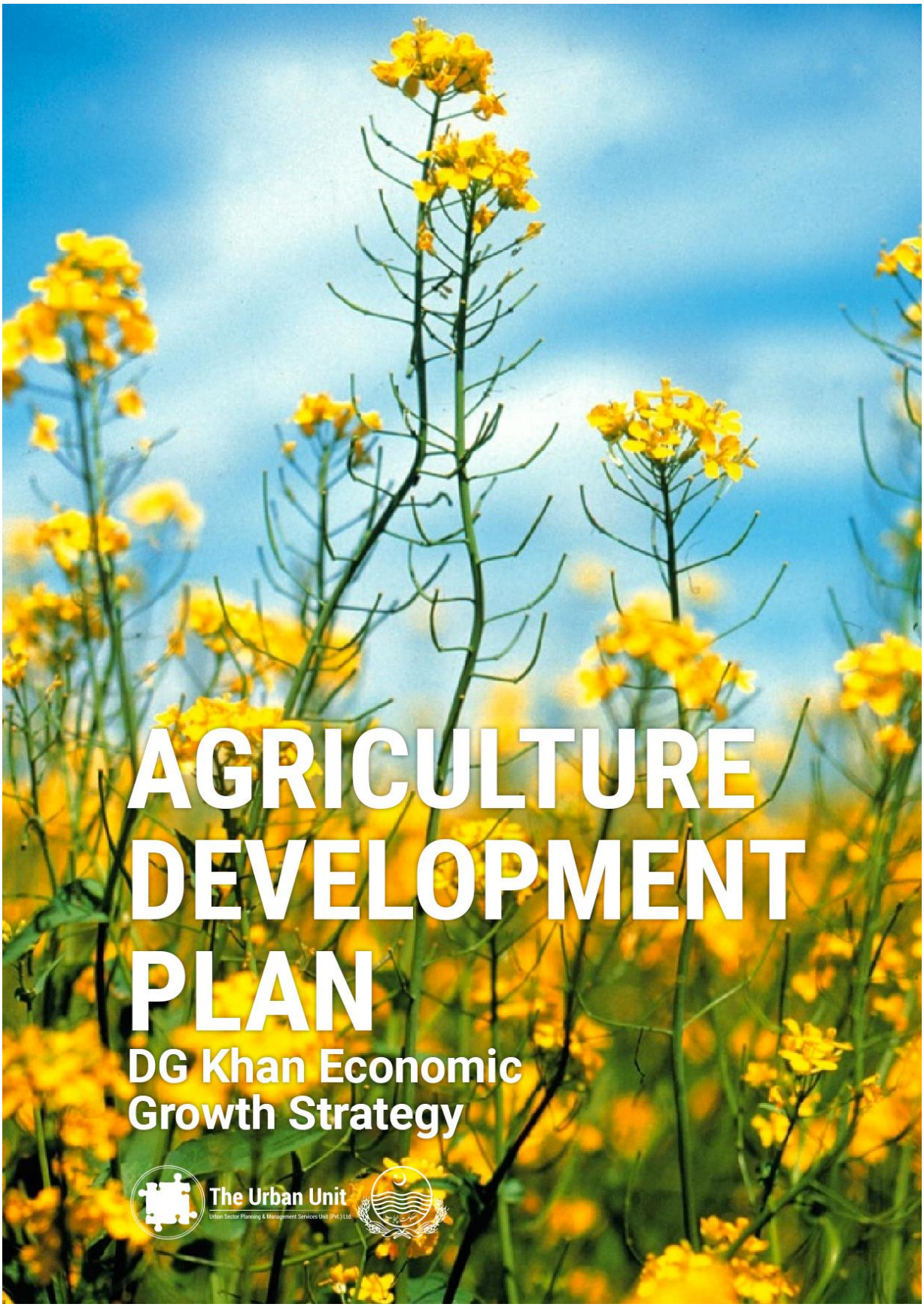
AGRICULTURE
DEVELOPMENT
PLAN
DG Khan Economic
Growth Strategy
The Urban Unit

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DISCLAIMER

Urban Sector Planning and Management Sector Unit (Pvt.) Ltd. has prepared this report on the Agriculture Development Plan of D.G. Khan Division. Maximum care and caution have been observed while developing this document.

The opinions expressed in the document are solely those of the authors and publishing in any way constitutes an endorsement of the opinion by the Urban Unit.

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AGRICULTURE CHAPTER

EXECUTIVE SUMMARY

Pakistan's economy significantly benefits from its agricultural sector, which contributes 24% to the GDP and employs 37.4% of the workforce. This sector's crucial role in economic growth, employment, and poverty alleviation highlights its interconnectedness with other sectors. The Kharif season of 2023 showcased robust crop production, notably in rice, which led to steady export growth and a reduction in cotton imports due to improved domestic yields. Factors such as credit facilitation, certified seeds, fertilizer use, and on-farm management techniques were pivotal in this enhanced performance. Maintaining these gains will depend on supportive government policies and farmers' self-reliance.

In the 2023-24 period, the agriculture sector experienced a growth of 6.25%, a significant increase from the previous year's 2.27%, driven primarily by major crops. Wheat production achieved a record growth of 11.6%, cotton production saw a notable rebound, and rice production increased by 34.8%. Despite slight declines in sugarcane and maize production, other crops demonstrated modest growth of 0.90%, with significant increases in fruit, vegetable, and pulse production. Additionally, cotton ginning grew by 47.23% due to the increased cotton yield.

Given Punjab's agricultural prominence, addressing issues in the D.G. Khan Division with a comprehensive development plan is essential. This plan evaluates challenges in agriculture and livestock, focusing on production, infrastructure, market access, and resource management. The proposed roadmap includes strategies and initiatives designed to enhance these sectors, promoting sustainable growth, productivity, and quality to benefit farmers and stakeholders.

Between 1995 and 2015, D.G. Khan District experienced notable urban growth, with a 22% increase from 1995 to 2005 and 63% from 2005 to 2015. Crop production in the D.G. Khan Division is crucial for Punjab's output, with tobacco, sunflower, and losan being major contributors. While contributions from most vegetables and fruits are minor, except for mangoes, there is potential for improvement through modern agricultural technologies and specialized support systems. The division cultivates 4.5 million acres out of a total reported area of 7.8 million acres. During the Rabi season, 3.5 million acres are cultivated, yielding modest returns. Addressing these challenges involves introducing high-value crops and optimizing resource use.

To boost Punjab's economic growth through agriculture, implementing a spatial strategy is essential. This plan involves several key components. First, it includes an assessment of the physical environment, such as land cover, geology, natural resources, climate, hydrology, population, land use, and community structure, to identify the most effective cropping patterns. Next, the plan focuses on cropping pattern identification by evaluating yield, price, cost of production, and profit per acre. It also proposes new cropping patterns by addressing issues in the value chain, including seed-to-market challenges, resource constraints, and financial limitations.

Water availability and utilization are also critical, with efforts aimed at preserving natural resources. Additionally, the plan assesses economic activities, including livestock, agro-based industries, employment, and labor markets. Key facilities such as agricultural markets, farm mechanization, and breeding and seeding facilities are also evaluated.

