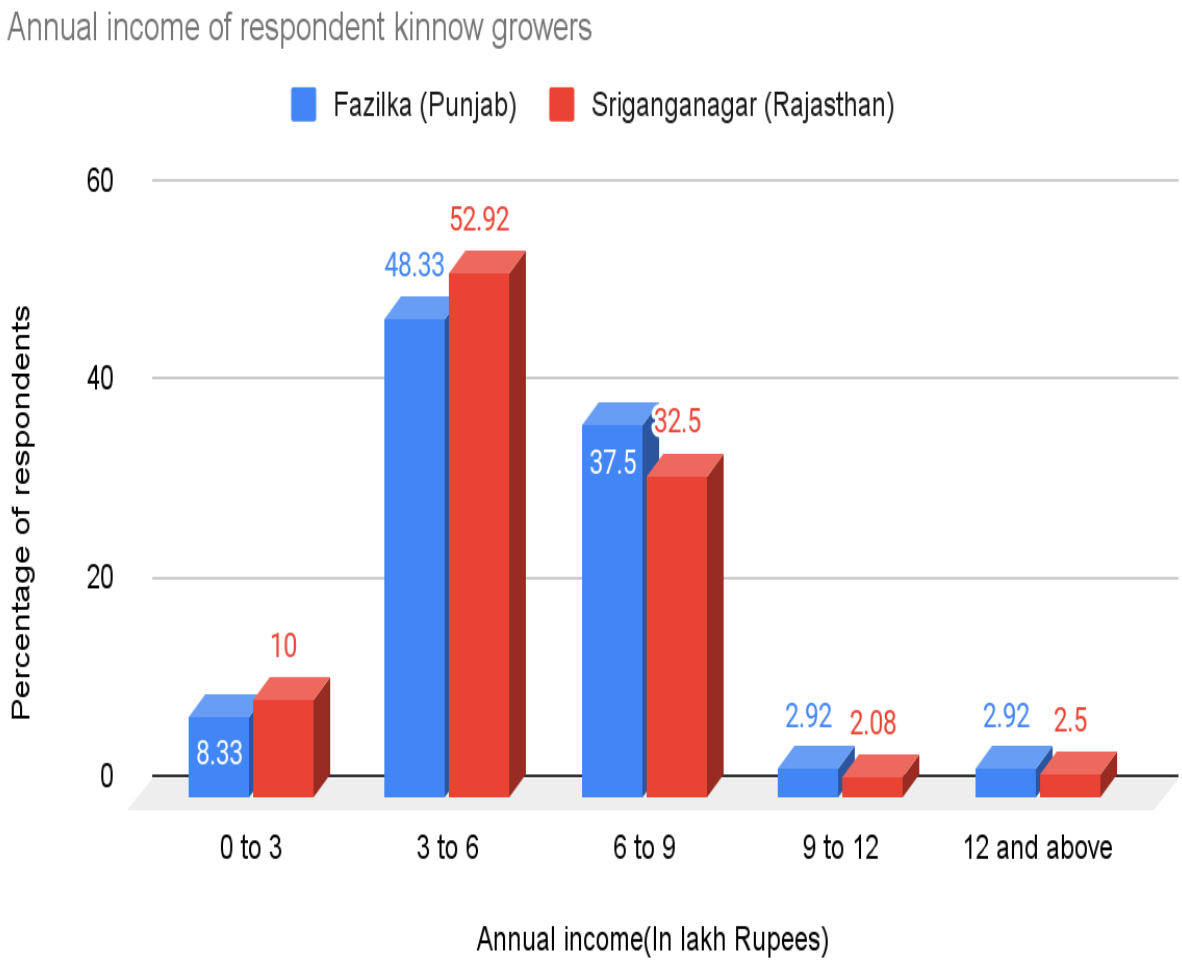


Table 5.22: Calculated Data for Lorenz Curve for Fazilka

Fazilka (Punjab)	
Cumulative % of income	Cumulative % of Kinnow growers
0	0
2.150538	8.333333
39.56989	56.66667
87.95699	94.16667
93.22581	97.08333
100	100

Figure 5.19: Lorenz curve for Income Inequality among Respondent Kinnow Grower

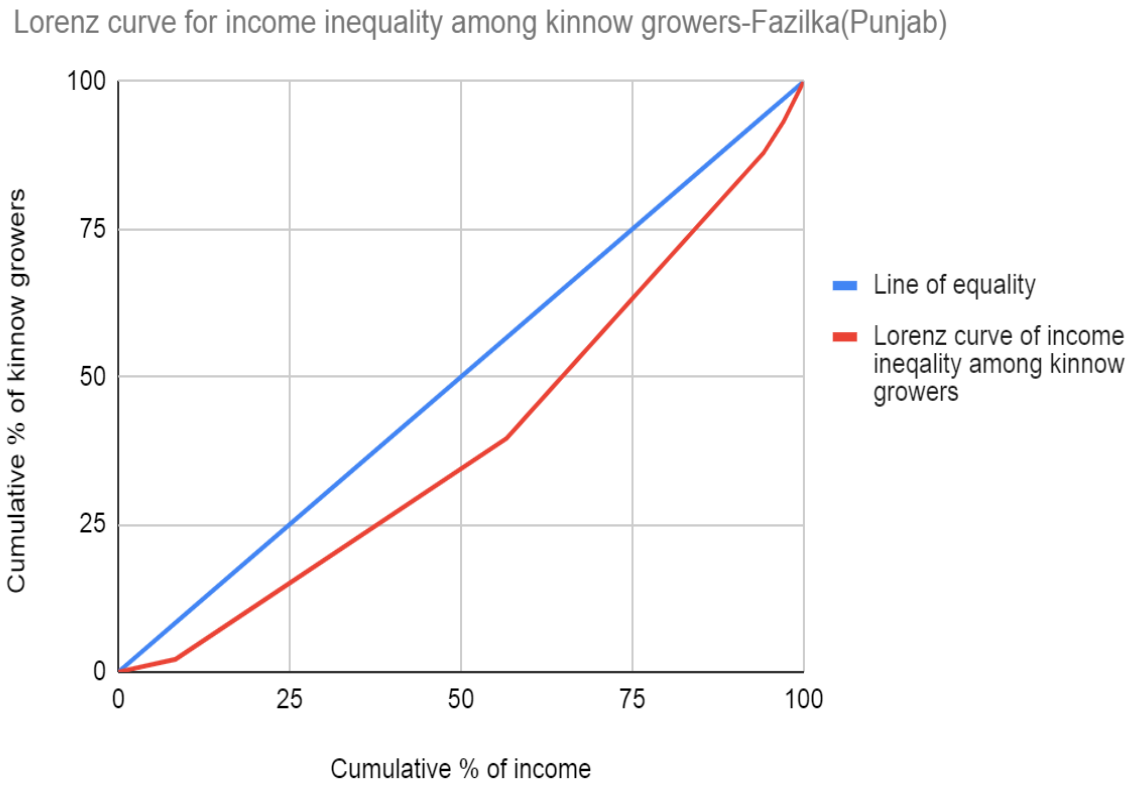
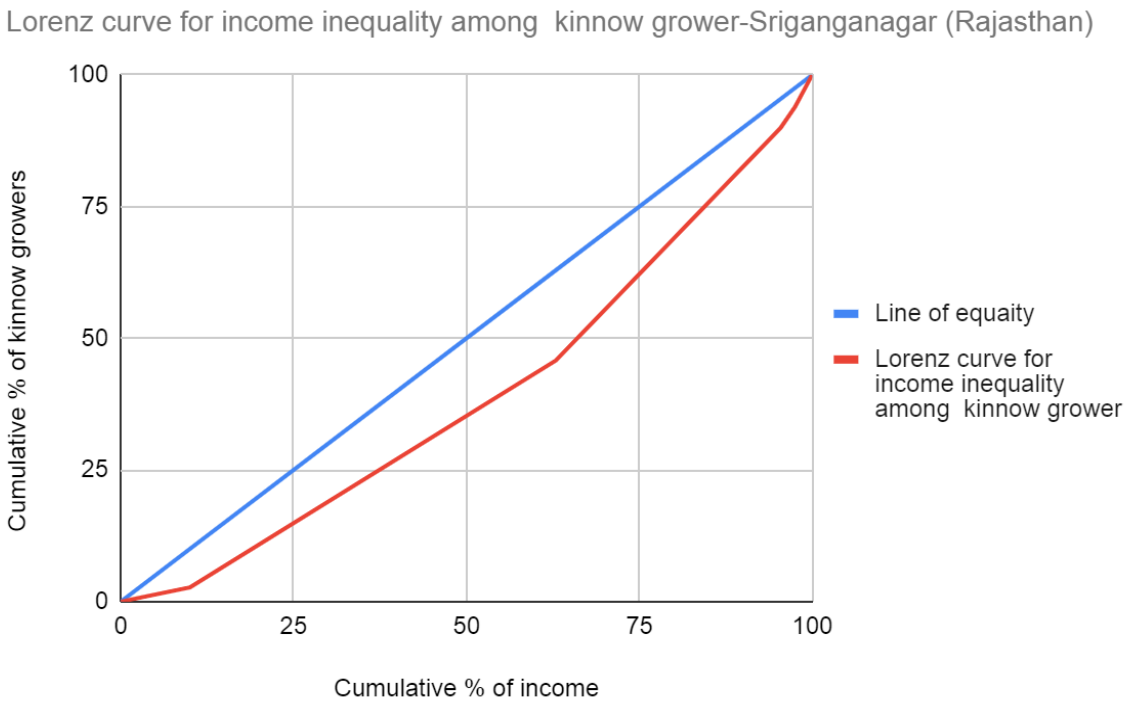


Table 5.23: Calculated Data for Lorenz Curve for Sriganganagar

Sriganganagar (Rajasthan)	
Cumulative % of income	Cumulative % of Kinnow growers
0	0
2.714932	10
45.81448	62.91667
89.93213	95.41667
93.8914	97.5
100	100

Figure 5.20: Lorenz curve for Income Inequality among Respondent Kinnow Grower



The majority of respondents in both regions reported an annual income between 3 to 6 lakh rupees, with 48.33% in Fazilka and 52.92% in Sriganganagar. A smaller proportion of respondents reported an income between 6 to 9 lakh rupees, with 37.5% in Fazilka and 32.5% in Sriganganagar. Only a few respondents reported an income above 9 lakh rupees, with 2.92% in Fazilka and 4.58% in Sriganganagar. In both regions, a small percentage of respondents reported an annual income between 0 to 3 lakh rupees. Overall, the data suggests that the majority of respondent Kinnow growers in both regions have an annual income between 3 to 6 lakh rupees, with a smaller proportion reporting higher incomes. Based on the calculated data for the Lorenz curve of income inequality among respondent Kinnow growers in Sriganganagar, Rajasthan, the results are as follows:

The cumulative percentage of Kinnow grower's ranges from 0% to 100% on the horizontal axis, indicating the entire population of Kinnow growers is being considered.

The cumulative percentage of income ranges from 0% to 100% on the vertical axis, indicating the entire range of income is being considered.

At 10% of the cumulative percentage of Kinnow growers, 2.71% of the cumulative percentage of income is earned, indicating a relatively low level of income for this segment of the population. At 62.92% of the cumulative percentage of Kinnow growers, 45.81% of the cumulative percentage of income is earned, indicating a significant increase in income earned.

At 95.42% of the cumulative percentage of Kinnow growers, 89.93% of the cumulative percentage of income is earned, indicating a high concentration of income among a small segment of the population. At 97.5% of the cumulative percentage of Kinnow growers, 93.89% of the cumulative percentage of income is earned, indicating an even higher concentration of income among an even smaller segment of the population.

At 100% of the cumulative percentage of Kinnow growers, 100% of the cumulative percentage of income is earned, indicating that the entire income range is being considered for the entire population of Kinnow growers.

Therefore, the Gini coefficient for the distribution of income among Kinnow growers in Sriganganagar (Rajasthan) is approximately 0.202. This indicates a low level of inequality in the distribution, with some Kinnow growers receiving a larger share of the total income.

To calculate Cramer's V value, we can use the following formula:

$$V = \sqrt{[x^2 / (n * (k - 1)]}$$

Where:

x^2 is the chi-square value, n is the total sample size, and k is the minimum number of rows and columns in the table (in this case, k=5).

Plugging in the values, we get:

$$V = \sqrt{[(338.5 / (240 * (5 - 1)]}$$

$$V = 0.5938$$

Therefore, Cramer's V value of approximately 0.5938 indicates a strong association between landholding and income levels in the dataset. A high Cramer's V value close to 1 suggests a strong relationship between the two variables. In this case, landholding and income are significantly related, implying that there is a notable connection between the amount of land held and the income levels of the individuals or groups represented in the data. The table represents the annual income and landholding of respondent Kinnow growers of Fazilka in Punjab. The data is presented in frequency counts, and the totals are provided for each combination of landholding and income levels. The chi-square value for the data is 338.5, and the Cramer's V value is 0.5938. Table 5.24 shows that most of the respondents fall in the semi-medium and medium landholding categories, with 89 and 121 growers respectively. The majority of growers in the 3-6 lakh annual income category belong to the semi-medium landholding category (84 out of 116). In contrast, for those earning between 6-9 lakh annually, the medium landholding category had the highest frequency (85 out of 90).

Table 5.24: Annual Income and Landholding of Kinnow Growers of Fazilka (Punjab)

Annual income(In lakh Rupees)	Landholding by size					
	Marginal	Small	Semi medium	Medium	Large	Total
3 to 6	0	1	84	31	0	116
6 to 9	0	0	2	85	3	90
9 to 12	0	0	0	5	2	7
12 to 15	0	0	0	0	7	7
Total	3	15	89	121	12	240
Chi-square value	338.5					
Cramer's V	0.5938					

Source: primary data

Furthermore, we observe that none of the marginal landholders reported an income of more than 3 lakhs. In contrast, the large landholders reported the highest income, with seven respondents earning more than 12 lakhs annually.

The chi-square value of 338.5 is statistically significant, indicating that there is a significant association between landholding and income categories. The Cramer's V value of 0.5938 indicates strong association between the two variables.

Overall, the data suggests that landholding is strongly associated with annual income for Kinnow growers in Fazilka, Punjab. Medium landholders tend to earn the most, and marginal landholders earn the least. The association between the two variables is moderately strong, indicating that landholding is an important factor in determining annual income for Kinnow growers in the region.

Table 5.25 presents data on the annual income and landholding of Kinnow growers in Sriganganagar, Rajasthan, categorized by landholding size and income levels. The total number of respondents in the sample is 240. The landholding size is classified into five categories, namely marginal, small, semi-medium, medium, and large.

Table 5.25: Annual Income and Landholding of Kinnow Grower of Sriganganagar (Rajasthan)

Annual income (In lakh Rupees)	Landholding by size					
	Marginal	Small	Semi medium	Medium	Large	Total
3 to 6	1	0	13	111	2	127
6 to 9	0	0	1	61	16	78
9 to 12	0	0	0	3	2	5
12 to 15	0	0	0	0	6	6
Total	1	5	33	175	26	240
chi-square value	92.3					
Cramer’s V	0.310					

Source: primary data

Similarly, the annual income is divided into five categories, i.e., 0-3 lakhs, 3-6 lakhs, 6-9 lakhs, 9-12 lakhs, and 12-15 lakhs. The data shows that out of 240 respondents, 24 belong to the marginal landholding category with an annual income of 0-3 lakhs. Among small landholders, 5 respondents have an annual income of 0-3 lakhs, whereas 111 respondents have an income of 3-6 lakhs. In the semi-medium category, 19 respondents have an income of 0-3 lakhs, 13 respondents have an income of 3-6 lakhs, and one respondent has an income of 6-9 lakhs. Among medium landholders, 175

respondents have an annual income of 3-6 lakhs, 61 have an income of 6-9 lakhs, three have an income of 9-12 lakhs, and none have an income of 12-15 lakhs. In the large landholding category, 26 respondents have an annual income of 3-6 lakhs, 16 have an income of 6-9 lakhs, two have an income of 9-12 lakhs, and six have an income of 12-15 lakhs. The chi-square value for this table is 92.3, which is statistically significant at $p<0.001$. This value indicates that there is a significant relationship between landholding size and annual income. Additionally, the Cramer's V coefficient is 0.31, which suggests a moderate association between these two variables. In conclusion, the data in the table indicates that Kinnow growers in Sriganganagar with larger landholdings tend to have higher annual incomes than those with smaller landholdings. The chi-square and Cramer's V tests confirm the existence of a relationship between landholding size and annual income.

Farming experience: Farming experience refers to the practical knowledge and skills gained through working on a farm or engaging in agricultural activities. Farming experience can include knowledge of planting and harvesting crops, raising livestock, managing farm equipment and machinery, and applying fertilizers and pesticides.

Table 5.26: Farming Experience of Respondent Kinnow Growers

Number of years	Fazilka (Punjab)	Sriganganagar(Rajasthan)
	Number of farmers	Number of farmers
0-5	14	16
05-10	39	44
10-15	87	83
15-20	57	54
20-25	34	37
25-30	9	6
Total	**240**	**240**
Mean	14.27	13.96
Standard deviation	5.94	5.98

Source: primary data

It is often acquired through hands-on experience and learning from seasoned farmers. Having farming experience can be valuable for those interested in pursuing a career in agriculture or for those who wish to grow their food and become more self-sufficient.