In terms of policy focus areas for agriculture and livestock, the plan emphasizes productivity enhancement by shifting from low to high productivity crops and livestock. It advocates for the creation of specialized zones for each crop, supported by comprehensive systems. The plan also aims to improve resource efficiency by optimizing land, labor, water, and input use. Water management is addressed through the development of agricultural corridors along canals and a focus on integrated rural development. Finally, it calls for integrated action plans to coordinate efforts across departments to fully realize agricultural potential.

The agricultural sector is grappling with substantial challenges related to the availability and quality of seeds and inputs, exacerbated by high costs and inadequate financing. Traditional farming methods contribute to inefficiencies, and the situation is worsened by poor mechanization and insufficient infrastructure. This lack of infrastructure extends to storage, transportation, and processing facilities, which adversely affects overall productivity and market access.

In addition to these issues, the irrigation network suffers from inadequate water allocation and outdated infrastructure, leading to an over-reliance on depleting groundwater resources and difficulties with timely water supply and brackish water management. The limited adoption of modern agricultural machinery further compounds production costs and inefficiencies, highlighting the need for strategic investments in infrastructure and training. Geographical isolation and insufficient storage facilities also hinder market access, while market inefficiencies and the dominance of middlemen disrupt fair pricing and equitable participation.

To bolster food security and drive economic growth in the D.G. Khan region, a targeted focus on sustainable agricultural development and specific interventions is crucial. Key measures include enhancing cropping patterns for both Rabi and Kharif seasons and providing comprehensive training for farmers. Utilizing high-quality seeds and modern technologies will be vital in boosting productivity and ensuring food security.

For optimal results, it is recommended to focus on a range of crops that align with regional conditions and economic potential. During the Rabi season, crops such as citrus, tomatoes, carrots, onions, gram, garlic, sugar beet, rapeseed, sunflower, tobacco, and wheat are suggested. In the Kharif season, date palm, olive, moong, chilies, mango, and cotton are recommended. These selections are made based on their adaptability, economic value, and yield potential, aiming to enhance agricultural production and economic stability.

The value chain concept is integral to this strategy, involving linked activities that add value to products through cooperation among stakeholders. This encompasses everything from sourcing inputs and production to processing, packaging, and distribution. Specific crop interventions include focusing on sesame for its high-quality oil and protein-rich seeds, chilies for their cash crop value, and onions for their steady market demand. Additionally, promoting the cultivation of mangoes, cotton, and citrus will contribute significantly to both local and global markets.

To support these efforts, it is essential to expand fruit and vegetable markets, provide technical and financial assistance to vegetable businesses, encourage value-added products, and improve storage and transportation facilities. Emphasizing sustainable farming practices, enhancing farmer training, and investing in agricultural research and development will further boost productivity and strengthen the D.G. Khan Division's contribution to Pakistan's economy.

1. INTRODUCTION

Pakistan has a diversified economic base with the agriculture sector, contributing 24 percent in GDP and 37.4 percent in employment. The predominance of agriculture in the economy indicates that agricultural growth is a critical driver of economic growth, employment, and poverty reduction, given its linkages with the other sectors. The promising crop production during the Kharif season of 2023 exhibited steady export growth – led by rice – while cotton imports decreased significantly due to better domestic output. Credit facilitation, certified seeds, fertilizer use, and on-farm management techniques played the primary role in better yield of crops that may be sustained depending on the agriculture policy of the government and the self-reliance of the farmers. Better economic returns have motivated farmers to go for other crops, indicating diversification when put into perspective.

The agriculture sector has shown a growth of 6.25 percent in 2023-24 compared to 2.27 percent last year, driven by healthy growth in important crops. Specifically, there was a significant growth of 16.82 percent in the production of major crops. Wheat production has witnessed a record growth of 11.6 percent, reaching 31.4 million tonnes compared to 28.2 million tonnes last year. Cotton production, which was severely damaged by floods and rains last year, recorded 10.2 million bales compared to 4.9 million bales last year, growing by 108.2 percent. Rice production also saw a significant increase, reaching 9.9 million tonnes compared to 7.3 million tonnes last year, representing a growth of 34.8 percent. In contrast, sugarcane and maize production declined by 0.4 percent and 10.4 percent, respectively, with sugarcane production at 87.6 million tonnes compared to last year's 88.0 million tonnes, and maize production at 9.8 million tonnes compared to 11.0 million tonnes last year. The negative growth in sugarcane and maize has been offset by the substantial growth in wheat, cotton, and rice. Other crops have also shown growth, increasing by 0.90 percent compared to a decline of -0.92 percent last year. This growth is attributed to increase in the production of fruits (8.40 percent), vegetables (5.77 percent), and pulses (1.45 percent). Additionally, cotton ginning, which has a share of 0.32 percent in GDP and 1.34 percent in agricultural GDP, grew by 47.23 percent due to the significant increase in cotton production.

1.1. SALIENT FEATURES OF PAKISTAN AGRICULTURE SECTOR (2022)

Crops	Forestry	Fisheries	Livestock
8.54% Value Addition in Agri.	0.56% Value Addition in Agri.	0.31% Value Addition in Agri.	14.63% Value Addition in Agri.

Table 1: Sector Wise GDP Share of Pakistan
Source: Economic Survey of Pakistan (2023-24)