Table 5.26 provides data on the farming experience of respondent Kinnow growers from - Fazilka in Punjab and Sriganganagar in Rajasthan. The data is divided into six different categories based on the number of years of farming experience, ranging from 0-5 years to 25-30 years. The first column of the table provides the number of years of farming experience, while the second and third columns provide the frequency of farmers in each region who have that level of experience. The fourth and fifth columns provide the mean and standard deviation of the data for each region.

From the table, we can see that the number of farmers in both regions with 10-15 years of farming experience is the highest, with 87 farmers in Fazilka and 83 farmers in Sriganganagar. This indicates that there is a large proportion of experienced Kinnow growers in both regions.

The mean farming experience for Kinnow growers in Fazilka is 14.27 years, while the mean for Sriganganagar is 13.96 years. This suggests that the average farming experience is slightly higher in Fazilka compared to Sriganganagar. The standard deviation for farming experience in Fazilka is 5.94 years, while the standard deviation for Sriganganagar is 5.98 years.

Overall, the data suggests that there is a significant number of experienced Kinnow growers in both Fazilka and Sriganganagar, with the highest proportion of farmers having 10-15 years of experience. The difference in mean and standard deviation between the two regions is relatively small, indicating that the farming experience of Kinnow growers in both regions is similar.

Set of other crops:

The set of crops grown in an area can be used as a socio-economic indicator, as it can provide insights into the local agricultural practices and the economic conditions of the region. The crops grown in an area are often influenced by factors such as climate, soil type, and availability of resources like water and labor. The choice of crops can also be influenced by market demand and government policies. Therefore, analyzing the crops grown in an area can provide information about the local environmental conditions, the level of agricultural productivity, the degree of specialization in certain crops, and the

economic opportunities available in the region. Table 5.27 provides information on the percentage of respondents Kinnow growers from two locations in India, Fazilka (Punjab) and Sriganganagar (Rajasthan), who reported growing various types of crops. In Fazilka, out of 240 total respondents, the most commonly grown crop was wheat with 100% of respondents growing it, followed by cotton (92.08%), barley (70.83%), mustard (79.17%), and sugarcane (10%).

Table 5.27: Set of Other Crops in Crop Pattern of Respondent Kinnow Growers

Crop	Fazilka (Punjab)		Sriganganagar (Rajasthan)	
	No. of responses	Percentage	No. of responses	percentage
Cotton	221	92.08	212	88.33
Moong	24	10	103	42.92
Guar	11	4.58	56	23.33
Rice	27	11.25	0	0
Maize	11	4.58	0	0
Millet	1	0.42	24	10
Sugarcane	24	10	45	18.75
Barley	170	70.83	185	77.083
Wheat	240	100	240	100
Gram	5	2.08	48	20
Mustard	190	79.17	229	95.41
Other Horticulture Crops	15	6.25	5	2.083
Total respondents	240		240	

Source: primary data

Other crops grown included rice (11.25%), maize (4.58%), millet (0.42%), gram (2.08%), guar (4.58%), and other horticulture crops (6.25%). In Sriganganagar, also with 240 total respondents, the most commonly grown crop was again wheat with 100% of respondents growing it, followed by mustard (95.41%), barley (77.083%), cotton (88.33%), and gram (20%). Other crops grown included moong (42.92%), guar (23.33%),

millet (10%), sugarcane (18.75%), and other horticulture crops (2.083%). It is important to note that crop preferences and cultivation patterns can vary depending on several factors such as climate, soil conditions, and local market demand. Nonetheless, the data suggests that wheat, cotton, mustard, and barley are among the most commonly grown crops in both locations.

Figure 5.21: Set of Other Crops in Crop Pattern of Respondent Kinnow Growers

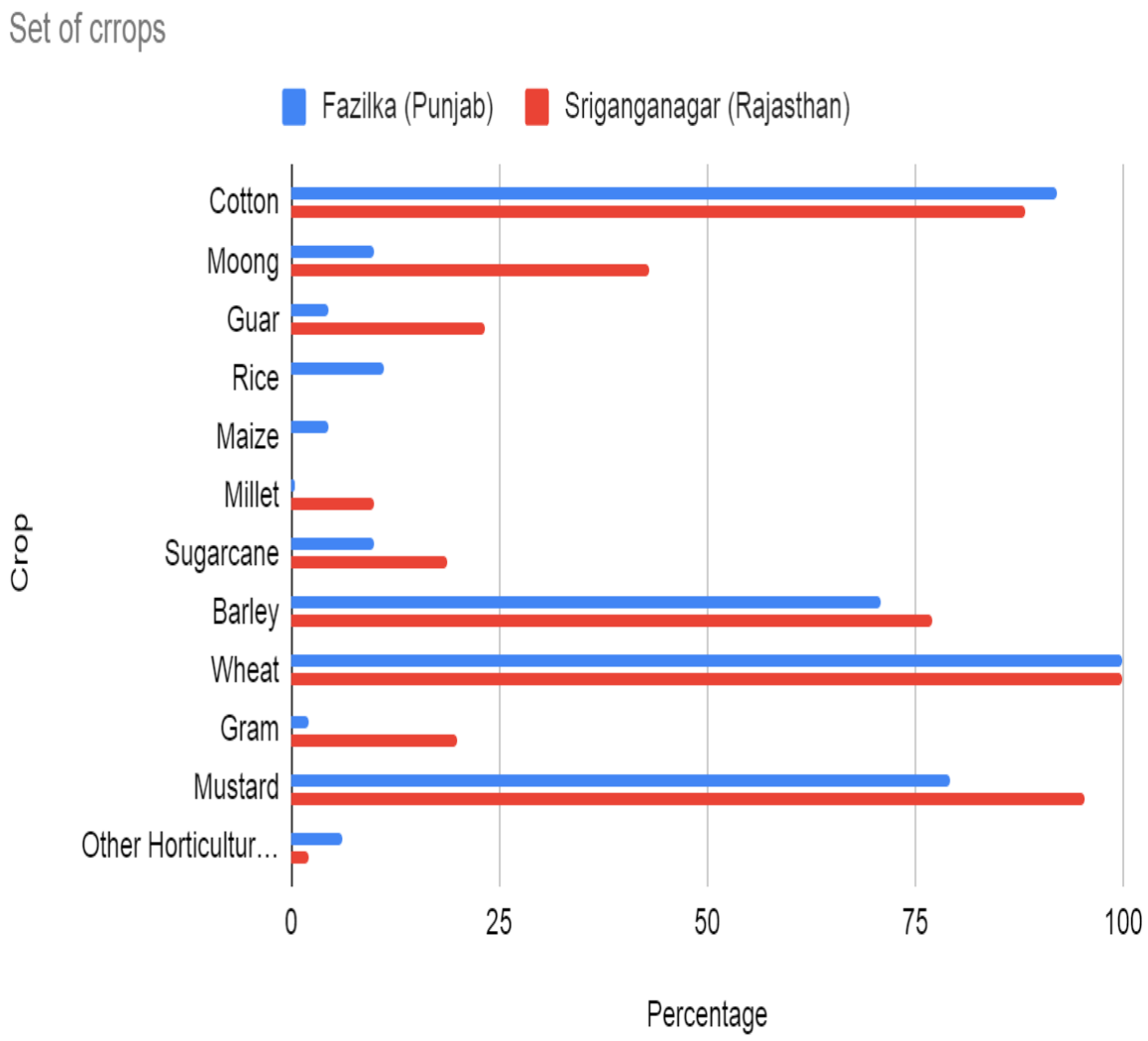


Table 5.28: All Socio-Economic Indicators

Socio-economic indicator	Fazilka (Punjab)	Sriganganagar (Rajasthan)
Mean age	39.54	38.85
S.D. of mean age	6.49	6.21
Mean family size	6.5875	6.7208
S.D. of mean family size	4.67	4.63
Mean electricity consumption	475	474.16
S.D. of Mean electricity consumption	216.89	206.15
Farming Experience (mean)	14.27	13.96
S.D. of farming Experience	5.94	5.98
Mean income	5.8125	5.525
S.D. of Mean income	2.41	2.356

Testing of hypothesis-1:

To test the hypothesis that there is no difference in the socio-economic status of Kinnow growers in Punjab and Rajasthan, we need to perform a two-sample t-test for each parameter. The null hypothesis is that there is no significant difference between the two groups, and the alternative hypothesis is that there is a significant difference. For each parameter, we can calculate the t-statistic using the formula:

t = (X_1 -X_2) / (S / $\sqrt{(n)}$

Where

X_1 and X_2 Are the sample means for Fazilka and Sriganganagar, S is the pooled sample standard deviation for that parameter, and n is the sample size (which is the same for both locations).

$$S=\sqrt{\frac{(n_1-1).S_1^2+(n_2-1).S_2^2}{n_1+n_2-2}}$$

Where:

s_1 = Sample standard deviation for Fazilka

s_2= sample standard deviation for Sriganganagar

We can then compare the calculated t-value to the critical t-value for a two-tailed t-test with a significance level of 0.05 and 478 degrees of freedom (480-2).

Let's calculate the t-statistic for each parameter:

Mean age:

$$x_1 = 39.54,\ x_2 = 38.85,\ S \approx 6.35,\ n = 240 \text{ for each}$$

$$t = \frac{(39.54 - 38.85)}{(6.35/\sqrt{240})} = 0.533$$

Mean family size:

$$x_1 = 6.5875,\ x_2 = 6.7208,\ S \approx 4.64,\ n = 240$$

$$t = \frac{(6.5875 - 6.7208)}{(4.64/\sqrt{240})} = -0.1124$$

Mean electricity consumption:

$$x_1 = 475,\ x_2 = 474.16,\ S \approx 211.63,\ n = 240$$

$$t = \frac{(475 - 474.16)}{(211.63/\sqrt{240})} = 0.0644$$

Farming Experience (mean):

$$x_1 = 14.27,\ x_2 = 13.96,\ S \approx 5.96,\ n = 240$$

$$t = \frac{(14.27 - 13.96)}{(5.96/\sqrt{240})} = 0.0212$$

Mean income:

$$x_1 = 5.8125,\ x_2 = 5.525,\ S \approx 2.38,\ n = 240$$

$$t = \frac{(5.8125 - 5.525)}{(2.38/\sqrt{240})} = 0.0267$$

Comparing the calculated t-values with the critical t-value, we can make the following conclusions:

Mean age: Since the calculated t-value (0.533) is less than the critical t-value (1.96), we fail to reject the null hypothesis and conclude that there is no significant difference in the mean age between Kinnow growers in Punjab and Rajasthan.

Mean family size: Since the calculated t-value (-0.1124) is less than the critical t-value (-1.96), we fail to reject the null hypothesis and conclude that there is no significant difference in the mean family size between Kinnow growers in Punjab and Rajasthan.

Mean electricity consumption: Since the calculated t-value (0.0644) is less than the critical t-value (1.96), we fail to reject the null hypothesis and conclude that there is no significant difference in the mean electricity consumption between Kinnow growers in Punjab and Rajasthan.

Farming Experience (mean): Since the calculated t-value (0.0212) is less than the critical t-value (1.96), we fail to reject the null hypothesis and conclude that there is no significant difference in the mean farming experience between Kinnow growers in Punjab and Rajasthan.

Mean income: Since the calculated t-value (0.0267) is less than the critical t-value (1.96), we fail to reject the null hypothesis and conclude that there is no significant difference in the mean income between Kinnow growers in Punjab and Rajasthan.

In summary, based on the results of the t-test for each parameter, we can conclude that there is no significant difference in the socio-economic status of Kinnow growers in Punjab and Rajasthan.

Chapter 5 provides a comprehensive comparison of the socio-economic characteristics of Kinnow growers in Rajasthan and Punjab. It is based on empirical data from primary sources and explores various socio-economic aspects such as landholding, family size, income, education, and other factors. Here's a summary of the key points:

Landholding:

Medium-sized farms dominate Kinnow farming in both regions. In Fazilka, 50.42% of farmers are medium-sized, while in Sriganganagar, 72.92% are medium farmers. The Gini coefficient indicates higher land inequality in Fazilka (0.626) compared to Sriganganagar (0.51).

Age of Farmers:

Most Kinnow farmers are in the 35-40 age group in both regions. The mean age in Fazilka is 39.54, and in Sriganganagar, it's 38.85, with no significant age distribution differences between the two regions.

Education:

A large portion of farmers in both regions have secondary or higher education, with 37.08% having completed graduation in both areas. Sriganganagar has a slightly higher proportion of postgraduates compared to Fazilka.

Family Structure:

Joint families dominate in both regions, with 61.67% in Fazilka and 65.42% in Sriganganagar living in joint family setups.

Income:

The majority of Kinnow growers have an annual income between ₹3-6 lakhs. Fazilka's mean income is slightly higher than Sriganganagar's, but the Gini coefficient shows greater income inequality in Fazilka (0.352) than in Sriganganagar (0.202).

Secondary Income Sources:

Livestock is the most common secondary source of income in both regions, with 51.67% in Fazilka and 58.33% in Sriganganagar.

Other Key Socio-Economic Indicators:

In both regions, a majority of farmers use tap water for drinking, live in rural areas, and have pucca (solidly constructed) houses.

Access to all-weather roads is significantly higher in Fazilka (97.92%) compared to Sriganganagar (72.08%). Overall, the chapter highlights the socio-economic similarities and differences between Kinnow growers in Rajasthan and Punjab, with Fazilka showing higher inequality in landholding and income, while Sriganganagar is more equitable in these aspects.

CHAPTER-6

SUPPORTIVE INFRASTRUCTURE

The chapter outlines the research questions guiding the analysis of supportive infrastructure for Kinnow production expansion. It explores key infrastructure components such as irrigation systems, transportation networks, cold storage facilities, and market infrastructure, examining their adequacy, accessibility, and functionality in Kinnow-growing regions. This chapter sets the stage for a comprehensive investigation into the role of supportive infrastructure in expanding the Kinnow production area. By identifying infrastructure constraints and opportunities, the study aims to inform policy recommendations and investment strategies aimed at promoting sustainable growth and development in the Kinnow sector.

Analysis of primary data:

In the first part of this section, we will compare the farm infrastructure available in the two districts, Fazilka and Sriganganagar, for Kinnow cultivation. This includes factors such as irrigation systems, farm machinery, and storage facilities. In the second part, we will evaluate the availability of other ancillary activities related to Kinnow cultivation in the region, such as transportation, marketing, and extension services. We will compare the two districts on these parameters and highlight any differences or similarities that exist. This information can help identify areas where farmers in these regions may need support or assistance to improve their access to these ancillary services and increase the profitability of their Kinnow cultivation.

Table 6.1 presents the responses of Kinnow growers from Fazilka in Punjab and Sriganganagar in Rajasthan regarding the production of bio-pesticides, bio-fungicides, and organic fertilizers. Out of 240 respondents from Fazilka, 57 (23.75%) reported making these products while the remaining 123 (76.25%) did not. On the other hand, out of 240 respondents from Sriganganagar, 38 (15.83%) reported making these products while 202 (84.17%) did not. From the table, it can be seen that a higher proportion of

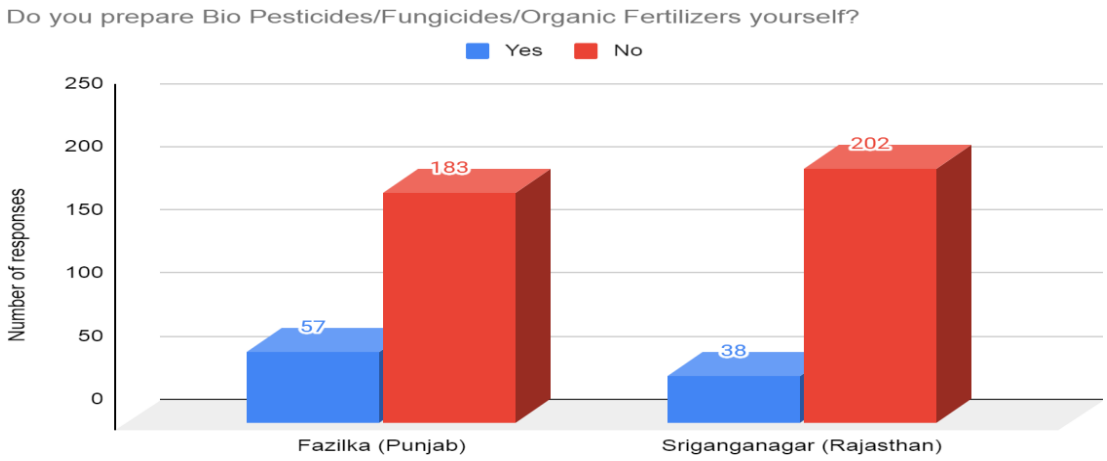
Kinnow growers in Fazilka are involved in the production of biopesticides, fungicides, and organic fertilizers compared to those in Sriganganagar.