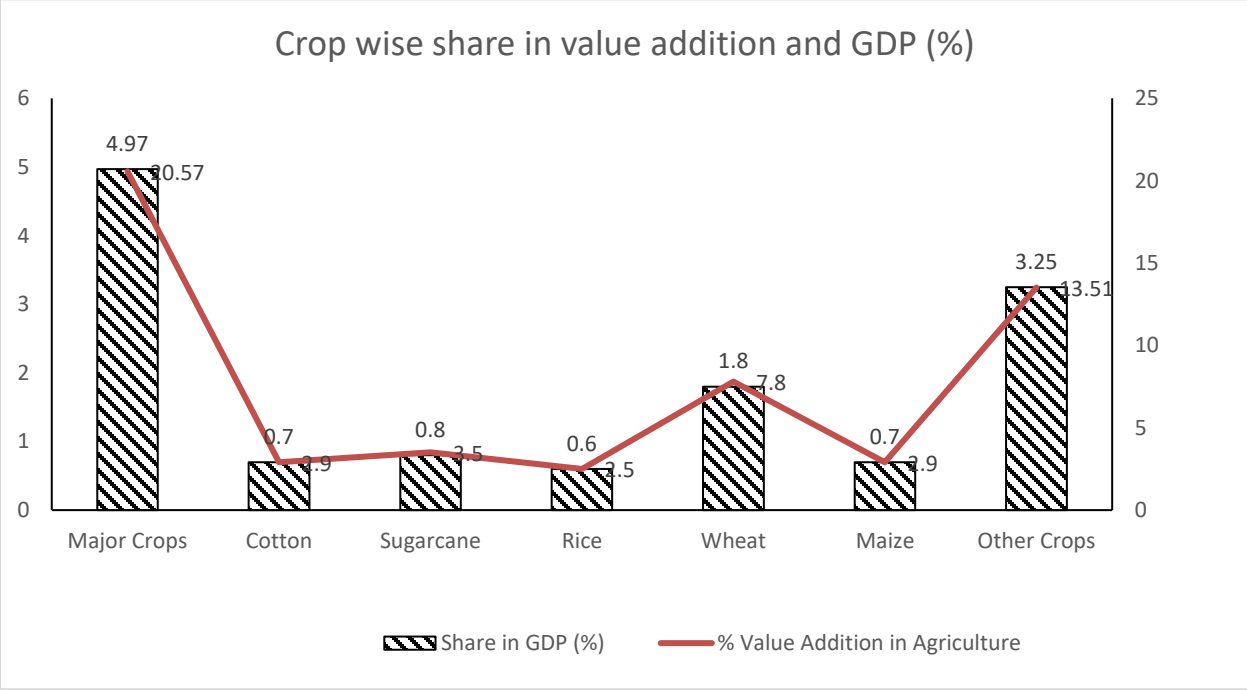


Figure 1: Crop Wise Share in Value Addition and GDP (%)

Source: Economic Survey of Pakistan (2023-24)

2. CHALLENGES AND CONCERNS IN THE AGRICULTURE SECTOR'S GROWTH AND DEVELOPMENT

The World Bank's "Enabling the Business of Agriculture" study highlights the impact of agricultural regulations on farmers, using indicators to measure performance, identify market barriers, and promote innovation. Countries with better regulations see lower poverty rates and greater development outcomes. However, Pakistan ranks low in this study, needing improvements in its agricultural environment (Enabling the Business of Agriculture 2019). Water scarcity significantly challenges agriculture globally, including in Pakistan, which has the lowest water productivity among compared countries. While the US and China excel, Pakistan needs improvement (INP, 2019). Additionally, Total Factor Productivity (TFP) in Pakistani agriculture is declining due to outdated practices and inadequate resources. Due to these reasons, crop production in Pakistan remains stagnant. Enhancing productivity is crucial for economic growth, poverty reduction, food security, and job creation, especially in rural areas (Sector Plan 2015).

Pakistan’s agriculture sector also faces significant challenges in food security and raw material production for industry. Limited arable land, water scarcity, and climate change threaten food security for the growing population, while producing enough raw materials for industry with limited resources is a daunting task.

The figures below show the challenges and concerns in the agriculture sector growth and development:

- Cotton production and yield have been decreasing since 2011-2012.
- The demand for cotton is increasing, but the industry is struggling to keep up with per capita requirements from the local market and that is why imports are increasing.

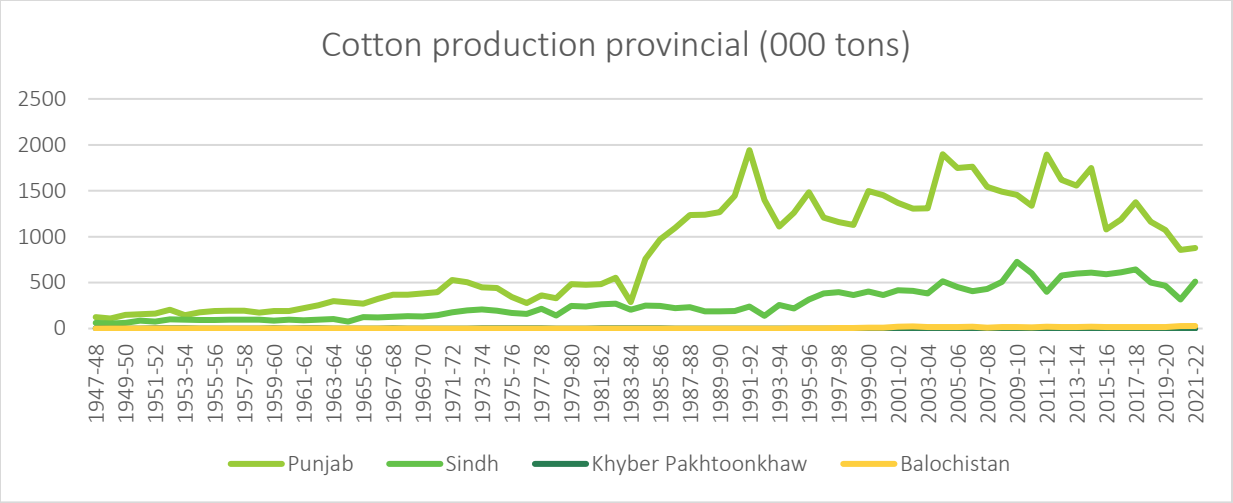


Figure 2: Province Wise Cotton Production

Source: AMIS

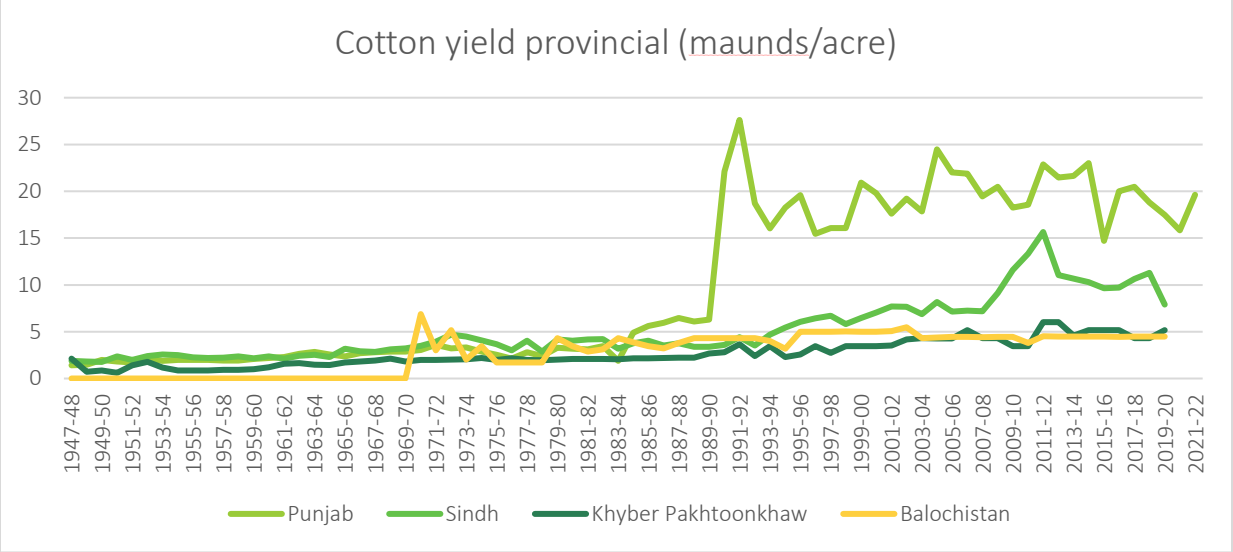


Figure 3: Province Wise Cotton Yield

Source: AMIS

- Citrus production is gradually increasing but its quality is decreasing due to diseases and pesticide attacks.
- The citrus industry often fails to capture maximum profit due to minimal value addition, relying primarily on raw fruit sales rather than diversified products.
- Without significant processing into products like juices, essential oils, the citrus sector misses opportunities for higher margins and market expansion.