Table 6.1: Making Bio Pesticides/Fungicides/Organic Fertilizers by Respondents

	No. of responses		
	Yes	No	Total
Fazilka (Punjab)	57 (23.75%)	123 (76.25%)	240 (100%)
Sriganganagar (Rajasthan)	38 (15.83%)	202 (84.17)	240 (100%)

Source: primary data

Figure-6.1: Making Bio Pesticides/Fungicides/Organic Fertilizers by Respondent Kinnow Growers



The percentage of respondents who reported making these products is 23.75% in Fazilka compared to 15.83% in Sriganganagar. This suggests that there may be differences in the level of awareness, access to information, and resources between the two regions, which could be influencing the adoption of these practices. Mishra et al., (2020) express concern over the reduced enthusiasm and waning interest of farmers in adopting biopesticides. Moreover, the long-term sustainability of these products is being questioned due to the technological challenges associated with their production, manufacturing, and application in agroecosystems.

Further analysis could be done to explore the reasons behind the differences in the adoption of these practices and their impact on the yield, quality, and profitability of Kinnow farming in these regions. Additionally, comparisons can be made between other

ancillary activities in these regions to gain a better understanding of the overall level of development and potential for growth in the Kinnow industry.

Despite the remarkable expansion in the availability of biopesticide and biofertilizer products in recent years, farmers have not embraced them enthusiastically. This is primarily because these products do not present practical benefits over conventional chemicals, and there is a shortage of high-quality offerings. This scarcity is mainly attributed to the absence of a suitable infrastructure and the insufficiency of technical expertise (Kalra & Khanuja, 2007).

Source of irrigation:

Table 6.2 provides information on the source of irrigation for Kinnow orchards in two regions, Fazilka in Punjab and Sriganganagar in Rajasthan. The table shows that in both regions, the source of irrigation for Kinnow orchards is mainly from canal water. In Fazilka, all 240 respondents reported using canal water as the source of irrigation, while none reported using tube well water. Similarly, in Sriganganagar, all 240 respondents reported using canal water and none reported using tube well water. Overall, the table suggests that canal water is the predominant source of irrigation for Kinnow orchards in these regions.

Kinnow plants are sensitive to salinity and can be negatively affected by high levels of salts in the soil or water used for irrigation. This is why Kinnow orchards need to have access to good quality irrigation water with low levels of salt. Canal water, which is typically sourced from rivers and other surface water sources, tends to have lower salinity levels compared to groundwater extracted through tubewells.

Table 6.2: Source of Irrigation for Kinnow Orchards

	No. of responses		
	Canal	Tube well	Total
Fazilka (Punjab)	240(100%)	0 (0%)	240(100%)
Sriganganagar (Rajasthan)	240 (100%)	0 (0%)	240(100%)

Source: primary data

Therefore, it is not surprising to see that the majority of respondents in the table reported using canal water for irrigation, as it is likely a more suitable water source for Kinnow orchards.

Irrigation water storage tank (pond) availability in Orchard:

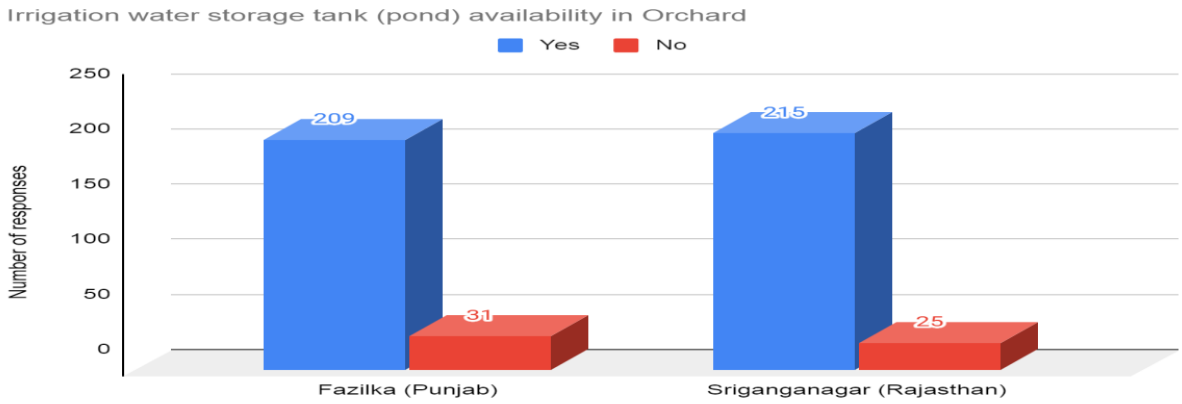
López-Felices et al. (2020) highlighted the growing importance of irrigation ponds in agricultural research. In recent years, these reservoirs have gained significance as they offer an efficient solution to enhance water availability and quality for irrigation, thereby playing a vital role in promoting agricultural sustainability.

Table 6.3: Irrigation Water Storage Tank (Pond) Availability in Orchard Of Respondents

	No. of responses		
	Yes	No	Total
Fazilka (Punjab)	209 (87.08%)	31 (12.92%)	240 (100%)
Sriganganagar (Rajasthan)	215 (89.58%)	25 (10.42%)	240 (100%)

Source: primary data

Figure-6.2: Irrigation Water Storage Tank (Pond) Availability in Orchard



The table 6.3 shows the availability of irrigation water storage tanks (ponds) in the orchards of Kinnow growers in two different locations: Fazilka (Punjab) and Sriganganagar (Rajasthan). In Fazilka, out of 240 respondents, 209 (87.08%) reported having irrigation water storage tanks available in their orchards, while 31 (12.92%) reported not having them. In Sriganganagar, out of 240 respondents, 215 (89.58%) reported having irrigation water storage tanks available in their orchards, while 25

(10.42%) reported not having them. Overall, the data suggests that the majority of Kinnow growers in both locations have irrigation water storage tanks available in their orchards. However, the difference in the percentage of respondents reporting availability of tanks is relatively small between the two locations, with a slightly higher percentage of respondents reporting availability in Sriganganagar compared to Fazilka.

Source of energy for irrigation:

Access to reliable and affordable energy sources is critical for sustainable agriculture. The use of solar panels for irrigation is gaining popularity in many regions due to its cost-effectiveness and environmental benefits. A study in India found that the use of solar-powered irrigation systems increased crop yield, reduced water usage, and improved rural livelihoods. However, the adoption of new technologies can be hindered by various factors such as access to finance, lack of awareness, and technical know-how. Therefore, there is a need for policies and initiatives to support the adoption of sustainable energy sources in agriculture. Harinarayana & Vasavi (2014) propose a strategy involving the utilization of fertile, cultivated land for the installation of elevated solar panels. This approach not only generates electricity but also provides shade to crops, all without compromising their productivity. Implementing this approach in India has the potential to bring about significant advantages for farmers, including the reduction of transmission and distribution costs.

Table 6.4: Source of Energy for Irrigation in Respondent Kinnow Grower's Orchard

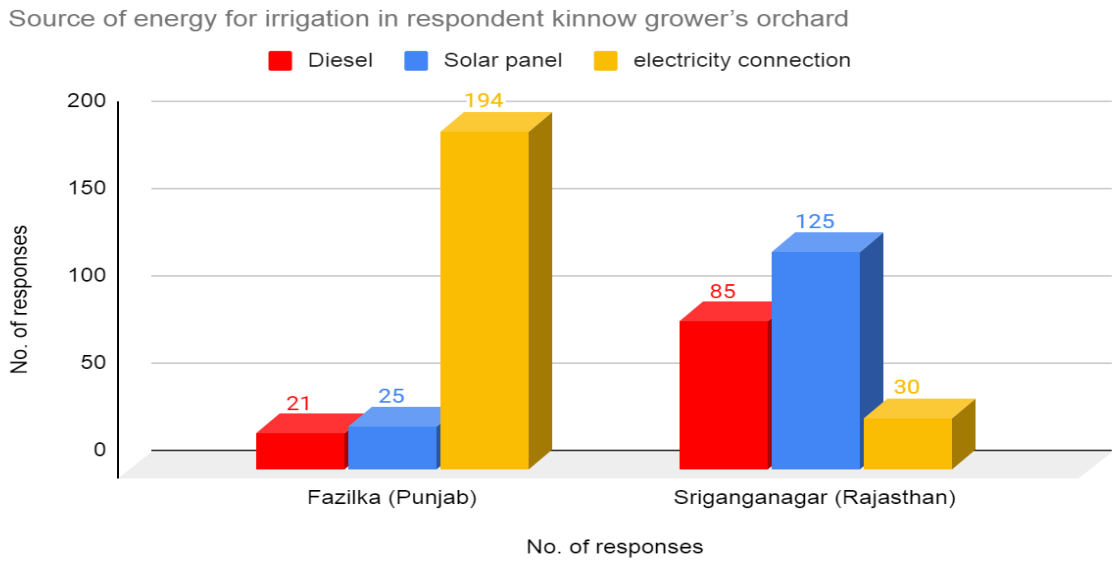
	No. of responses			
	Diesel	Solar panel	electricity connection	Total
Fazilka (Punjab)	21(8.75%)	25(10.42%)	194(80.83%)	240(100%)
Sriganganagar (Rajasthan)	85(35.42%)	125(52.09%)	30(12.5%)	240(100%)

Source: primary data

Table 6.4 shows the source of energy for irrigation in the orchards of Kinnow growers in two different locations: Fazilka (Punjab) and Sriganganagar (Rajasthan). In Fazilka, out of 240 respondents, 194 (80.83%) reported using an electricity connection as their source of energy for irrigation, while 25 (10.42%) reported using solar panels, and

only 21 (8.75%) reported using diesel. In Sriganganagar, out of 240 respondents, the majority of respondents reported using solar panels (125, 52.09%) followed by diesel (85, 35.42%), and a smaller percentage reported using electricity connection (30, 12.5%) for irrigation. Overall, the data suggests that electricity connection is the most commonly used source of energy for irrigation in Fazilka, while in Sriganganagar, a higher proportion of respondents reported using solar panels and diesel for irrigation.

Figure 6.3: Source of Energy for Irrigation in Respondent Kinnow Grower's Orchard



This difference may be attributed to the availability and cost of energy sources in the two regions. This information can be useful for policymakers and researchers to understand the energy usage patterns in agriculture in different regions and to plan for sustainable and cost-effective energy sources for irrigation

Based on the data provided in the table, it appears that a relatively small proportion of Kinnow growers in Sriganganagar, Rajasthan reported using electricity connection as their source of energy for irrigation (30, 12.5%). This could suggest that there is a need for improvement in the availability or reliability of electricity connections in the region. And Punjab needs to improve solar energy in the farm sector.

Irrigation method

The data shows the number of responses for drip and flood irrigation methods in two locations, Fazilka in Punjab and Sriganganagar in Rajasthan. To analyze the data, we can calculate the percentage of responses for each irrigation method in each location.

In Fazilka, out of a total of 240 responses, 130 (54.17%) were for drip irrigation and 110 (45.83%) were for flood irrigation.

Table 6.5: Irrigation methods used by respondent Kinnow growers

	No. of responses		
	Drip	Flood	Total
Fazilka (Punjab)	130 (54.17%)	110(45.83%)	240(100%)
Sriganganagar (Rajasthan)	139 (57.92%)	101(42.08%)	240(100%)

Source: primary data

In Sriganganagar, out of a total of 240 responses, 139 (57.92%) were for drip irrigation, and 101 (42.08%) were for flood irrigation.

From the data in Table 5.05, we can see that in both locations, the majority of responses were for drip irrigation. In Fazilka, 54.17% of responses were for drip irrigation, while in Sriganganagar, 57.92% of responses were for drip irrigation. This suggests that drip irrigation may be more popular or more commonly used among Kinnow growers in both locations. Drip irrigation is an efficient method of irrigation that can significantly improve the crop yield, water-use efficiency, and profitability of farmers. It is particularly suitable for water-scarce regions, where the availability of water is limited and uncertain. With proper design, installation, and management, drip irrigation can provide a precise and uniform supply of water and nutrients to the root zone of crops, resulting in higher yields, better quality, and lower costs. Drip irrigation can also help to conserve soil moisture, reduce soil erosion, and improve soil health and fertility. Drip irrigation stands out as a highly efficient method for enhancing water utilization, finding extensive application in conventional crops across the globe, particularly in arid areas (Wang et al., 2013).

Road connectivity to orchards of respondent Kinnow growers:

Table 5.06 presents data on road connectivity to orchards of respondent Kinnow growers in two districts, Fazilka in Punjab and Sriganganagar in Rajasthan, India. The table shows the number and percentage of respondents who answered "yes" or "no" to the question of whether their orchards have road connectivity.

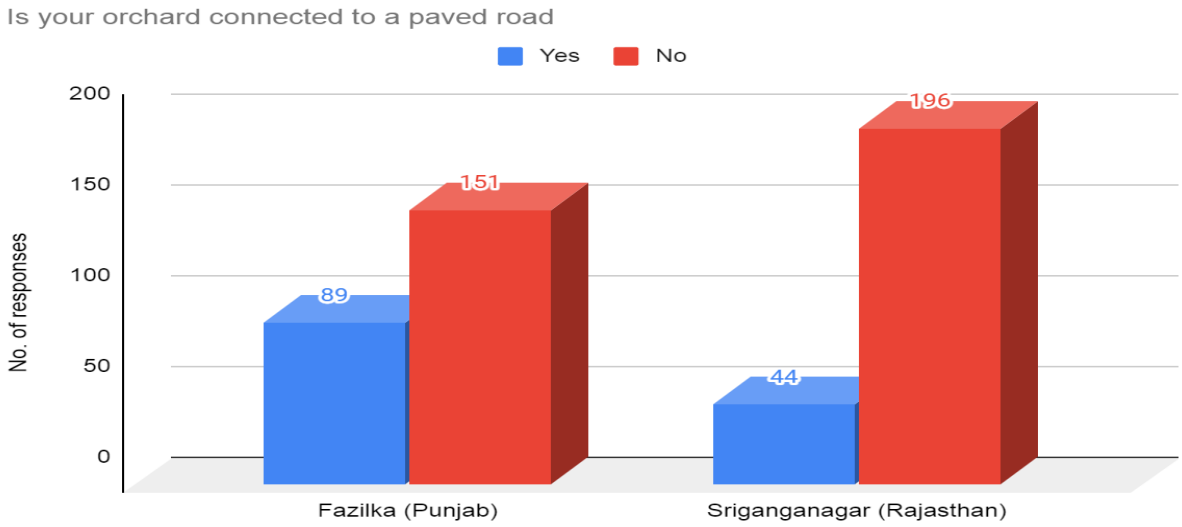
In Fazilka, out of the total 240 respondents, 89 (37.08%) reported having road connectivity to their orchards, while 151 (62.92%) reported not having road connectivity. In Sriganganagar, out of the total 240 respondents, only 44 (18.33%) reported having road connectivity to their orchards, while 196 (81.67%) reported not having road connectivity.

Table 6.06: Road Connectivity to Orchards of Respondent Kinnow Growers

	No. of responses		
	Yes	No	Total
Fazilka (Punjab)	89 (37.08%)	151 (62.92%)	240 (100%)
Sriganganagar (Rajasthan)	44 (18.33%)	196 (81.67%)	240 (100%)

Source: primary data

Figure-6.04: Road Connectivity to Orchards of Respondent Kinnow Growers



This table highlights the lack of road connectivity to orchards of Kinnow growers in both districts, with a higher percentage of respondents in Sriganganagar reporting no road connectivity. This lack of road connectivity can pose challenges for the transportation of Kinnow fruits from orchards to markets, resulting in higher transportation costs and reduced profitability for farmers. Addressing this issue could require improving the infrastructure, such as building new roads or improving existing ones, to better connect orchards to markets. Patarasuk (2013) demonstrated that enhancing road connectivity leads to substantial alterations in the extent of forests, upland crops, and plantations.

Distance of nearest bank branch from respondent's orchard:

The given table 6.7 represents the distance of the nearest bank branch from respondents' orchards in two different regions, Fazilka (Punjab) and Sriganganagar (Rajasthan), with the number of responses for each distance range.

Table 6.7: Distance of Nearest Bank Branch from Respondent Orchard

Distance in k.m.	Fazilka (Punjab)	Sriganganagar (Rajasthan)
	No. of responses	No. of responses
0-5	105	58
05-10	114	116
10-15	9	34
15-20	7	25
20-25	5	6
More than 25	0	1
Total	**240**	**240**
Mean distance	6.104	8.5
S.D.	4.187	5.127

Source: primary data

From the table, we can see that the mean distance for Fazilka is 6.104 km, while it is 8.5 km for Sriganganagar. This suggests that bank branches are located farther away from respondents' orchards in Sriganganagar as compared to Fazilka. Additionally, the standard deviation (SD) for both regions shows that the distance from respondents' orchards to the nearest bank branch is more widely spread out in Sriganganagar (SD = 5.127) than in Fazilka (SD = 4.187). Furthermore, the table indicates that the majority of

respondents in both regions have bank branches located within a distance range of 5-10 km from their orchards. However, more respondents in Sriganganagar have bank branches located farther away (more than 15 km) than those in Fazilka. Overall, the table suggests that there may be a need for more bank branches in Sriganganagar, particularly in areas farther away from respondents' orchards, to increase accessibility and convenience for farmers.

Several studies support the idea that increasing access to financial services, such as bank branches, can have a positive impact on agriculture and rural development. Yüksel and Dinçer (2020) suggest that financial institutions should establish a system allowing customers to access their services at flexible hours suitable for agricultural financing. Additionally, a key recommendation is for banks to establish new branches in proximity to agricultural areas, ensuring convenient access to banking services for farmers.

Another study by the Food and Agriculture Organization of the United Nations (FAO) found that increasing access to financial services can improve food security and nutrition by enabling farmers to invest in more diverse crops, purchase inputs such as fertilizers and seeds, and improve their storage and processing capabilities.

A study in India by the National Bank for Agriculture and Rural Development (NABARD) found that the presence of bank branches in rural areas increased the accessibility and affordability of credit for smallholder farmers, which in turn led to higher agricultural productivity and incomes. Overall, these studies suggest that increasing access to financial services, including bank branches, can have significant positive impacts on agriculture and rural development.

Distance of nursery plant from the orchards:

Table 6.8 presents data on the distance of nursery plants from the orchards of respondent Kinnow growers in two locations, Fazilka (Punjab) and Sriganganagar (Rajasthan). The data is based on the number of responses received from the growers and is grouped into distance categories of 0-5 km, 5-10 km, 10-15 km, 15-20 km, 20-25 km, and more than 25 km. The table shows that in Fazilka, 95 growers reported that their nursery plants were

within 0-5 km from their orchards, and 83 growers reported a distance of 5-10 km. In comparison, in Sriganganagar, only 19 growers reported a distance of 0-5 km, while 21 reported a distance of 5-10 km. This suggests that growers in Fazilka tend to have their nursery plants located closer to their orchards compared to those in Sriganganagar. Furthermore, the table indicates that the mean distance of nursery plants from orchards in Fazilka is 7.81 km, while in Sriganganagar, it is 18 km. This means that, on average, the nursery plants in Sriganganagar are located further away from the orchards than those in Fazilka.

Table 6.8: Distance of nursery plant from the orchard of respondent Kinnow growers

Distance in k.m.	Fazilka (Punjab)	Sriganganagar (Rajasthan)
	No. of responses	No. of responses
0-5	95	19
05-10	83	21
10-15	32	38
15-20	12	42
20-25	18	79
More than 25	0	41
Total	**240**	**240**
Mean distance	7.81	18
S.D.	5.92	7.45

Source: primary data

The standard deviations (S.D.) for Fazilka and Sriganganagar are 5.92 and 7.45, respectively. This suggests that there is more variation in the distance of nursery plants from orchards in Sriganganagar than in Fazilka. In summary, the table provides insights into the distance of nursery plants from orchards for Kinnow growers in Fazilka and Sriganganagar, highlighting differences between the two locations.

Distance of the orchards from the nearest waxing, grading, and packaging unit: The table 6.9 presents data on the distance of orchards of respondent Kinnow growers from the nearest waxing, grading, and packaging unit in two locations, Fazilka (Punjab) and Sriganganagar (Rajasthan). The data is based on the number of responses received from the growers and is grouped into distance categories of 0-5 km, 5-10 km, 10-15 km, 15-20

km, 20-25 km, and more than 25 km. The table shows that in Fazilka, 178 growers reported that their orchards were located within a distance of 0-5 km from the nearest waxing, grading, and packaging unit, and 39 growers reported a distance of 5-10 km. In comparison, in Sriganganagar, only 21 growers reported a distance of 0-5 km, while 39 growers reported a distance of 5-10 km. This suggests that growers in Fazilka tend to have their orchards located closer to waxing, grading, and packaging units than those in Sriganganagar. Furthermore, the table indicates that the mean distance of orchards from the nearest waxing, grading, and packaging unit in Fazilka is 4.375 km, while in Sriganganagar, it is 17.625 km.

Table 6.9: Distance of Orchards of Respondent Kinnow Growers From the Nearest Waxing, Grading, Packaging Unit

Distance in km.	Fazilka (Punjab)	Sriganganagar (Rajasthan)
	No. of responses	No. of responses
0-5	178	21
05-10	39	39
10-15	18	13
15-20	5	7
20-25	0	160
More than 25	0	0
Total	**240**	**240**
Mean distance	4.375	17.625
S.D.	3.57	7.344

Source: primary data

This means that, on average, the orchards in Sriganganagar are located further away from the nearest waxing, grading, and packaging unit than those in Fazilka. The standard deviations (S.D.) for Fazilka and Sriganganagar are 3.57 and 7.344, respectively. This suggests that there is more variation in the distance of orchards from the nearest waxing, grading, and packaging unit in Sriganganagar than in Fazilka.

In summary, the table provides insights into the distance of orchards from the nearest waxing, grading, and packaging unit for Kinnow growers in Fazilka and Sriganganagar, highlighting differences between the two locations. The mean distance of orchards from the nearest unit is much higher in Sriganganagar (17.625 km) as compared

to Fazilka (4.375 km). This indicates that Kinnow growers in Sriganganagar have to travel longer distances to get their produce waxed, graded, and packed, which could potentially increase their transportation costs and reduce their profitability. Banner & Oppong-Kyeremeh (2019) unveiled that farmers directly benefit from purchases made by processors and exporters. Moreover, when it comes to value-added activities conducted by wholesalers, it was observed that, besides washing, which has a comparatively lower significance, packaging, waxing, grading, and sorting play crucial roles in the process.

Distance from the nearest cold store:

Table .10 provides information about the distance of the orchards of Kinnow growers in Fazilka (Punjab) and Sriganganagar (Rajasthan) from the nearest cold store. It can be observed that in Fazilka, a higher number of respondents (176) reported a distance of 10-15 km from the nearest cold store, while in Sriganganagar, the majority of respondents (115) reported a distance of 10-15 km. In terms of mean distance, the orchards of Kinnow growers in Sriganganagar are slightly closer to the nearest cold store (14.96 km) than in Fazilka (13.625 km).

Table 6.10: Distance of Nearest Cold Store from Respondents Orchard

Distance in k.m.	Fazilka (Punjab)	Sriganganagar (Rajasthan)
	No. of responses	No. of responses
0-5	3	4
05-10	16	14
10-15	176	115
15-20	19	84
20-25	21	13
More than 25	5	10
Total	**240**	**240**
Mean distance	13.625	14.96
S.D.	4.1313	4.54

Source: primary data

The standard deviation (S.D.) values indicate that the distance of orchards from the nearest cold store in Fazilka is relatively less dispersed compared to Sriganganagar. This may suggest that the proximity of the cold store may be more consistent among Kinnow growers in Fazilka than in Sriganganagar. Overall, the table highlights the

importance of the distance of the orchards from the nearest cold store, as it affects the quality and marketability of the Kinnow produce.

Khan et al. (2016) discovered that kinnow farmers in Pakistan experience yield losses resulting from various factors, including fruit injuries during picking, insufficient transportation and storage capabilities, and shortcomings in the marketing system. As a solution, the researchers recommend the establishment of an efficient citrus marketing system by the government to address these challenges.

Insufficient market information, deficient marketing infrastructure, limited processing and post-harvest facilities, and frequent price fluctuations have all been recognized as the primary impediments to the growth of kinnow cultivation in the state (Mavi et al., 2012).

Distance of orchard from 'Custom Hiring' Center for the availability of latest farm equipment on rent:

Table 6.11 provides information about the distance of respondent Kinnow growers' orchards from the nearest Custom Hiring Center (CHC) for the availability of the latest farm equipment on rent. The data is divided into different distance categories in kilometers (0-5, 5-10, 10-15, 15-20, 20-25, and more than 25), and the number of responses is given for each category for Fazilka (Punjab) and Sriganganagar (Rajasthan). The total number of responses is the same for both locations, i.e240. The mean distance of respondent Kinnow growers' orchards from the nearest CHC in Fazilka is 10.23 km, and in Sriganganagar, it is 11.83 km. The standard deviation of distances for Fazilka is 5.75 km, and for Sriganganagar, it is 6.45 km.

The data suggests that Kinnow growers in both Fazilka and Sriganganagar have access to CHCs within a distance of 15-20 km from their orchards, with 51 and 65 respondents, respectively. However, there are some differences between the two locations. For example, in Fazilka, 55 and 66 respondents have CHCs within 0-5 km and 5-10 km distances, respectively, whereas in Sriganganagar, 46 and 54 respondents have CHCs within these distances. In contrast, in Sriganganagar, more respondents (23) have

CHCs at a distance of 20-25 km, whereas in Fazilka, only 7 respondents have CHCs at this distance.

Table-6.11: Distance of Respondent Kinnow Grower's Orchard from Custom Hiring Center for Availability of Latest Farm Equipment on Rent:

Distance in k.m.	**Fazilka (Punjab)**	**Sriganganagar (Rajasthan)**
	No. of responses	No. of responses
0-5	55	46
05-10	66	54
10-15	59	51
15-20	53	65
20-25	7	23
More than 25	0	1
Total	**240**	**240**
Mean distance	10.23	11.83
S.D.	5.75	6.45

Source: primary data

Overall, the data suggests that there are some differences in the availability of CHCs for Kinnow growers in Fazilka and Sriganganagar, with slightly better access in Fazilka. However, a more detailed analysis is required to understand the implications of these differences for the Kinnow industry in these locations. Farmers were able to enhance their crop production by adopting improved tools and utilizing better irrigation infrastructure. Simultaneously, their income and overall well-being saw improvement thanks to strengthened connections with markets and the availability of new information sources, all facilitated through agricultural innovation platforms (Prabhavathi, Kishore, & Charishma, 2021).

Overall, this study suggests that access to modern farm machinery through custom hiring centers can have positive impacts on small-scale farmers' livelihoods and agricultural productivity. Therefore, policymakers need to address the challenges faced by farmers in accessing these services, such as distance from custom hiring centers, and implement policies and programs to improve their access to modern farm machinery.

Distance from nearest fruit market:

Table 6.12 shows the distance of respondent Kinnow growers' orchards from the nearest fruit market in Fazilka (Punjab) and Sriganganagar (Rajasthan) in kilometers. The

table also displays the number of responses in each category of distance. From the table, it can be observed that the mean distance from the nearest fruit market is higher in Sriganganagar (15.38 km) than in Fazilka (14.21 km). The standard deviation is also higher in Sriganganagar (6.01 km) compared to Fazilka (5.6 km), indicating a wider range of distances in Sriganganagar. It is important to note that there are no responses in the 0-5 km category in both Fazilka and Sriganganagar. This suggests that there are no Kinnow orchards located very close to the nearest fruit market in either region.

Table 6.12: Distance of Respondent Kinnow Grower's Orchard from Nearest Fruit Market

Distance in k.m.	Fazilka (Punjab)	Sriganganagar (Rajasthan)
	No. of responses	No. of responses
0-5	0	0
05-10	61	54
10-15	94	70
15-20	51	54
20-25	19	48
More than 25	15	14
Total	**240**	**240**
Mean distance	14.21	15.38
S.D.	5.6	6.01

Source: primary data

Overall, the table highlights the importance of considering the distance of fruit growers' orchards from the nearest market while planning marketing and extension services. Growers located farther away from the market may face higher transportation costs and lower profitability due to longer travel times and higher expenses. Extension services can play a crucial role in educating growers on efficient marketing strategies and transportation options to reduce these costs and improve profitability. There have been various studies conducted on the impact of distance from fruit markets on the profitability of fruit growers. In contrast to common belief, the traditional marketing channels for kinnow yielded a higher net benefit. The study underscores the necessity for introducing new marketing channels while promoting the coexistence of both traditional and modern

channels to reinforce the kinnow value chain, ultimately benefiting all stakeholders involved (Yogi et al., 2020).

Distance of Respondent Orchard from 'Extension Service Office':

Table 6.13 shows the distance of respondents' orchards from the 'Extension Service Office' in two different locations, Fazilka (Punjab) and Sriganganagar (Rajasthan). The data is categorized into different ranges of distances in kilometers, and the number of responses in each range is given. In Fazilka, none of the respondents had their orchards located within 5 km of the Extension Service Office, while 60 respondents had their orchards located between 5-10 km. The number of respondents decreased as the distance increased; with 15 respondents having their orchards located more than 25 km away. In Sriganganagar, the pattern was different.

Table 6.13: Distance of Respondents Orchard from 'Extension Service Office'

Distance in k.m.	Fazilka (Punjab)	Sriganganagar (Rajasthan)
	No. of responses	No. of responses
0-5	0	0
05-10	60	0
10-15	95	22
15-20	52	28
20-25	18	85
More than 25	15	105
Total	240	240
Mean distance	14.02	23.19
S.D.	5.56	4.75

Source: primary data

The majority of respondents (105) had their orchards located more than 25 km away from Extension Service Office. The number of respondents in the other distance ranges decreased when the distance increased. The mean distance of respondents' orchards from the Extension Service Office was 14.02 km in Fazilka and 23.19 km in Sriganganagar. The standard deviation was 5.56 km in Fazilka and 4.75 km in Sriganganagar. Overall, the table suggests that the respondents in Fazilka were closer to the Extension Service Office than the respondents in Sriganganagar. This could have implications for the accessibility of extension services and the effectiveness of outreach programs in these

areas. The distribution of agricultural extension services to different settlements is influenced by a combination of economic, social, and policy-related factors. Moreover, the quantity of extension services allocated has a reciprocal relationship with the demand for extension services, and various variables, including settlement characteristics such as structure, size, age, and proximity to the extension center, also contribute to this dynamic (Dinar, 1989).

A study titled "Farmers' Perception about Agricultural Extension Services in Punjab" by Kaur & Dhaliwal (2013) found that the distance of farmers' fields from the extension service offices was a major constraint in accessing extension services. The study recommended that extension services should be decentralized and made available at the village level to improve access.

All indicators of infrastructure and ancillary:

Table 6.14 presents statistical measures of supportive infrastructure and ancillary for Kinnow (a type of citrus fruit) in two different regions, Fazilka (Punjab) and Sriganganagar (Rajasthan). The data represents the mean and standard deviation (S.D.) of the distance of the nearest bank branch, nursery plant, waxing/grading/packaging unit, cold store, custom hiring center, fruit market, and extension service office from respondents' orchards in both regions. Firstly, we can observe that the mean distances for all the facilities are higher in Sriganganagar than in Fazilka. This indicates that in Sriganganagar, the orchards are generally situated farther away from these supportive infrastructures than in Fazilka.

Testing of hypothesis-2

To test the hypothesis that there is no difference in the level of supportive infrastructure for Kinnow between Rajasthan and Punjab, we can perform a separate one-sample t-test for each parameter and compare the means between the two locations. Since we are given the sample standard deviations for each parameter, we can assume that the population standard deviations are unknown and use the t-distribution for our test.

Table 5.14: All Indicators of Infrastructure and Ancillary

Supportive infrastructure and ancillary for Kinnow	Statistical measures	Fazilka (Punjab)	Sriganganagar (Rajasthan)
Distance of nearest bank branch from respondents' orchard	Mean	6.104	8.5
	S.D.	4.187	5.127
Distance of orchards from the nearest nursery plant	Mean	7.81	18
	S.D.	5.92	7.45
Distance of orchards nearest waxing, grading, packaging unit	Mean	4.375	17.625
	S.D.	3.57	7.344
Distance of orchards from the nearest cold store	Mean	13.625	14.96
	S.D.	4.1313	4.54
Distance of orchards from Custom Hiring Center	Mean	10.23	11.83
	S.D.	5.75	6.45
Distance of orchards from the nearest fruit market	Mean	14.21	15.38
	S.D.	5.6	6.01
distance of orchards from 'Extension Service Office'	Mean	14.02	23.19
	S.D.	5.56	4.75

For each parameter, we can calculate the t-statistic using the formula:

$$t = (X_1 - X_2) / (S / \sqrt{(n)}$$

Where

X_1 and X_2 Are the sample means for Fazilka and Sriganganagar, S is the pooled sample standard deviation for that parameter, and n is the sample size (which is the same for both locations).

$$S=\sqrt{\frac{(n_1-1).s_1^2+(n_2-1).s_2^2}{n_1+n_2-2}}$$

Where:

s_1 = Sample standard deviation for Fazilka

s_2= sample standard deviation for Sriganganagar

We can then compare the calculated t-value to the critical t-value for a two-tailed t-test with a significance level of 0.05 and 478 degrees of freedom (480-2).

Here are the results of the t-tests for each parameter:

Distance of nearest bank branch from respondents' orchard:

x_1 = 6.104, x_2 = 8.5, S≈5, n = 240 for each

$$t = \frac{(6.1.04 - 8.5)}{(5/\sqrt{240})} = -7.424$$

The critical t-value is ±1.96, and our calculated t-value of -7.424 is outside this range, so we reject the null hypothesis and conclude that there is a significant difference in the distance of the nearest bank branch between Fazilka and Sriganganagar.

Distance of orchards from nearest nursery plant:

x_1 = 7.81, x_2 = 18, S≈6.726, n = 240 for each

$$t = \frac{(7.81 - 18)}{(6.726/\sqrt{240})} = -23.476$$

The critical t-value is ±1.96, and our calculated t-value of -23.476 is outside this range, so we reject the null hypothesis and conclude that there is a significant difference in the distance of the nearest nursery plant between Fazilka and Sriganganagar.

Distance of orchards nearest waxing, grading, and packaging unit:

x_1 = 4.375, x_2 = 17.625, S≈5.774, n = 240 for each

$$t = \frac{(4.375 - 17.625)}{(5.774/\sqrt{240})} = -35.55$$

The critical t-value is ±1.96, and our calculated t-value of -35.55 is outside this range, so we reject the null hypothesis and conclude that there is a significant difference in the distance of the nearest waxing, grading, and packaging unit between Fazilka and Sriganganagar.