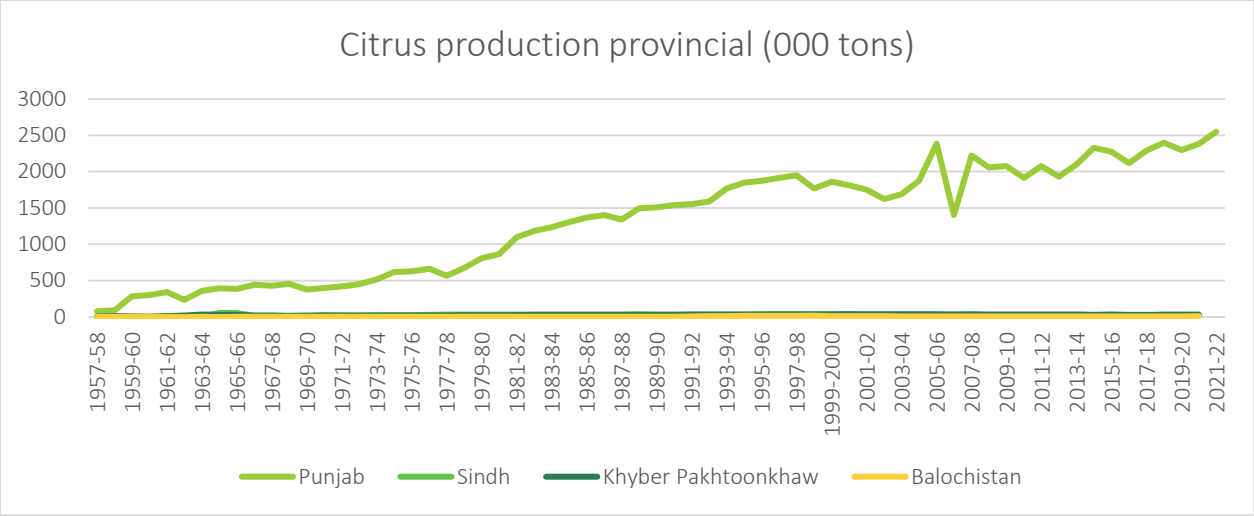


Figure 4: Province Wise Citrus Production

Source: AMIS

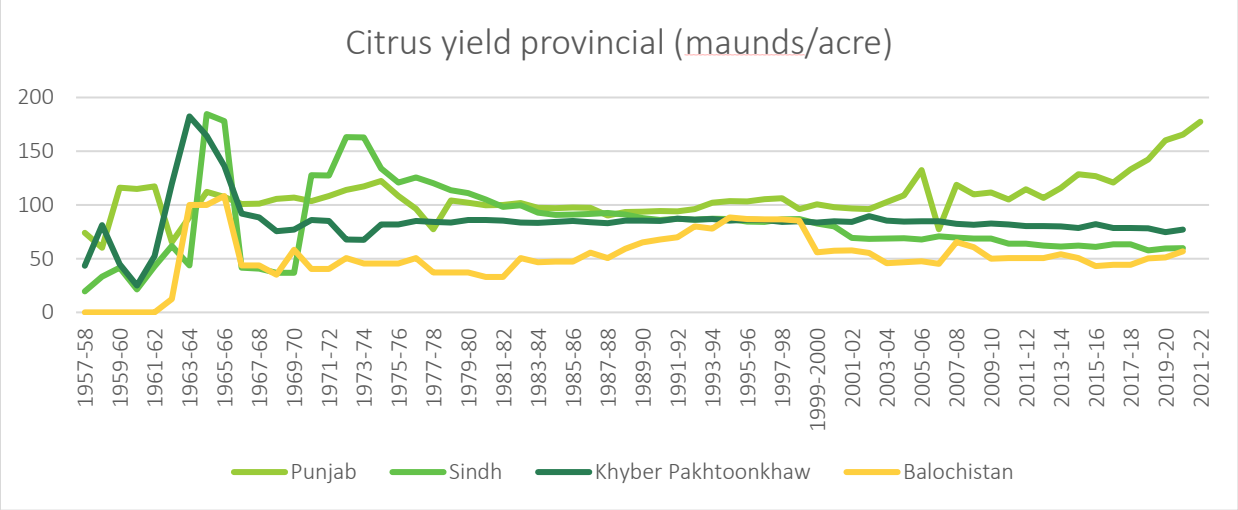


Figure 5: Province wise citrus yield

Source: AMIS

- The production and yield of mango is stagnant due to low quality seed, disease outbreaks and pest attacks.
- Disease outbreaks and pest attacks, exacerbated by inferior seed quality, significantly hinder the growth and productivity of mango orchards.