Distance of orchards from the nearest cold store:

x_1 = 13.625, x_2 = 14.96, S≈4.341, n = 240 for each

$$t = \frac{(13.625 - 14.96)}{(4.341/\sqrt{240})} = -4.765$$

The critical t-value is ±1.96, and our calculated t-value of -4.765 is outside this range, so we reject the null hypothesis and conclude that there is a significant difference in the distance of the nearest cold store between Fazilka and Sriganganagar.

Distance of orchards from Custom Hiring Center:

$$x_1 = 10.23,\ x_2 = 11.83,\ S \approx 6.11,\ n = 240 \text{ for each}$$

$$t = \frac{(10.23 - 11.83)}{(6.11/\sqrt{240})} = -4.06$$

The critical t-value is ±1.96, and our calculated t-value of -4.06 is outside this range, so we reject the null hypothesis and conclude that there is a significant difference in the distance of the nearest Custom Hiring Center between Fazilka and Sriganganagar

Overall we reject the null hypothesis and conclude that there is a significant difference in the level of supportive infrastructure for Kinnow between Rajasthan and Punjab.

Chapter 6 focuses on the supportive infrastructure necessary for Kinnow production in the Fazilka (Punjab) and Sriganganagar (Rajasthan) regions. The chapter examines various infrastructure components, such as irrigation, transportation, storage, and market facilities, and compares the two regions.

Key Points:

Irrigation and Water Sources:

In both regions, Kinnow orchards rely primarily on canal water for irrigation, as Kinnow is sensitive to saline water. About 87% of growers in Fazilka and 89% in Sriganganagar have irrigation water storage tanks, showing slightly better availability in Sriganganagar.

Energy for Irrigation:

In Fazilka, 80.83% of growers use electricity for irrigation, while in Sriganganagar, 52.09% rely on solar panels, followed by diesel. Electricity is more common in Fazilka, while Sriganganagar relies more on renewable energy.

Irrigation Methods:

Drip irrigation is the most widely used method in both regions, with 54.17% of Fazilka and 57.92% of Sriganganagar farmers using it. This method helps conserve water and increase efficiency.

Road Connectivity:

Fazilka has better road connectivity (37.08%) to orchards compared to Sriganganagar (18.33%), posing challenges for farmers in terms of transporting produce to markets.

Distance from Infrastructure:

Bank branches, cold storage, custom hiring centers, and extension service offices are farther from farmers in Sriganganagar compared to Fazilka. This increased distance in Sriganganagar reduces accessibility to essential services, affecting profitability and efficiency. For example, the nearest waxing, grading, and packaging units are 17.62 km away in Sriganganagar, compared to just 4.37 km in Fazilka.

Cold Storage and Markets:

Cold storage is critical for preserving Kinnow produce, and the average distance from orchards is slightly longer in Sriganganagar (14.96 km) than in Fazilka (13.62 km). Proximity to markets is also a challenge, with longer distances in Sriganganagar (15.38 km) than Fazilka (14.21 km).

The chapter concludes that Fazilka has better infrastructure compared to Sriganganagar, which negatively impacts farmers in Rajasthan by increasing transportation costs and reducing profitability. The study calls for improved infrastructure, including roads, storage, and access to financial services, especially in Sriganganagar.

CHAPTER-7

CHALLENGES IN KINNOW PRODUCTION

The chapter begins by contextualizing the challenges faced by Kinnow growers within the broader agricultural landscape of Rajasthan and Punjab. The chapter delves into a detailed analysis of the constraints faced by Kinnow growers, drawing on empirical evidence from primary data sources such as surveys, interviews, and field observations. Common constraints may include limited access to water resources, pest and disease outbreaks, market volatility, lack of infrastructure, labor shortages, and land degradation, among others. Furthermore, the chapter examines the interrelationships between different constraints and their cumulative impact on Kinnow cultivation practices and outcomes. It also considers the perspectives and experiences of Kinnow growers, incorporating their insights into the analysis of constraints.

Through a systematic assessment of constraints, this study aims to provide valuable insights into the challenges confronting Kinnow growers in Rajasthan and Punjab. By identifying priority areas for intervention and recommending targeted solutions, the research endeavors to support the resilience and sustainability of Kinnow cultivation in the study area.

Table 7.1 shows data on the constraints faced by Kinnow growers in Fazilka, Punjab, and Sriganganagar, Rajasthan. The constraints are categorized into four groups: production constraints, input constraints, infrastructure constraints, and other constraints. The number of responses and the percentage of respondents facing each constraint are provided for both locations.

The most common production constraints reported by the growers are "difficulty obtaining specialist services" (50% in Fazilka and 83.75% in Sriganganagar) and "lack of training programs for orchard management" (68.75% in Fazilka and 92.5% in Sriganganagar). Farmers reported a need for workshops on Kinnow crop management, noting that such educational opportunities are currently lacking. They also highlighted

that no effective solutions were provided despite consulting experts about citrus decline problem in previous years.

Table 7.1: Production Constraints Faced by Respondent Kinnow Growers

Constraints	Fazilka (Punjab)		Sriganganagar (Rajasthan)	
Production constraints	No. of responses	Percentage	No. of responses	Percentage
1. Information				
Difficulty obtaining specialist services.	120	50	201	83.75
Lack of training programs for orchard management	165	68.75	222	92.5
2. Input				
High investment	107	44.58	109	45.42
High interest rates on finance	125	52.08	147	61.25
Irregularity of irrigation water	187	77.92	231	96.25
High input prices	225	93.75	235	97.92
Timely nonavailability of fertilizers	222	92.5	238	99.17
losses due to low-quality pesticides	99	41.25	81	33.75
Shortage of reliable nursery plants.	24	10	195	81.25
3. Infrastructure				
Non-availability of modern farm equipment on rent	65	27.08	83	34.58
unavailability of machinery for shifting large plants	83	34.58	73	30.42
4. Other constraints				
Pre-harvest losses due to rapid weather changes	190	79.17	196	81.67
High rate of citrus decline in recent years	165	68.75	161	67.08
Polluted water supply in canals damaging orchards	166	69.17	167	69.58

Source: primary data

Additionally, farmers mentioned that they either had to travel to obtain specialist services or relied on phone consultations, which often provided incomplete information. These constraints indicate that growers face challenges in accessing the knowledge and

skills necessary for optimal orchard management. Among the input constraints, "high input prices" (93.75% in Fazilka and 97.92% in Sriganganagar) and "timely non-availability of fertilizers" (92.5% in Fazilka and 99.17% in Sriganganagar) are the most frequently reported constraints. Farmers have reported that there is a shortage of fertilizers, including urea and NPK, in the market following the harvesting period. This scarcity often leads to black marketing. Additionally, some shopkeepers engage in the practice of bundling fertilizers with non-essential products, compelling farmers to purchase these unwanted items along with the fertilizers. These constraints suggest that growers face challenges in accessing affordable and timely inputs, which could negatively impact their yields and profitability.

The infrastructure constraints category indicates that growers face challenges in accessing modern farm equipment or machinery for shifting large plants. In past years, the issue of citrus decline has been a significant challenge for farmers, leading to the death of many plants. Consequently, farmers have felt the necessity to relocate the remaining large plants. However, a notable obstacle they encountered was the lack of suitable technology for this task. Shifting large plants, particularly mature citrus trees, presents unique challenges due to their size, weight, and delicate root systems. Traditional methods of transplanting, such as manual digging and relocation, are labor-intensive, time-consuming, and often result in damage to the plant and its root structure. Moreover, such methods may not be feasible for large-scale operations or may pose safety risks to workers. In the absence of specialized equipment or technology tailored for transplanting large citrus plants, farmers have had to resort to makeshift solutions or rely on manual labor, neither of which is ideal. These makeshift approaches may include using ropes, pulleys, or even heavy machinery not specifically designed for this purpose, leading to suboptimal results and potential plant harm. The lack of appropriate technology for transplanting large citrus plants not only hampers the efficiency of the relocation process but also contributes to additional costs, as farmers may incur expenses for labor, equipment rental, or potential damage to the plants during the relocation process. To address this pressing need, there is a clear opportunity for research and

development in the agricultural sector to innovate and create specialized equipment or machinery tailored for transplanting large citrus plants. Such technology could incorporate features like gentle root excavation, root ball wrapping, and hydraulic lifting mechanisms to minimize stress on the plant and facilitate safe and efficient relocation. Furthermore, education and training programs could be implemented to familiarize farmers with best practices for transplanting large citrus plants using the newly developed technology. This holistic approach would not only empower farmers with the tools and knowledge needed to manage citrus decline effectively but also contribute to the sustainability and resilience of citrus farming operations in the face of challenges.

The other constraints reported by the growers include "pre-harvest losses due to rapid weather changes" (79.17% in Fazilka and 81.67% in Sriganganagar), "high rate of citrus decline in recent years" (68.75% in Fazilka and 67.08% in Sriganganagar), and "polluted water supply in canals damaging orchards" (69.17% in Fazilka and 69.58% in Sriganganagar). These constraints suggest that growers face challenges related to environmental factors that could negatively impact their yields and profitability. Overall, the table highlights the significant challenges faced by Kinnow growers in both Fazilka and Sriganganagar.

The constraints related to knowledge, input availability, and environmental factors are the most commonly reported. Addressing these challenges could help improve the productivity and profitability of Kinnow orchards in the region. Similar views on the challenges faced by Kinnow growers: Nonvide et al. (2018) uncover significant challenges faced by farmers, including limited access to agricultural credit, insufficient availability of production inputs, a lack of knowledge regarding water resources management, restricted access to agricultural information and markets, and the issue of field flooding. Mavi et al. (2012) identified significant impediments to the growth of kinnow cultivation in the state, including the absence of market information and marketing infrastructure, insufficiencies in processing and post-harvest facilities, and the frequent fluctuations in prices.

Table 7.2 presents the marketing constraints faced by Kinnow growers in two different regions of India, Fazilka in Punjab and Sriganganagar in Rajasthan.

Table 7.2: Marketing Constraints Faced by Respondent Kinnow Grower

Constraints	Fazilka (Punjab)		Sriganganagar (Rajasthan)	
Marketing constraints	No. of responses	Percentage	No. of responses	Percentage
1. Information				
Real-time price volatility information is not available	195	81.25	203	84.58
Non-access to export information	188	78.33	207	84.58
2. Input				
High cost of transportation	205	85.42	199	82.92
Shortage of transport facilities	163	67.92	159	66.25
3. Infrastructure				
Poor quality of rural roads	91	37.92	176	73.33
Inadequate infrastructure to access distant markets	156	65	174	72.5
Less number of waxing and grading units	35	14.58	189	78.75
4. Other constraints				
Kinnow's tendency to perish quickly	230	95.83	226	94.17
Low price	235	97.92	237	98.75

Source: primary data

The data is presented in terms of the number of responses and the percentage of respondents who identified each constraint. In both regions, the most commonly identified constraints were related to the availability of information. The real-time price volatility information was not available for 81.25% of respondents in Fazilka and 84.58% of respondents in Sriganganagar. Similarly, non-access to export information was reported by 78.33% of respondents in Fazilka and 84.58% of respondents in Sriganganagar. In terms of input-related constraints, the high cost of transportation was reported by 85.42% of respondents in Fazilka and 82.92% of respondents in

Sriganganagar. Shortage of transport facilities was also reported as a constraint by 67.92% of respondents in Fazilka and 66.25% of respondents in Sriganganagar.

The infrastructure-related constraints varied between the two regions. Poor quality of rural roads was identified as a constraint by 37.92% of respondents in Fazilka and 73.33% of respondents in Sriganganagar. Similarly, inadequate infrastructure to access distant markets was reported by 65% of respondents in Fazilka and 72.5% of respondents in Sriganganagar. On the other hand, the number of waxing and grading units was identified as a constraint by only 14.58% of respondents in Fazilka and 78.75% of respondents in Sriganganagar.

Kinnow's tendency to perish quickly and low price were identified as constraints by almost all respondents in both regions, with 95.83% to 97.92% of respondents identifying perishability as a constraint and 97.92% to 98.75% of respondents identifying low price as a constraint. Ghafoor et al., (2010) highlighted various critical factors that contribute to the challenges faced in the harvesting and marketing of Kinnow, including delayed payments from dealers, low market prices for Kinnow, the dominance of middlemen, elevated carriage and handling charges, absence of adequate storage facilities, and issues related to packing and loading.

Kumar & Sharma, (2019) discovered that several significant production challenges were identified, including a shortage of skilled labor, elevated wage rates, and issues with stray animals. When it comes to marketing-related obstacles, the study found statistically significant issues such as higher wage rates, the unavailability of labor during peak operation times, increased prices of packing materials, and elevated transportation charges. Additionally, the study indicated that timely input availability and the implementation of effective marketing strategies could potentially enhance both production and income from agricultural produce in the study area.

In summary, the data highlights the various marketing constraints faced by Kinnow growers in different regions of India. The constraints are related to information, inputs, infrastructure, and other factors such as the perishability of Kinnow and low prices.

Addressing the challenges related to knowledge and training programs could help Kinnow growers adopt best practices for orchard management, leading to higher yields and better-quality produce. This can be done by organizing training programs, workshops, and extension services that provide growers with the necessary knowledge and skills. Reducing input prices and improving their availability could help growers reduce their production costs and improve their profitability. This could be done by improving the supply chain for inputs, encouraging competition among suppliers, and providing subsidies and other incentives to growers.

The challenges related to environmental factors, such as weather changes and water quality, could be addressed by implementing better irrigation systems, adopting crop management practices that are better suited to the local climate, and improving the quality of water supply for irrigation.

Supporting research and development in the Kinnow industry could help to identify and address other constraints that growers may face. This could include developing new pest and disease management strategies, identifying new markets for Kinnow, and improving post-harvest handling and storage techniques. Encouraging collaboration among growers, researchers, and other stakeholders in the Kinnow industry could help to develop and implement more effective strategies for addressing the challenges faced by growers. This could include forming grower associations, participating in research projects, and sharing best practices and other information.

Improved market information systems: Providing real-time price information to growers through various channels, including mobile phone apps and SMS messages, can help them make informed decisions about when and where to sell their produce.

Infrastructure development: Developing better rural roads, storage facilities, and transportation systems can help reduce transportation costs and increase the shelf-life of perishable produce. This could be achieved through government investments, public-private partnerships, or other innovative financing models.

Capacity building: Providing training and technical assistance to farmers on good agricultural practices, post-harvest handling, and marketing strategies can help improve

the quality and value of their produce, leading to better prices and increased competitiveness.

Market linkages: Facilitating direct linkages between farmers and buyers, including exporters, can help improve market access and reduce the role of middlemen in the marketing chain.

Policy support: Implementing policies that support farmers, including price stabilization mechanisms and input subsidies, can help reduce production costs and increase the profitability of farming. These policy suggestions are not exhaustive, but they highlight some key areas where policy interventions could have a significant impact on improving the marketing environment for Kinnow growers and other farmers facing similar constraints.

The chapter titled Challenges in Kinnow Production provides an in-depth analysis of the multifaceted constraints affecting Kinnow growers in the regions of Fazilka (Punjab) and Sriganganagar (Rajasthan). The study, grounded in empirical data from surveys and field observations, identifies a range of production, input, infrastructure, and environmental challenges.

Production Constraints: Farmers in both regions face significant obstacles in accessing specialized agricultural services, with 50% of respondents in Fazilka and 83.75% in Sriganganagar reporting difficulties in obtaining expert advice. Additionally, the lack of orchard management training programs is a pervasive issue, affecting 68.75% of farmers in Fazilka and 92.5% in Sriganganagar. These findings suggest that the limited availability of expert knowledge and training is hindering optimal agricultural practices.

Input Constraints: High input prices, reported by 93.75% of respondents in Fazilka and 97.92% in Sriganganagar, and the timely unavailability of fertilizers (92.5% in Fazilka and 99.17% in Sriganganagar) represent major barriers to effective production. Farmers have also highlighted the challenge of fertilizer shortages, exacerbated by black market activities, further inflating costs and complicating access.

Infrastructure Constraints: The report indicates a widespread deficiency in modern farming equipment and appropriate machinery for relocating large citrus plants, a critical

issue given the high rate of citrus decline in recent years. The lack of suitable technology for transplanting mature trees adds to labor and operational costs, complicating efforts to manage declining orchards efficiently.

Environmental and Market Challenges: Environmental factors such as pre-harvest losses due to rapid weather changes and polluted water from canals pose additional risks, affecting 81.67% and 69.58% of respondents in Sriganganagar, respectively. In terms of market-related constraints, price volatility, inadequate transportation, and the perishability of Kinnow were identified as critical issues by over 95% of respondents in both regions.

The chapter advocates for targeted interventions to mitigate these challenges, including the implementation of training programs, improved access to inputs, infrastructure development, and enhanced market information systems. Furthermore, policy recommendations include price stabilization mechanisms, investment in rural infrastructure, and the promotion of direct market linkages to reduce the role of intermediaries. These measures are deemed essential to enhance the resilience and profitability of Kinnow cultivation in these regions.

CHAPTER-8

FINDINGS, CONCLUSION, AND SCOPE FOR FURTHER RESEARCH

This chapter is critical as it summarizes the entire study's key findings and provides insights into the research problem's resolution. In the findings section, the researcher presents the study's results, interpretations, and implications. The conclusion section summarizes the study's primary findings, reiterates its significance, and makes recommendations for future research. Finally, the scope for further research section highlights possible avenues for future research that could extend or refine the current study's findings. This chapter serves as a critical contribution to the literature and guides researchers in the field on potential areas for future research.

For the first objective of the study to identify trends and patterns based on the regression results, we can conclude the following:

1. Area trend: The area under cultivation of Kinnow oranges in Fazilka and Sriganganagar has been increasing, as indicated by the positive slope of the linear trend equation for Fazilka and the exponential trend equation for Sriganganagar. However, the coefficient of determination for Sriganganagar is very low, indicating that the trend is not very strong.
2. Production trend: The production of Kinnow oranges in both districts has been increasing over time, as indicated by the positive slope of the linear trend equations. Coefficient of determination Sriganganagar is again very low, indicating that the trend is not very strong.
3. Productivity trend: The productivity of Kinnow oranges in Fazilka has been increasing, as indicated by the positive slope of the linear trend equation, while in Sriganganagar; it has remained relatively stagnant.

Our other objective is to compare the socio-economic and infrastructure status and constraints faced by Kinnow growers. The study suggests that medium-sized farms dominate the Kinnow farming landscape in these regions. The Gini coefficient value for

Fazilka indicates a higher degree of inequality in the distribution of landholding among Kinnow farmers as compared to Sriganganagar. a large proportion of farmers (50.417%) fall in the medium category, indicating a concentration of landholding among a relatively small group of farmers. In contrast, in Sriganganagar, a relatively higher percentage of farmers (72.917%) fall in the medium category, indicating a more equal distribution of landholding among farmers. Looking at the age-wise distribution, we can see that the majority of respondents in both regions are in their middle age. The study shows that the age-wise distribution of respondent Kinnow growers is similar in both regions, with the majority of respondents falling in the age group of 35-40 years. The mean age and standard deviation of the age distribution were also quite similar between the two regions. The study suggests that the Kinnow-growing industry is predominantly male-dominated, with very few female growers. From the Study, it can be inferred that the majority of Kinnow growers in both districts are married. The difference in percentage between the two districts is negligible. The majority of Kinnow growers in all regions belong to the general caste category. However, there are also significant numbers of OBC and SC category respondents in some regions. Overall, the education level of Kinnow growers appears to be relatively high, with a significant number of respondents having completed graduation or post-graduation. The distribution of education levels among respondents is quite similar in both locations. The study suggests that there are more options for senior secondary education near the Kinnow growers in both Fazilka and Sriganganagar. This could have implications for the quality and accessibility of education for young children in these areas. , the data suggest that the traditional joint family structure is still prevalent among Kinnow growers in these areas. Understanding family structures is important for understanding the social dynamics and support systems available to Kinnow growers. For example, joint families may provide a built-in support system for agricultural activities, with multiple generations contributing to the labor and knowledge required for successful cultivation. The study suggests that the family size of Kinnow growers in Fazilka and Sriganganagar is similar, with the majority of families having 4 to 8 members. The majority of Kinnow growers in both regions consume electricity in the range of 200 to

600 units per month. The majority of Kinnow growers in both regions live in villages rather than cities. This could be due to several reasons such as the availability of land for farming, lower cost of living, and a preference for a rural lifestyle. Pucca houses are the most common type of house owned by Kinnow growers in both regions, with a combined percentage of 86.87%. The data suggests that a significantly higher proportion of Kinnow growers in Fazilka, Punjab have access to all-weather roads connecting to their houses compared to Sriganganagar, Rajasthan. The data suggests that a higher proportion of respondents in Fazilka, Punjab have access to paved drains compared to Sriganganagar, Rajasthan. Cooking Gas is the most common source of cooking used by Kinnow growers in both regions. Kinnow growers in both regions rely on a variety of secondary income sources to supplement their farming income. Livestock is the most common secondary income source. The majority of respondent Kinnow growers in both regions have an annual income between 3 to 6 lakh rupees, with a smaller proportion reporting higher incomes. The study suggested that Kinnow cultivation had the potential to improve the socio-economic status. Data suggests that landholding is strongly associated with annual income for Kinnow growers. Study suggests that wheat, cotton, mustard, and barley are among the most commonly grown crops in both locations. A higher proportion of Kinnow growers in Fazilka are involved in the production of biopesticides, fungicides, and organic fertilizers compared to those in Sriganganagar. Canal water is the predominant source of irrigation for Kinnow orchards in these regions. The majority of Kinnow growers in both locations have irrigation water storage tanks available in their orchards. The study suggests that electricity connection is the most commonly used source of energy for irrigation in Fazilka, while in Sriganganagar, a higher proportion of respondents reported using solar panels and diesel for irrigation. This difference may be attributed to the availability and cost of energy sources in the two regions. The study suggests that drip irrigation may be more popular or more commonly used among Kinnow growers in both locations. The study highlights the lack of road connectivity to orchards of Kinnow growers in both districts, with a higher percentage of respondents in Sriganganagar reporting no road connectivity. The majority of respondents in both

regions have bank branches located within a distance range of 5-10 km from their orchards. However, more respondents in Sriganganagar have bank branches located farther away (more than 15 km) than those in Fazilka. Kinnow growers in Fazilka tend to have their nursery plants located closer to their orchards compared to those in Sriganganagar. Study indicates that Kinnow growers in Sriganganagar have to travel longer distances to get their produce waxed, graded, and packed, which could potentially increase their transportation costs and reduce their profitability. Orchards of Kinnow growers in Sriganganagar are slightly away from the nearest cold store (14.96 km) than in Fazilka (13.625 km). The study suggests that there are some differences in the availability of CHCs for Kinnow growers in Fazilka and Sriganganagar. The study suggests that the respondents in Fazilka were closer to the Extension Service Office than the respondents in Sriganganagar. This could have implications for the accessibility of extension services and the effectiveness of outreach programs in these areas. The study highlights the significant challenges faced by Kinnow growers in both Fazilka and Sriganganagar. The constraints related to knowledge, input availability, and environmental factors are the most commonly reported. "Polluted water supply in canals damaging orchards" and Pre-harvest losses due to rapid weather changes are major environmental issues. Kinnow growers in both regions face similar marketing constraints. Lack of information, high input costs, inadequate infrastructure, and low prices are the major challenges faced by these growers.

Policy Suggestions for Enhancing Kinnow Cultivation and Farmer Welfare

Adoption of Modern Farming Practices and Technologies:

Policymakers should actively promote the adoption of modern farming practices and advanced agricultural technologies among farmers. This includes the use of precision farming tools, drip irrigation systems, and high-efficiency fertilizers to improve yield and efficiency. Financial incentives, subsidies, and training programs could be offered to encourage farmers to integrate these technologies into their practices.

Technical Assistance for Farmers:

To address the stagnation in productivity in Sriganganagar, it is crucial to provide comprehensive technical assistance to farmers. This can be achieved by organizing regular training sessions and educational programs focusing on best farming practices, pest and disease management, and efficient resource utilization. Establishing farmer field schools and demonstration plots can also facilitate hands-on learning.

Investment in Research and Development:

Significant investment in research and development is necessary to develop new and improved varieties of Kinnow oranges that are better suited to local conditions and offer higher yields. Collaborative efforts with agricultural universities and research institutions can help in breeding Kinnow varieties that are resilient to climatic challenges and have superior productivity.

Learning from Punjab's Horticulture Success:

Rajasthan can emulate Punjab's successful horticulture initiatives, such as the Citrus Estate model, to enhance Kinnow yield and orchard management. This involves setting up dedicated horticulture offices to provide targeted support and resources to farmers. Ensuring sustainable agricultural practices and scientific cultivation techniques, coupled with regular irrigation, is essential for improving productivity. Given the water scarcity in Sriganganagar, the government should prioritize the construction of additional 'diggis' (water ponds) in established orchards under the grant-in-aid scheme for better water management.

Improved Market Information Systems:

Implementing advanced market information systems to provide real-time price updates and market trends through mobile apps, SMS, and other communication channels will empower farmers to make informed decisions about selling their produce. Enhancing market access by developing better transportation infrastructure and strengthening market linkages will help farmers achieve better prices and increase their income.

Supportive Policies for Market Stability:

To stabilize prices and reduce production costs, policymakers should consider implementing price stabilization mechanisms and providing input subsidies. Integrating

Kinnow into government initiatives like the Mid Day Meal Program can create consistent local demand, thereby mitigating price instability.

Promotion of Gender Equity:

Policies and programs aimed at promoting gender equity in the Kinnow cultivation industry are essential. Encouraging and supporting women's participation through targeted training, financial assistance, and creating women-centric agricultural cooperatives can enhance their involvement and contribution to the sector.

Sustainable Energy Planning:

Understanding regional energy usage patterns in agriculture is crucial for planning sustainable and cost-effective energy sources for irrigation. Promoting renewable energy sources such as solar-powered irrigation systems can reduce dependency on traditional energy sources and lower costs for farmers.

Infrastructure Development:

Improving infrastructure by constructing new roads and upgrading existing ones will better connect orchards to markets, reducing transportation time and costs, and enhancing the overall supply chain efficiency.

Banking Accessibility:

Increasing the number of bank branches in Sriganganagar, especially in remote areas, will improve financial accessibility and convenience for farmers. This will facilitate easier access to credit, loans, and other financial services essential for agricultural investments.

Establishment of Nursery Plants:

Encouraging farmers to establish nursery plants in Rajasthan can ensure the availability of high-quality Kinnow saplings. Providing technical and financial support for setting up these nurseries will enhance the propagation of superior Kinnow varieties.

Waxing and Grading Units:

Promoting the establishment of new waxing and grading units in Rajasthan will improve the quality and marketability of Kinnow oranges. These units will help in extending the shelf life of the produce and ensuring that it meets market standards.

Cold Storage Facilities:

Expanding the number of cold storage units in both Rajasthan and Punjab is essential for reducing post-harvest losses and maintaining the quality of Kinnow oranges during transportation and storage.

Decentralized Extension Services:

Decentralizing extension services and making them available at the village level will enhance farmers' access to necessary agricultural support and information. This includes establishing local extension offices and deploying field officers to provide timely advice and assistance.

Addressing Water Pollution:

Tackling water pollution in canals is critical for sustainable agriculture. Policymakers should invest in wastewater treatment plants and promote sustainable farming practices to reduce pollution levels. This will improve the quality of irrigation water and boost agricultural productivity.

Real-Time Price and Export Information:

Setting up systems to provide real-time price and export information will help farmers make strategic decisions regarding the sale and export of their produce. This can be supported by initiatives to improve canal water quality and extend training programs to nearby areas, enhancing overall productivity.

By implementing these detailed policy suggestions, policymakers can significantly enhance Kinnow cultivation, improve farmer welfare, and ensure sustainable agricultural practices in Rajasthan and Punjab.

Further scope:

Further research is necessary to thoroughly understand the impact of family size on Kinnow cultivation and the broader social and economic dynamics within these

communities. Such research could explore how family size influences labor availability, decision-making processes, and the distribution of income from Kinnow farming. Additionally, it is important to investigate the socio-economic implications of family size on education, health, and overall community well-being in Kinnow-growing regions.

Moreover, further analysis is warranted to explore the reasons behind the varying levels of adoption of bio-pesticides, fungicides, and organic fertilizers among Kinnow farmers. Understanding the factors influencing these differences could provide insights into farmers' knowledge, attitudes, and practices regarding sustainable agriculture. This analysis should also examine the impact of these inputs on Kinnow yield, quality, and profitability, potentially identifying barriers to adoption and strategies to promote sustainable farming practices.

The study indicates some differences in the availability of Custom Hiring Centers (CHCs) for Kinnow growers in Fazilka and Sriganganagar, with Fazilka having slightly better access. However, a more detailed analysis is required to understand the implications of these differences for the Kinnow industry in these locations. This analysis should consider how access to CHCs affects farm productivity, cost-efficiency, and overall competitiveness of Kinnow growers. Additionally, it should explore the potential for policy interventions to improve CHC availability and support the Kinnow industry in both regions.

Further research is needed to investigate the issue of polluted water supply in the canals of both Fazilka and Sriganganagar. This research should aim to identify the sources and extent of water pollution, including agricultural runoff, industrial discharge, and other contaminants that may be affecting water quality. It is essential to assess the impact of polluted water on soil health, crop yield, and the overall sustainability of Kinnow cultivation in these regions.

Additionally, the study should evaluate the effectiveness of existing water management practices and policies in mitigating water pollution. It should also explore potential solutions, such as the implementation of more stringent regulations, the

adoption of water purification technologies, and the promotion of sustainable agricultural practices that reduce the use of harmful chemicals.

Understanding the socio-economic consequences of water pollution for local communities, including health impacts and economic losses, is crucial. This research should provide recommendations for stakeholders, including farmers, policymakers, and water management authorities, to address the challenges posed by polluted water supply and ensure the long-term viability of Kinnow farming in Fazilka and Sriganganagar.

BIBLIOGRAPHY

Acharya, S. S. (2004). *Agricultural marketing in India*. Oxford and IBH publishing.

Agarwal, D., Singh, J. M., & Horo, A. (2022), An Economic Analysis of Mentha Cultivation in Punjab. *Indian Journal of Economics and Development*, Vol. 18(2), 501-506.

Ahmad, M. S., Thakur, K. S., & Siddiqui, M. W. (2013). Postharvest treatments for preserving quality of "Kinnow" fruit under different storage conditions. *Advances in Horticultural Science*, Vol. *27*(4), 152–158.

Ahmed, U. I., Ying, L., Mushtaq, K., & Bashir, M. K. (2015). An econometric estimation of post-harvest losses of kinnow in Pakistan. *International Journal of Economics, Commerce and Management*, Vol. *3*(5), 373-383.

Ayana, A. N., Berhe, T. K., & Belay, H. (2017). The impact of farm machinery use on smallholder farmers' production efficiency: Evidence from the maize producing areas of Ethiopia. *Journal of Agricultural Extension and Rural Development, Vol. 9(2)*, 26-36.

Bannor, R. K., & Madhu, S. (2015), An analysis of the socioeconomic characteristics of kinnow producers in Rajasthan state of India. *International Journal of Management Research and Business Strategy*, Vol. *4*(3), 180-192.

Bannor, R. K., & Oppong-Kyeremeh, H. (2019), Market concentration and value chain analysis of kinnow in Rajasthan, India. *Applied Research Journal*, Vol. *4*(1), 12-30.

Baswal, A. K., Dhaliwal, H. S., Singh, Z., & Mahajan, B. V. C. (2021). Post-harvest application of methyl jasmonate, 1-methylcyclopropene and salicylic acid elevates health-promoting compounds in cold-stored 'kinnow'mandarin (Citrus nobilis Lour x C. deliciosa Tenora) Fruit. *International Journal of Fruit Science*, Vol. *21*(1), 147-157.

Bhat, J. A., & Aara, R. R. (2012), Marketing Efficiency of Kashmir Apple. *Marketing*, Vol. *35*(227.17), 50-64.

Bhat,A., Kachroo,J. and Kachroo,D.2011.Economic Appraisal of Kinnow Production and its Marketing under North -Western Himalayan Region of Jammu.*Agricultural Economics Research Review*.Vol. 24. pp 283-290.

Chand, R., Joshi, P., & Khadka, S. (2022). *Indian Agriculture Towards 2030: Pathways for Enhancing Farmers' Income, Nutritional Security and Sustainable Food and Farm Systems* (p. 311). Springer Nature.

Devi, G., & Bhoi, R. (2022). Economic Impact of Turmeric Processing in Middle Gujarat. *Indian Journal of Economics and Development*, Vol. *18*(2), 303-312.

Dhawan, V., & Singh, J. M. (2018). How Profitable is Agriculture in Indian Punjab: An Insight from Cost of Cultivation Surveys. *Indian Journal of Economics and Development*, Vol. *14*(1a), 71-76.

Dinar, A. (1989). Provision of and Request for Agricultural Extension Services. *American Journal of Agricultural Economics*, Vol. *71*, 294-302.

Feder, G., Just, R. E., & Zilberman, D. (1985). Adoption of agricultural innovations in developing countries: A survey. *Economic development and cultural change*, Vol. *33*(2), 255-298.

Gangwar, L. S., Ilyas, S. M., Singh, D., & Kumar, S. (2005). An economic evaluation of kinnow mandarin cultivation in Punjab. *Agricultural Economics Research Review*, Vol. *18*(1), 71-80.

Ghafoor, U., Muhammad, S., Randhawa, M. A., & Ashraf, I. (2010). Harvesting and marketing problems faced by citrus (Kinnow) growers of tehsil Toba Tek Singh. *Journal of Agricultural Research (03681157)*, Vol. *48*(2).

Gill, K. K., & Gill, S. S. (1990). Agricultural development and industrialisation in Punjab: Some issues related to the Pepsi model. *Economic and Political Weekly*, 2507-2509.