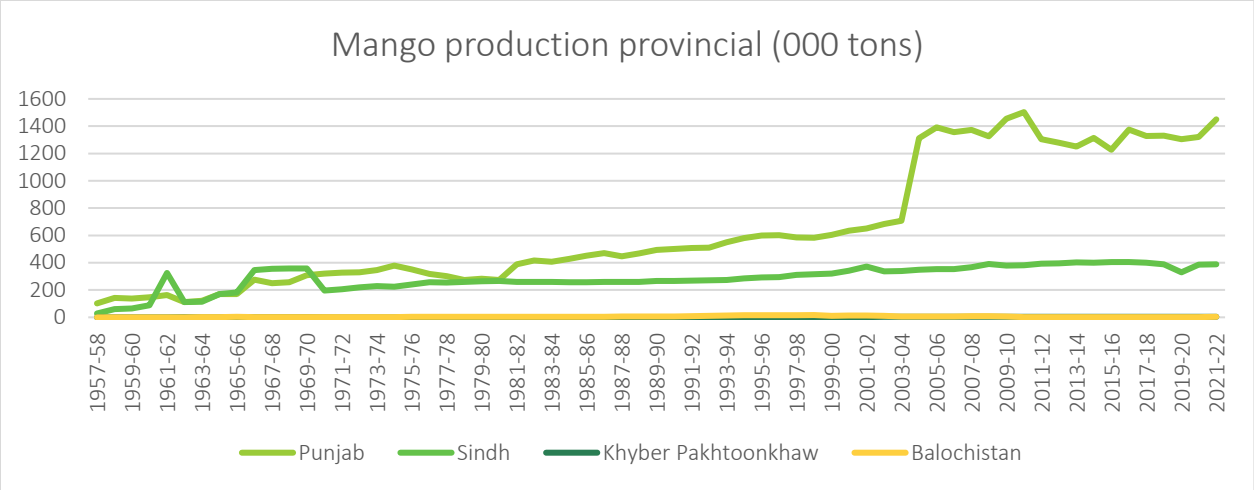


Figure 6: Province wise mango production

Source: AMIS

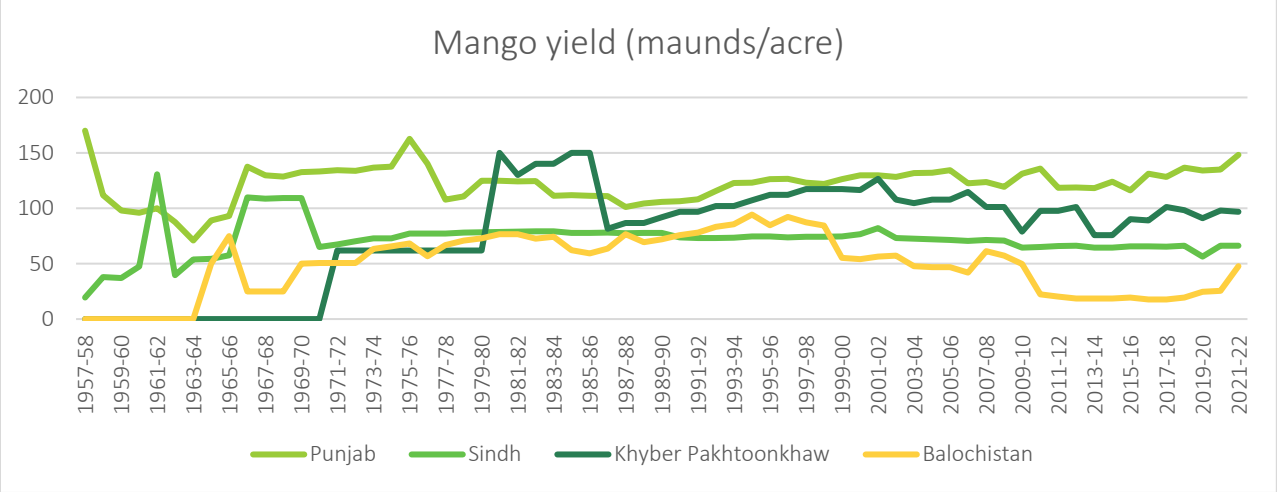


Figure 7: Province wise mango yield

Source: AMIS

- Onion production is up, but stagnant yields highlight the need for enhanced agricultural practices to meet demand.
- Boosting onion yields is essential to align increasing production with the rising local and international demand.

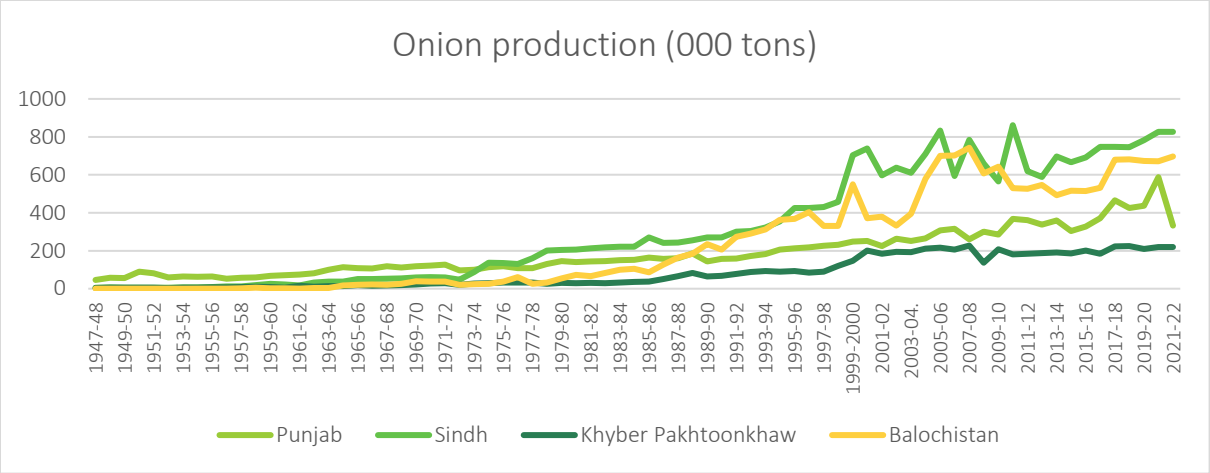


Figure 8: Province wise onion production

Source: AMIS

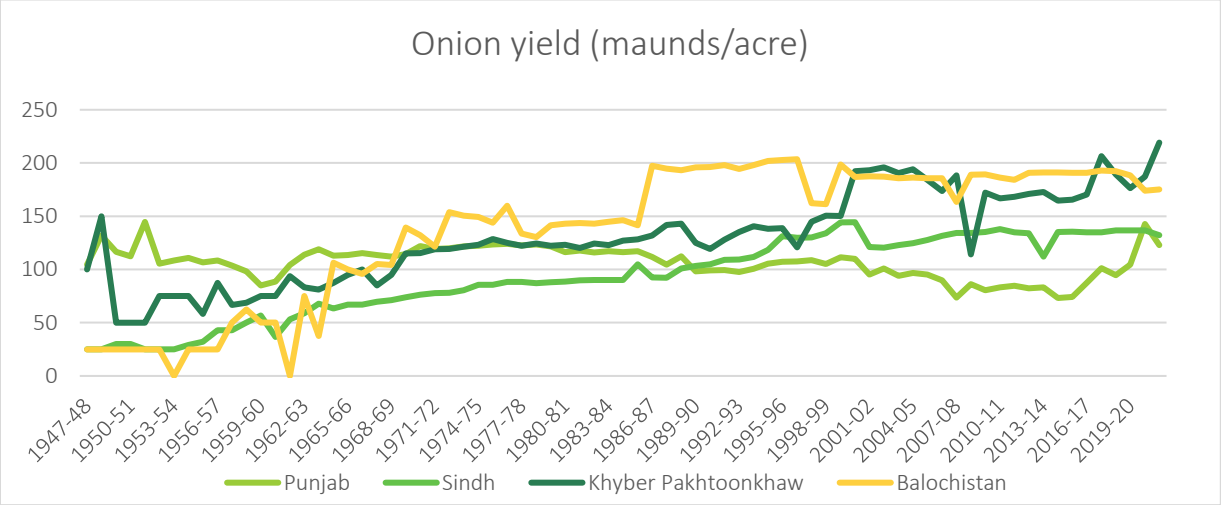


Figure 9: Province wise onion yield

Source: AMIS

- The yield of chilies is decreasing due to disease outbreaks and climate change effect.
- Additionally, the upward trend in their international market share has significantly impacted on domestic prices because yield is stagnant.