Gill, M. I. S., Dhillon, B. S., Singh, Z., & Gosal, S. S. (1991). Induction of high frequency somatic embryogenesis and plant regeneration in mandarins. In *Horticulture—New Technologies and Applications: Proceedings of the International Seminar on New Frontiers in Horticulture, organized by Indo-American Hybrid Seeds, Bangalore, India, November 25–28, 1990* (231-235). Springer Netherlands.

Gini, C. W. (1912). Variability and mutability, contribution to the study of statistical distributions and relations. *Studi Economico-Giuridici della R. Universita de Cagliari*.

Gora, J. S., Kumar, R., Ram, C., Sarolia, D. K., Haldar, S. M., Berwal, M. K., & Meena, R. (2019). Production Management of citrus fruits under arid region of Rajasthan. *book: Recent Approaches in Pre and Post-Harvest Management of Horticultural Crops for Enhanced Parm IncomePublisher: ICAR-CAZRI, Jodhpur*.

Goyal, K.L. & Goyal,T. (2018). Economy of Rajasthan, Rajasthani granthagar,jodhpur. First edition.

Harinarayana, T., & Vasavi, K. (2014). Solar energy generation using agriculture cultivated lands. *Smart Grid and Renewable Energy*, Vol. 5(2), 31-42. https://doi.org/10.4236/sgre.2014.52004

Hassan, B., Bhattacharjee, M., & Wani, S. A. (2022). Flow and Rental-Based Opportunity Cost of the Land under Walnut Cultivation in India. *Indian Journal of Economics and Development*, Vol. *18*(2), 341-349.

Kalra, A., & Khanuja, S. P. S. (2007). Research and Development priorities for biopesticide and biofertiliser products for sustainable agriculture in India. *Business Potential for Agricultural Biotechnology (Teng, PS ed.), Asian Productivity Organisation, 96102*.

Kaur, M., & Singla, N. (2016). An economic analysis of kinnow cultivation and marketing in Fazilka district of Punjab. *Indian Journal of Economics and Development*, Vol. *12*(4), 711-718.

Kaur, M., Singh, J., & Kumar, S. (2016). Economic Viability of Kinnow Orchards in South-Western Punjab. *Indian Journal of Economics and Development*, Vol. *12*(4), 703-710.

Kaur,S. 2013.(Ph.D. study completed in 2013, Punjabi university patiala)marketing of fruits in Punjab.(http://hdl.handle.net/10603/146672)

Khan, F. U., Khan, N., & Anjum, F. (2016). Farmers perception about yield losses of kinnow (Citrus reticulate) during its harvesting and post harvesting operations: A case study of tehsil Sargodha, Pakistan. *Journal of Pure and Applied Agriculture*, Vol. *1*(1), 12-19.

Khan, M., Asim, M., Mahmood, A., , E., Ashraf, T., Anjum, N., Faisal, H., Salik, R., Jamil, A., & Qamar, R. (2020). Characterization and comparative nutritional study of three strains of Kinnow Mandarin (Citrus reticulata Blanco). *Asian Journal of Agriculture and Biology*, Vol. 8, 299-307. https://doi.org/10.35495/ajab.2019.12.570.

Khandker, S., Bakht, Z., & Koolwal, G. (2006). The Poverty Impact of Rural Roads: Evidence from Bangladesh. *Economic Development and Cultural Change*, Vol. 57, 685 - 722. https://doi.org/10.1086/598765.

Kour, N., & Malhotra, N. (2022). The Socio-economic Evaluation of the MGNREGS in Punjab. *Indian Journal of Economics and Development*, Vol. *18*(2), 426-435.

Kumar, A. D., Pant, S. C., Gummagolmath, K. C., & Kadam, M. M. (2022). Growth Performance of Different Varieties of Grapes in Karnataka. *Indian Journal of Economics and Development*, Vol. *18*(2), 395-401.

Kumar, N., Duhan, A., Bhatia, J., & Malik, V. (2017). Economic appraisal of kinnow production and its marketing in Sirsa district of Haryana, India.

International Journal of Current Microbiology and Applied Sciences, Vol. *6*(11), 4045-4053.

Kumar, R., SUMIT, S., Bishnoi, D. K., & Kumar, A. (2021). Economic appraisal of Kinnow production in Sirsa district of Haryana. *The Indian Journal of Agricultural Sciences*, Vol. *91*(3), 464-467.

Kumar, S., & Sharma, R. R. (2019). Production and marketing constraints analysis of kinnow growers in Himachal Pradesh. *Agriculture Update*, Vol. *14*(1), 52-57.

Langgut, D. (2017). The citrus route revealed: from Southeast Asia into the Mediterranean. *HortScience*, Vol. *52*(6), 814-822.

Liu, J., Huang, F., Wang, Z., & Shuai, C. (2021). What is the anti-poverty effect of solar PV poverty alleviation projects? Evidence from rural China. *Energy*, Vol. 218, 119498. https://doi.org/10.1016/j.energy.2020.119498.

López-Felices, B., Aznar-Sánchez, J. A., Velasco-Muñoz, J. F., & Piquer-Rodríguez, M. (2020). Contribution of irrigation ponds to the sustainability of agriculture. A review of worldwide research. *Sustainability*, Vol. *12*(13), 5425.

Lorenz, M. O. (1905). Methods of measuring the concentration of wealth. *Publications of the American statistical association*, Vol. *9*(70), 209-219.

Luh, J., & Bartram, J. (2015). Drinking water and sanitation: progress in 73 countries in relation to socioeconomic indicators. *Bulletin of the World Health Organization*, Vol. *94*, 111 - 121A. https://doi.org/10.2471/BLT.15.162974.

Mahajan, B. V. C., & Singh, R. (2014). Effect of packaging films on shelf life and quality of kinnow fruits packed in consumer packages. *International Journal of Farm Sciences*, Vol. *4*(1), 92-98.

Mavi, H. K., Sidhu, R. S., & Sidhu, J. S. (2012). Investigating the efficiency of various marketing models and problems of kinnow growers of Punjab §. *Agricultural Economics Research Review*, Vol. *25*(1), 87-97.

Malik, A. U., Amin, M., & Asad, H. U. (2014, August). Advances and challenges in value chain development in' Kinnow' mandarin and mango industries of Pakistan. In *XXIX International Horticultural Congress on Horticulture: Sustaining Lives, Livelihoods and Landscapes (IHC2014): 1128* (277-284).

Meena, D. C., & Kumari, M. (2022). Impediments in Achieving Food and Livelihood Securities in Ravine Areas: Empirical Evidence from Yamuna Ravine in Uttar Pradesh. *Indian Journal of Economics and Development*, Vol. *18*(2), 270-280.

Meena, D.P. 2012. An Economic analysis of production and marketing of Kinnow in the state of Rajasthan (Master's thesis). Swami Keshwanand Rajasthan Agricultural University,Bikaner, Rajasthan, India.

Melkamu, M., & Bannor, R. K. (2015). Estimation of agricultural resource inequality in India using Lorenz curve and Gini coefficient approach. *International Journal of Current Research and Academic Review*, Vol. *3*(4), 174-184.

Melkamu, M., & Singh, N. (2016). Agricultural Resource and Income Inequality in Northern Rajasthan. *Indian Journal of Economics and Development*, Vol. 12, 265-272. https://doi.org/10.5958/2322-0430.2016.00135.9.

Mishra, J., Dutta, V., & Arora, N. K. (2020). Biopesticides in India: technology and sustainability linkages. *3 Biotech*, Vol. *10*(5), 210.

Niranjan, S., Singh, D. R., & Krishnakumare, B. (2022). Indian Agriculture vis-à-vis Youth: Evidence from Tamil Nadu. *Indian Journal of Economics and Development*, Vol. *18*(2), 292-302.

Pangaribowo, E. H., & Iskandar, D. D. (2023). Exploring socio-economic determinants of energy choices for cooking: the case of eastern

Indonesian households. *Environment, Development and Sustainability*, Vol. *25*(7), 7135-7148.

Prabhavathi, Y., Kishore, N., & Charishma, C. (2021). Penetration of farm mechanization services through FPOs: rural dynamics-based business modelling. *International Journal Of Agricultural Sciences*, Vol. *17*(2), 558-568

Patarasuk, R. (2013). Road network connectivity and land-cover dynamics in Lop Buri province, Thailand. *Journal of Transport Geography*, Vol. *28*, 111-123. https://doi.org/10.1016/J.JTRANGEO.2012.11.011.

Porwal, C. (2014). A Study on Growth And Production of Mandarin Citrus Reticulata) in Jhalawar Dist. of Rajasthan, India. *Journal of Industrial Pollution Control*, Vol. *30*(2).

Poudel, A., Sapkota, S., Bhatt, R. P., & Bhandari, S. (2022). Influence of socio-economic attributes of farmers on the adoption of orchard management practices of mandarin in Myagdi district, Nepal. *Archives of Agriculture and Environmental Science*, Vol. *7*(2), 218-225.

Rai, R., & Kundu, R. (2022). An Analysis of Socio-economic Characteristics of Homestay Operators in the Darjeeling Hills, West Bengal. *Indian Journal of Economics and Development*, Vol. *18*(2), 419-425.

Rana, R. K., Kumar, S., & Kumar, S. (2019). Constraints faced by khasi mandarin growers in North-Eastern Himalayas-A case study from Assam. *International Research Journal of Agricultural Economics and Statistics*, Vol. *10*(1), 84-89.

Rattanpal, H. S., Gurteg, S., Sandeep, S., & Anita, A. (2017). Citrus cultivation in Punjab . Punjab Agriculture University Ludhiana.

Savandkar, M.D.2016. (Ph.D. study completed in 2016, swami ramanand teerth marathwada university nanded) impact of rural development programmes on socio-economic development of parbhani district. (http://hdl.handle.net/10603/217437)

Schultz, T. W. (1964). Transforming traditional agriculture Yale University press. *New Haven*, Vol. *212*.

Schultz, T. W. (1975). The value of the ability to deal with disequilibria. *Journal of economic literature*, Vol. *13*(3), 827-846.

Sharif, M., Farooq, U., Malik, W., & Bashir, M. (2005). Citrus Marketing in Punjab: Constraints and Potential for Improvement [with Comments]. *The Pakistan Development Review*, Vol. *44*(4), 673–694. http://www.jstor.org/stable/41261125

Sharma, A. D. (2009). *Postharvest technology of Kinnow*. Scientific Publishers.

Sharma, A., & Ghuman, B. S. (2009). Evaluation of on-farm waxing and grading prototype for fresh Kinnow fruits. *Indian Journal of Horticulture*, Vol. *66*(2), 288-290.

Sidhu, R. S., Vatta, K., Kumar, S., & Singh, P. (2012). Production and Marketing System for Kinnow in Punjab. *Journal of Agricultural Development and Policy*, Vol. *22*(1), 49-58.

Singh, I. P., Singh, S., Srivastava, R., & Singh, K. (2001). Exploration and collection of citrus germplasm from NEH region (Meghalaya) of India. *Indian Journal of Plant Genetic Resources*, Vol. *14*(1), 70-73.

Singh, M., Chandel, R., & Thakur, S. S. (2021). Technical and field evaluation of tractor operated frontal pre-pruner for Kinnow Mandarin (Citrus reticulata) and Guava (Myrtaceae) orchard. *Journal of Agricultural Science*, Vol. *13*(4), 173.

Singh, S. (2012). Institutional and Policy Aspects of Punjab Agriculture: A Smallholder Perspective. *Economic and Political Weekly*, Vol. *47*(4), 51–57. http://www.jstor.org/stable/41419765

Sohi, H. S., & Matharu, K. S. (2018). Constraints Faced by Farmers in Adoption of Kinnow Growing in Barnala District. *International Journal of Current Microbiology and Applied Sciences*, Vol. *7*(10), 710-719.

Soni, M. L., Birbal, S. A., Nangia, V., & Yadava, N. D. (2021). Intercropping with vegetables on productivity and economic returns of Kinnow in arid region. *Indian Journal of Horticulture*, Vol. *78*(2), 211-215.

Tauer, L. (1995). Age and Farmer Productivity. *Review of Agricultural Economics*, Vol. *17*(1), 63–69. https://doi.org/10.2307/1349655

Thomson, H., Thomas, S., Sellström, E., & Petticrew, M. (2013). Housing improvements for health and associated socio-economic outcomes. *Cochrane Database of Systematic Reviews*, 2013(2).

Tiwari, A. K., Eapen, L. M., & Nair, S. R. (2021). Electricity consumption and economic growth at the state and sectoral level in India: Evidence using heterogeneous panel data methods. *Energy Economics*, Vol. *94*, 105064.

Usman Ghafoor, S. M., & Ch, K. M. (2008). Constrains in availability of inputs and information to citrus (kinnow) growers of tehsil Toba Tek Singh. *Pak. J. Agri. Sci*, Vol. (*45)*4, 520-522.

Wang, L., Zhao, Z., Zhang, K., & Tian, C. (2013). Reclamation and utilization of saline soils in arid northwestern China: a promising halophyte drip-irrigation system. *Environmental science & technology*, Vol. 47 11, 5518-9. https://doi.org/10.1021/es4017415.

Yogi, V., Kumar, P., Bishnoi, S., & Chauhan, J. K. (2021). An economic analysis of price behaviour of kinnow market in north-western India (Punjab). *Indian Res. J. Ext. Edu*, Vol. *21*, 53-59.

Yüksel, S., & Dinçer, H. (2020). SERVQUAL-based performance analysis of agricultural financing in E-banking industry: An evaluation by IT2 fuzzy decision-making model. In *Tools and techniques for implementing international E-Trading tactics for competitive advantage* (pp. 21-41). IGI Global.

Other publication and reports:

Committee on Doubling Farmers' Income. (2017). *March of Agriculture since independence and growth trends*. Report of the Committee on Doubling Farmers' Income, I. Department of Agriculture, Cooperation and Farmers' Welfare.

Food and Agriculture Organization. (2020). *The state of food security and nutrition in the world 2020: Transforming food systems for affordable healthy diets*. Rome: Food and Agriculture Organization. https://doi.org/10.4060/cb2342en

Food and Agriculture Organization of the United Nations. (2021). *FAO Statistical Yearbook 2021: Asia and the Pacific Food and Agriculture*. Retrieved from http://www.fao.org/faostat/en/#data/QC.

Horticulture Statistics Division. (2018). *Horticulture at a glance*. Ministry of Agriculture and Farmers' Welfare, Government of India.

ICAR-Central Institute of Post-Harvest Engineering and Technology. (2009, January). *CIPHET Newsletter*. Retrieved from https://ciphet.icar.gov.in/wp-content/uploads/newsletter/Jan_09.pdf

Indian Council of Agricultural Research. (2011). *ICAR vision 2030*. Indian Council of Agricultural Research. https://icar.org.in/sites/default/files/inline-files/ICARVision-2030.pdf

Indian Council of Medical Research-National Institute of Nutrition. (2008). *Nutrient requirements and recommended dietary allowances for Indians*: A report of the expert group of the Indian Council of Medical Research. Indian Council of Medical Research.

Web Sources:

http://nhb.gov.in/Statistics.aspx?enc=WkegdyuHokljEtehnJoq0KWLU79sOQCy+W4MfOk01GFOWQSEvtp9tNHHoiv3p49g

https://agriculture.rajasthan.gov.in/horticulture/#/pages/department-page/2470

http://Punjabhorticulture.com/AYP_Crops.html

https://m.patrika.com/sri-ganganagar-news/5555-trees-per-tree-of-kinnu-2103398

https://Fazilka.nic.in/

https://Punjab.gov.in/know-Punjab/

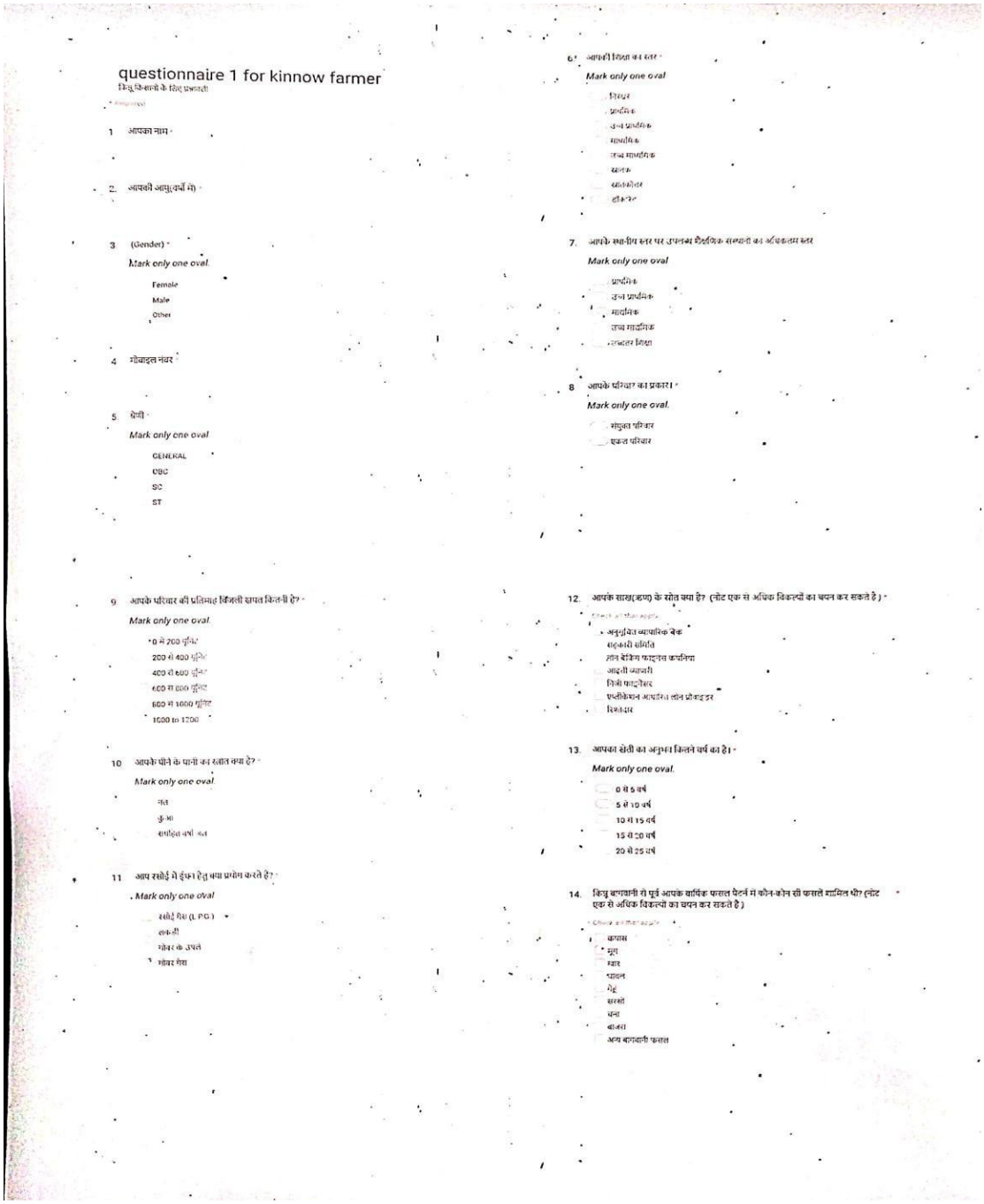
https://agcensus.dacnet.nic.in/DL/districtT1table2.aspx

Appendices

Regression Results - Area, Production, and Productivity of Kinnow and C.A.G.R.