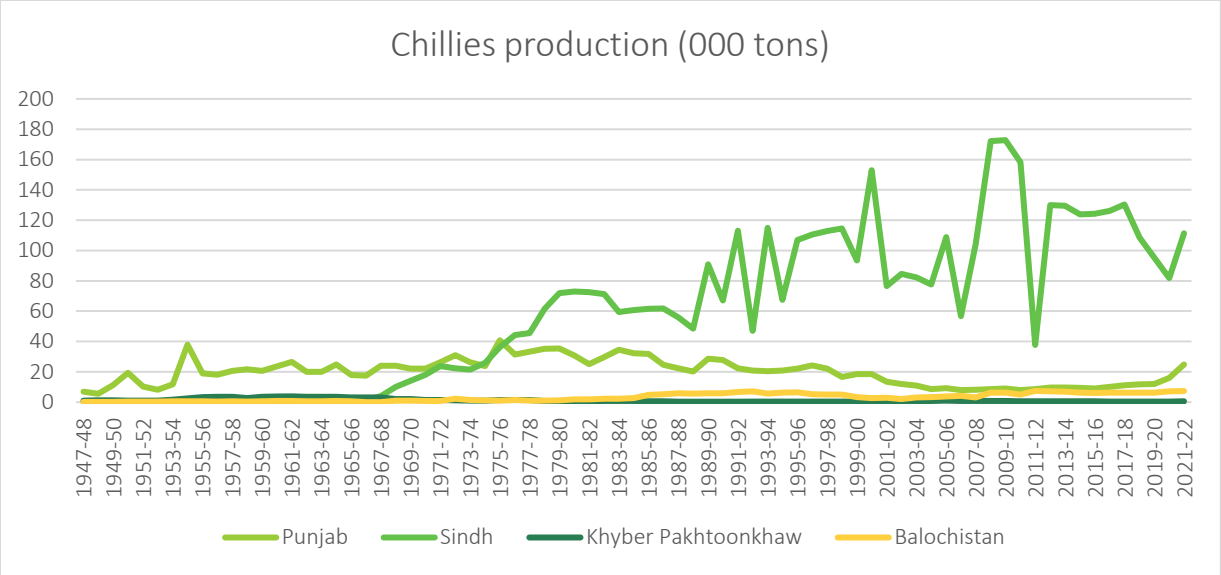


Figure 10: Province wise chillies production

Source: AMIS

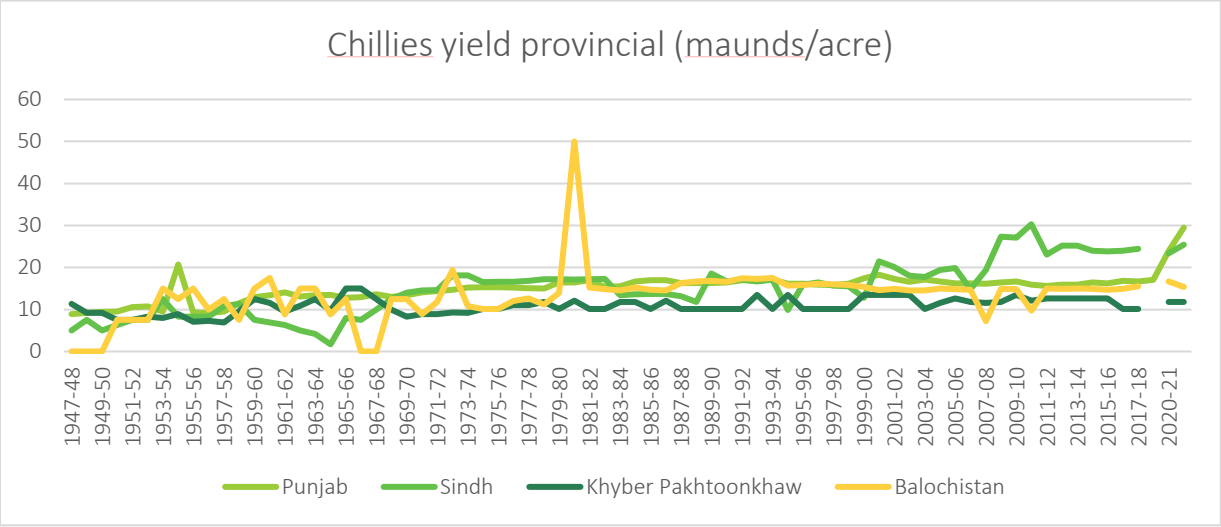


Figure 11: Province wise chillies yield

Source: AMIS

- Rapeseed crop production fluctuates significantly due to an unstable local market and insufficient policy focus and support for farmers.