District	Intercept	Slope	R^2	C.A.G.R.	S.E.	Trend equation	Type of trend
Area							
Fazilka	1262.1	21836	0.99		407.73048	Y=1262.1x+21836	(L)
Sriganganagar	-64.507	11295	0.1094		591.02124	Y=-64.507x+11295	(L)
Fazilka			0.9756	4.57		$Y=22321e^{0.0447x}$	(E)
Sriganganagar			0.1041	-0.57		$Y =11278\ e^{-0.006x}$	(E)
Production							
Fazilka	42654	45346	0.9824		18318.79207	Y = 42654x + 453461	(L)
Sriganganagar	9672.2	174306	0.2557		52999.3276	Y = 9672.2x + 174306	(L)
Fazilka			0.9855	6.47		$Y = 479457e^{0.0627x}$	(E)
Sriganganagar			0.2843	5.17		$Y = 166605e^{0.0504x}$	(E)
Productivity							
Fazilka	0.4334	21.372	0.8405		0.6031	Y = 0.4334x + 21.372	(L)
Sriganganagar	0.9875	15.497	0.2686		5.23208	Y = 0.9875x + 15.497	(L)
Fazilka			0.858	1.82		$Y = 21.48e^{0.018x}$	(E)
Sriganganagar			0.3101	5.78		$Y = 14.773e^{0.0562x}$	(E)

Questionnaire



questionnaire 1 for kinnow farmer

किन्नू किसानों के लिए प्रश्नावली

1 आपका नाम *

2. आपकी आयु(वर्षों में) *

3 (Gender) *

Mark only one oval.

- Female
- Male
- Other

4 मोबाइल नंबर *

5 श्रेणी *

Mark only one oval.

- GENERAL
- OBC
- SC
- ST

6 आपकी शिक्षा का स्तर *

Mark only one oval.

- निरक्षर
- प्राथमिक
- उच्च प्राथमिक
- माध्यमिक
- उच्च माध्यमिक
- स्नातक
- स्नातकोत्तर
- डॉक्टरेट

7. आपके स्थानीय स्तर पर उपलब्ध शैक्षणिक संस्थानों का अधिकतम स्तर

Mark only one oval.

- प्राथमिक
- उच्च प्राथमिक
- माध्यमिक
- उच्च माध्यमिक
- स्नातकोत्तर शिक्षा

8 आपके परिवार का प्रकार। *

Mark only one oval.

- संयुक्त परिवार
- एकल परिवार

9 आपके परिवार की प्रतिमाह बिजली खपत कितनी है? *

Mark only one oval.

- 0 से 200 यूनिट
- 200 से 400 यूनिट
- 400 से 600 यूनिट
- 600 से 800 यूनिट
- 800 से 1000 यूनिट
- 1000 to 1200

10 आपके पीने के पानी का स्रोत क्या है? *

Mark only one oval.

- नल
- कुआ
- वर्षाजल संग्रह

11 आप रसोई में ईंधन हेतु क्या प्रयोग करते है? *

Mark only one oval.

- रसोई गैस (LPG)
- लकड़ी
- गोबर के उपले
- गोबर गैस

12. आपके सारा(ऋण) के स्रोत क्या है? (नोट एक से अधिक विकल्पों का चयन कर सकते है) *

- अनुसूचित व्यापारिक बैंक
- सहकारी समिति
- लोन देने वाला कंपनियां
- आढ़ती व्यापारी
- निजी फाइनेंसर
- एप्लीकेशन आधारित लोन प्रोवाइडर
- रिश्तेदार

13. आपका खेती का अनुभव कितने वर्ष का है। *

Mark only one oval.

- 0 से 5 वर्ष
- 5 से 10 वर्ष
- 10 से 15 वर्ष
- 15 से 20 वर्ष
- 20 से 25 वर्ष

14. किन्नू बागवानी से पूर्व आपके वार्षिक फसल पैटर्न में कौन-कौन सी फसलें शामिल थी? (नोट एक से अधिक विकल्पों का चयन कर सकते है) *

- कपास
- मूंग
- ग्वार
- चावल
- गेहूं
- सरसों
- धना
- बाजरा
- अन्य बागवानी फसल

15 आपके पशुओं की कुल संख्या कितनी है?

Mark only one oval.

- 0
- 1 से 5
- 5 से 10
- 10 से 15
- 15 से अधिक

16 क्या आप किवू बागवानी के साथ साथ पशुपालन भी करते है

Mark only one oval.

- हां
- नहीं

17 आप किवू के बाग में निम्न में से कौन कौन सी खादों का प्रयोग करते है? (नोट एक से अधिक विकल्पों का चयन कर सकते है)

Check all that apply.

- रासायनिक खाद
- गोबर की खाद
- वर्मी कम्पोस्ट (केंचुआ खाद)
- अन्य जैव उर्वरक

18 क्या आप स्वयं जैव कीटनाशक/फफूंदनाशक/जैविक खाद तैयार करते है

Mark only one oval.

- हां
- नहीं

19 आपके पास कुल कितनी भूमि है?

Mark only one oval.

- 1 हेक्टेयर से कम(4 बीघा/2.5 एकड़ से कम)
- 1से 2 हेक्टेयर (4 से 8 बीघा) 2.5-5 एकड़
- 2से 4 हेक्टेयर (8 से 16 बीघा) 5-10 एकड़
- 4 से 10 हेक्टेयर (16 से 40 बीघा) 10-25 एकड़
- 10 हेक्टेयर से अधिक (40बीघा से अधिक/25 एकड़ से अधिक

20 आपका किवू का बाग कुल कितने हेक्टेयर में है(एक हेक्टेयर= 4बीघा(1हेक्टेयर=2.5एकड़)

Mark only one oval.

- 1 हेक्टेयर से कम(4 बीघा/2.5 एकड़ से कम)
- 1से 2 हेक्टेयर (4 से 8 बीघा) 2.5-5 एकड़
- 2से 4 हेक्टेयर (8 से 16 बीघा) 5-10 एकड़
- 4 से 10 हेक्टेयर (16 से 40 बीघा) 10-25 एकड़
- 10 हेक्टेयर से अधिक (40बीघा से अधिक/25 एकड़ से अधिक

21. आपका किवू का बाग कितने वर्ष पुराना है?

Mark only one oval.

- 1-4 वर्ष
- 5-7 वर्ष
- 8-25 वर्ष

22. किवू हेतु सिंचाई का स्रोत क्या है ? (नोट एक से अधिक विकल्पों का चयन कर सकते है)

Check all that apply.

- ट्यूबवेल
- नहर

23 क्या आप के बाग में सिंचाई जल संचय हेतु (पौंड) डिग्गी उपलब्ध है?

Mark only one oval.

- हां
- नहीं

24 आप बाग में सिंचाई किस विधि से करते है? (नोट एक से अधिक विकल्पों का चयन कर सकते है)

Check all that apply.

- फ्लड
- ड्रिप
- फव्वारा

25 सिंचाई हेतु ऊर्जा का स्रोत क्या प्रयोग करते है?

Check all that apply.

- सौलर
- डीजल पैनल
- विद्युत कनेक्शन

26 आपने अब तक बागवानी विभाग द्वारा आयोजित किवू संबंधी कितने जागरूकता कार्यक्रमों में भाग लिया है?

Mark only one oval.

- 0
- 1-2
- 3-4
- 4-5
- 5-6
- 6 से अधिक

27. क्या आपके क्षेत्र में बाग में कटाई-छंटाई और फल तुड़ाई के लिए पर्याप्त मात्रा में श्रमिक उपलब्ध है ?

Mark only one oval.

- हां
- नहीं

28. आपकी वार्षिक पारिवारिक आमदनी लगभग कितनी है?

Mark only one oval.

- 0-2.5 लाख
- 2.5 से 5 लाख
- 5 से 7.5 लाख
- 7.5 से 10 लाख
- 10 लाख से अधिक

29. किवू बागवानी अपनाने के बाद आपके जीवन स्तर एवं आमदनी में क्या बदलाव आया है?

Mark only one oval.

- सुधार हुआ है
- गिरावट आई है
- कोई अंतर नहीं पड़ा

30. क्या बाग लगाने हेतु सरकारी अनुदान अथवा सहायता प्राप्त हुई है?

Mark only one oval.

- हां
- नहीं

31. आपके परिवार का शिक्षा पर वार्षिक व्यय(खर्च) कुल कितना है?

32. आपके परिवार में कुल कितने सदस्य है?(केवल संख्या भरें)

33. आपका निवास स्थान किस क्षेत्र में आता है।

Mark only one oval.

- ग्रामीण
- शहरी

34. क्या आपका निवास स्थान पक्की सड़क से जुड़ा हुआ है?

Mark only one oval.

- हां
- नहीं

35. क्या आपका बाग पक्की सड़क से जुड़ा हुआ है?

Mark only one oval.

- हां
- नहीं

36. आपके घर की जल निकासी व्यवस्था किस प्रकार की है?

Mark only one oval.

- पक्की नाली
- सोख्ता
- कच्ची नाली

37. आपके घर का प्रकार

Mark only one oval.

- पक्का
- कच्चा
- कुछ भाग कच्चा व कुछ भाग पक्का

38. आप निम्न में से कौन-कौनसी बैंक सेवाओं का उपयोग कर रहे है? (नोट एक से अधिक विकल्पों का चयन कर सकते है)

- बचत खाता
- चालू खाता
- इंटरनेट बैंकिंग
- किसान क्रेडिट कार्ड
- म्यूचुअल फंड
- सावधि जमा खाता (F D)
- डेबिट कार्ड
- क्रेडिट कार्ड
- गोल्ड लोन

39. आप किवी फार्म के अतिरिक्त शेष बची भूमि पर क्या फसल लेते है? (नोट एक से अधिक विकल्पों का चयन कर सकते है)

- पड़ता (खाली)
- कपास
- मूंग
- ज्वार
- धान्य
- गेहूं
- सरसों
- चना
- बाजरा
- गन्ना
- अन्य बागवानी फसल

40. आपके फार्म पर निम्नमें से कौन-कौन से कृषि उपकरण एवं सुविधाएं उपलब्ध है? (नोट एक से अधिक विकल्पों का चयन कर सकते है)

- ट्रैक्टर
- ट्रॉली
- रोटावेटर
- ट्रैक्टर चालित स्प्रेयर
- हस्तचालित रोटावेटर
- ट्रैक्टर से चलने वाली गोबर कटाई-छंटाई मशीन
- ट्रैक्टर चालित खाद छिड़कने की मशीन
- बड़े पेड़ों को स्थानान्तरित करने की मशीन

41. आपकी निकटतम बैंक शाखा से दूरी कितने किलोमीटर है?

Mark only one oval.

- 0-5
- 5-10
- 10-15
- 15-20
- 20-25
- 25 किलोमीटर से अधिक

42. आपकी नजदीकी किवी नर्सरी प्लांट से दूरी (किलोमीटर में) कितनी है?

Mark only one oval.

- 0-5 किलोमीटर
- 5-10 किलोमीटर
- 10-15 किलोमीटर
- 15-20 किलोमीटर
- 20-25 किलोमीटर
- 25 किलोमीटर से अधिक

43. नजदीकी पैकिंग,ग्रेडिंग, पैकेजिंग यूनिट से आपके बाग की दूरी (किलोमीटर में) कितनी है?

Mark only one oval.

- 0-5
- 5-10
- 10-15
- 15-20
- 20-25
- 25 किलोमीटर से अधिक

44. नजदीकी कोल्ड स्टोर से आपके बाग की दूरी (किलोमीटर में)कितनी है?

Mark only one oval.

- 0-5
- 5-10
- 10-15
- 15-20
- 20-25
- 25 किलोमीटर से अधिक

45. नजदीकी फूट मंडी से आपके बाग की दूरी (किलोमीटर मे) कितनी है?

Mark only one oval.

- 0-5
- 5-10
- 10-15
- 15-20
- 20-25
- 25 किलोमीटर से अधिक

46. दूरस्थ बाजारों मे किन्नू बिक्री के लिए भेजने हेतु निकटतम माल ढुलाई रेलवे स्टेशन से आपके बाग की दूरी (किलोमीटर मे) कितनी है?

Mark only one oval.

- 0-5
- 5-10
- 10-15
- 15-20
- 20-25
- 25 किलोमीटर से अधिक

47. आपको क्या में नवीनतम कृषि उपकरणो की किराए पर उपलब्धता हेतु कस्टम हायरिंग सेंटर से आपके बाग की दूरी (किलोमीटर मे)कितनी है?

Mark only one oval.

- कस्टम हायरिंग सेंटर उपलब्ध नही
- 0-5
- 5-10
- 10-15
- 15-20
- 20-25
- 25 किलोमीटर से अधिक

48. आपके बाग में कीटों एवं रोगों की रोकथाम के लिए आवश्यक विशेषज्ञ सेवाओ हेतु उपलब्ध निजी अथवा सरकारी कार्यालय की आपके बाग से दूरी (किलोमीटर मे) कितनी है ?

Mark only one oval.

- 0-5
- 5-10
- 10-15
- 15-20
- 20-25
- 25 किलोमीटर से अधिक

49. आप के बाग में बागवानी विभाग के विशेषज्ञ द्वारा 1 वर्ष मे लगभग कितने बार भ्रमण किया जाता है?

Mark only one oval.

- कोई भ्रमण नही
- 1 बार
- 2 बार
- 3 बार
- 4 बार
- 5 बार
- 5 बार से अधिक

50. क्या आपके खेत पर खाद बनाने के लिए वर्मी कम्पोस्ट प्लांट लगा है ?

Mark only one oval.

- हा
- नही

51. क्या आपके बाग की पूर्णतया चारदीवारी की हुई है?

Mark only one oval.

- हा
- नही

52. क्या आप के बाग मे फार्म शेड उपलब्ध है?

Mark only one oval.

- हा
- नही

53. क्या आप के बाग मे ऑन फॉर्म वैक्सिंग एव ग्रेडिंग प्लांट लगा है?

Mark only one oval.

- हां
- नही

54. आपके राज्य का नाम

Mark only one oval.

- पजाब
- राजस्थान

55. आपका बाग किस ब्लॉक मे स्थापित है?

Mark only one oval.

- श्रीकरणपुर (राजस्थान)
- श्री गंगानगर (राजस्थान)
- सूरैया सरवर (पंजाब)
- अबोहर (पजाब)

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List of Conference

Sno.	Title of Conference	International /National	Conference date
1.	Multidisciplinary Approach towards sustainable development and climate change for a viable future	International	12-8-2022 to 14-08-2022
2.	Research, Education and sustainable development: Opportunities and challenges	International	19-11-2022
3.	1st International Conference on Sustainable Energy Sources, Technologies and Systems (ICSESTS-2023)	International	August 2-3, 2023
4.	Vision and Objectives of New Education policy 2020 in Higher Education	National	January 21, 2023

List of Workshop

Sno.	Title of Workshop	Organizer	Date of workshop
1.	Advance research methodology	T.L.C. Ramanujan College, New Delhi	22-01-2022 05 -02-2022
2.	NSSO Unit Level Data extraction and analysis using SAS	Human resource Development Center Lovely Professional University Jalandhar	31-10-2022 09-11-2022