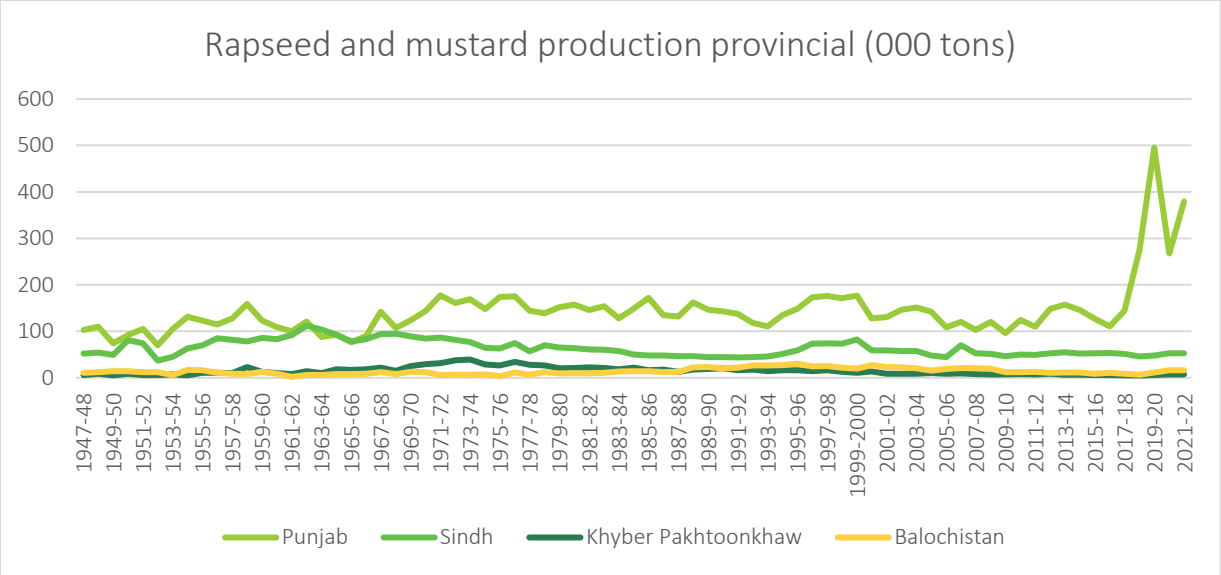


Figure 12: Province wise rapseed and mustard production

Source: AMIS

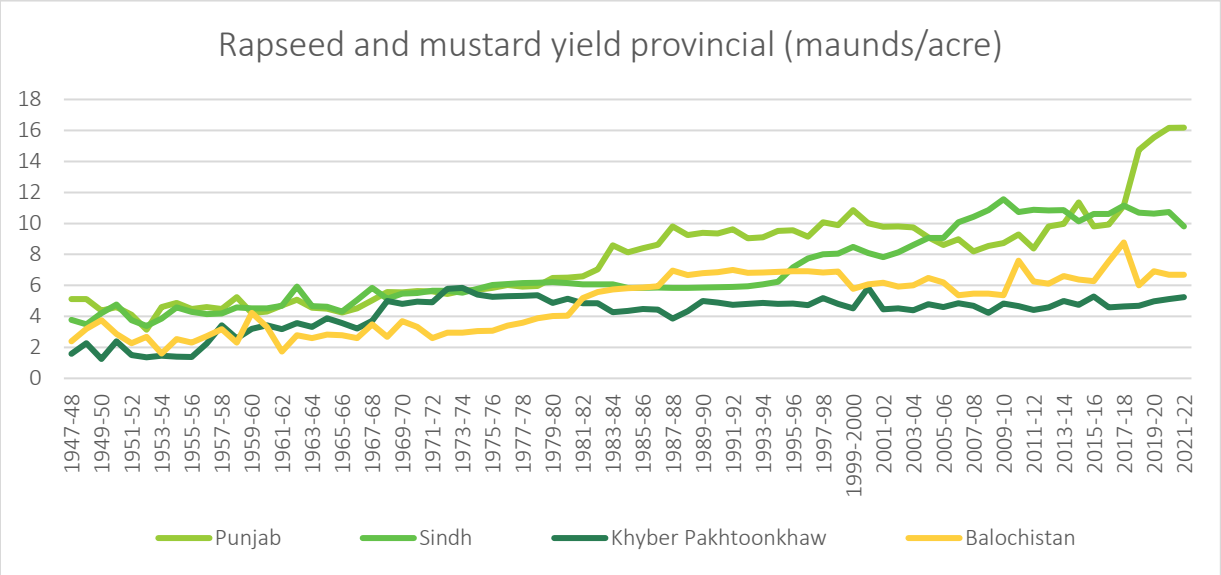


Figure 13: Province wise rapseed and mustard yield

Source: AMIS

- The yield of the sesamum crop is increasing but due to the unavailability of proper export mechanisms, farmers are reluctant/confused to cultivate it on larger area.

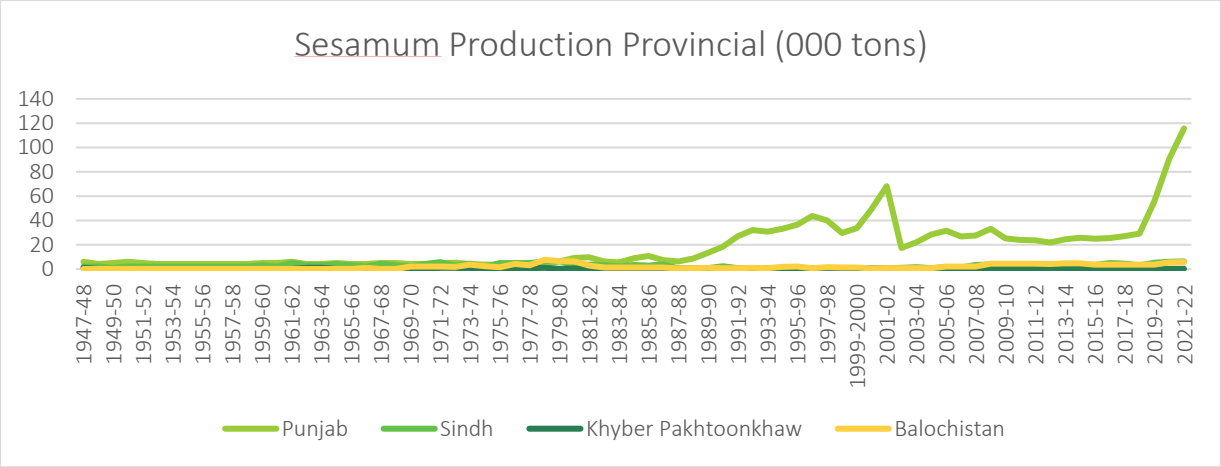


Figure 14: Province wise sesamum production

Source: AMIS

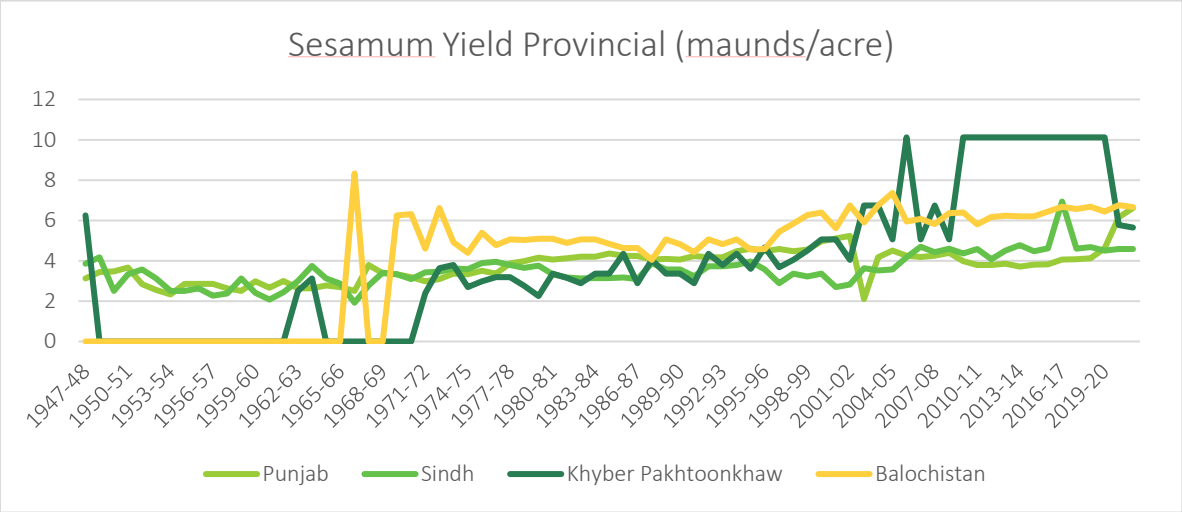


Figure 15: Province wise sesamum yield

Source: AMIS

3. COMPREHENSIVE AGRICULTURE TRANSFORMATION PLAN

Given the challenges at hand, it is crucial for the government to take a multifaceted approach, which includes three overarching strategies. Firstly, the government should identify areas with potential for cultivating specific crops and then establish clusters or zones dedicated to each crop. These designated areas should be equipped with comprehensive amenities and specialized support systems tailored to the unique requirements of each crop. By implementing this system, the government can enhance overall efficiency by optimizing the utilization of resources such as land, labor, water, and inputs. Additionally, it would enable the government to oversee the entire value chain of each crop effectively, which includes input management, extension services, technological advancements, research and development, and subsidy provisions.

Transitioning crop-mix patterns from low-value to high-value crops is a recommended practice. This can be achieved by identifying regions suitable for cultivating high-value crops, and prioritizing the cultivation of those crops over the next five years. To ensure the success of this strategy, it is important to establish a comprehensive value chain for the identified crops. In D.G. Khan's agriculture sector, Citrus and Ground Nut have been selected for cultivation over the next five years due to their profitability, demand, potential for value addition, export opportunities, and comparative advantage in international markets.

This strategic decision aims to foster growth in the agricultural industry of the region. By enhancing the productivity of primary crops as well as other agricultural products such as horticulture, food grain, oilseed, and minor crops, it is possible to make efficient use of limited land resources. This would enable the cultivation of high-value crops on the remaining land space.

Punjab spatial strategy is a long-term spatial development framework for the province of Punjab, across all sectors including agriculture, livestock, irrigation, food, forestry, industries, environment, urban planning, and social development. The strategy aims to ensure integrated spatial planning by identifying the comparative advantage of each area that will structurally transform Punjab into an economically developed region.

Furthermore, in PSS a comprehensive agriculture transformation plan was prepared which focuses on the comparative advantage of each region/division of Punjab. In this regard, the Urban Unit has

been given the task to devise a comprehensive agriculture development plan for the D.G. Khan region which covers detailed agriculture and livestock plan by value chain of each potential/identified crop of the region.

3.1. REGIONAL PLANNING (SCOPE OF WORK)

The agriculture sector is one of the most important sectors of the economy of Punjab; an increase in agricultural productivity will make a massive contribution to increasing the growth rate of Punjab's economy. However, there is no spatial lens through which development projects can be assessed and evaluated for the targeted economic growth. Therefore, the Punjab Spatial Strategy focuses on the potential for economic growth in the agriculture of the province.

Considering the Punjab Spatial Strategy framework, the agriculture sector of Punjab must reposition itself to transform the agriculture sector in the province of Punjab to increase crop productivity, bring the additional uncultivated area under cultivation and improve the crop mix to create maximum value addition in the province to contribute towards inclusive economic growth. This would be done by transforming the farmers of Punjab into progressive farmers, equipping them with state-of-the-art support and knowledge, providing them with quality and timely inputs as well as creating an enabling environment.

This work will be to develop and validate agro-ecological conditions and socio-economic profiling of agriculture and livestock sectors of the region focused on;

a. Assessment of physical environment (land cover, geology, natural resources, climate and meteorology, hydrology, population, land use, community social structure, etc) to determine optimal cropping pattern for intensification
b. Cropping pattern identification with yield, price, cost of production, profit per acre, etc
c. Proposed cropping pattern for intensification
d. Identification of problems in the product-level value chain (seed to market), resource, and financial constraints.
e. Proposing solutions and interventions at each stage of the value chain to enhance production and exports
f. Focusing on exportable surplus and finding value propositions for interventions leading to economic growth in the area

g. Water availability and utilization assessments for natural resource preservation

h. Economic activities (livestock and agro-based industries, employment, and labor market) assessments.

i. Key facilities assessments (agricultural markets, farm mechanization, breeding and seeding facilities, etc) for infrastructure and policy interventions

Hence, the regional development strategy for D.G. Khan Division places emphasis on the imperative of transitioning from cultivating low-value crops to cultivating high-value crops under our current cropping pattern. In order to enhance farmer income and promote the growth of the agriculture industry. The aforementioned objective can be accomplished by the strategic formation of clusters consisting of high-value crops, namely in regions where we possess a competitive advantage in terms of both yield and productivity, in addition to favorable ecological circumstances

4. D.G. KHAN DIVISION PROFILE

Considering the current state of agriculture in Punjab, it is essential to tackle the issues in D.G. Khan with a thorough development plan. This plan aims to thoroughly assess the existing challenges in agriculture and livestock, providing a detailed analysis of production, infrastructure, market access, and resource management in the region. The proposed roadmap will outline targeted strategies and initiatives designed to boost these sectors, promoting sustainable growth, increasing productivity, improving the quality of produce, and creating favorable conditions for farmers and stakeholders. By implementing this development plan, D.G. Khan can transform into a thriving hub for agriculture and livestock, significantly contributing to the economic progress of the area.

Between 1995 and 2015, D.G. Khan District saw significant urban development and growth. Urban development increased by 22% from 1995 to 2005, and by a substantial 63% from 2005 to 2015 (Table 2).

Table 2: Continuous Urban Development in D.G. Khan District

Contiguous Urban Development in D.G. Khan District	Total
1995-2005	22%
2005-2015	63%

Source: Urban Unit

The annual growth rate was 2.02% in 1995-2005, surged to 4.99% in 2005-2015, and averaged 3.49% over the two decades (Table 3).

Table 3: Annual Area Growth rate in D.G. Khan District

Annual Area Growth Rate in D.G. Khan District	Total
1995-2005	2.02%
2005-2015	4.99%
1995-2015	3.49%

Source: Urban Unit

The table below illustrates district-wise employment percentages in the agriculture sector across D.G. Khan Division. D.G. Khan itself has 52.3% of its workforce employed in agriculture, while Layyah follows with 50.7%. Rajan Pur leads with the highest rate at 65.2%, emphasizing its strong reliance on agriculture. Muzaffargarh records 53.5%, indicating the sector's significant role in local employment across the division. At the same time, urban expansion in these areas influence the availability of agriculture land and employment opportunities in non-agricultural sectors. Balancing urban growth with agricultural needs is essential for sustainable development, ensuring adequate land for residential and industrial purposes while preserving agricultural productivity.

Table 4: District-wise Employment by Agriculture sector (%) in D.G. Khan Division

	Employment by Sector (%)
	(Agriculture)	**Total**
D.G. Khan	52.3
LAYYAH	50.7
RAJAN PUR	65.2
MUZAFFARGARH	53.5

Source: LFS 2021

4.1. D.G. KHAN AGRICULTURE SECTOR PLAN

VISION

The vision is expressed through a detailed outline of policy areas, targets, key actions, and stakeholders in the D.G. Khan division. The Agriculture Development Plan for the D.G. Khan region focuses on:

"Efficient use of resources to enhance productivity and generate value addition in agriculture through improving the regional and country positioning in terms of attractiveness and competitiveness by leveraging existing natural endowments for the economic wellbeing of people, especially rural communities."

AGRICULTURE OBJECTIVES

The main objectives of the regional plan for the agricultural sector are:

- Enhance the competitive position of the agriculture sector to capture global demand and cater to domestic demand through the modernization of traditional agriculture practices.
- Ensure food security by improving food quantity, quality, and nutrition diversity through higher yields, better crop mix, and farmer profitability.
- Enhance sustainability and resilience in the wake of climate changes by conserving agricultural resources through efficient use of land & water.
- Strengthen and promote private sector participation in agriculture value chains with increased investment, technology infusion, and resource management.
- Improving breed development, on-farm mechanisms, medical facilities, and providing high-quality nutritional feed for enhanced productivity.
- Contribute towards poverty alleviation and economic development of the province through the provision of an enabling environment and farmer support services.
- Strengthen local markets and price mechanisms and increase accessibility to the international market by adopting international standards and certification.

POLICY FOCUS AREAS IN AGRICULTURE AND LIVESTOCK

To achieve the above-stated objectives, the following policy focus areas should be adopted strictly to increase the income of the farmer, improve their standard of living and bring overall development to the rural areas.

- Low productivity to high productivity (Lessening the productivity gap in all crops, livestock)
- Identify the potential areas for each crop and make a cluster/zone of each crop
- Provide all ancillary facilities and specialized support systems for each crop in the cluster/zone.
- Gradually shift crop-mix pattern from low-value crops to high-value crops (identifying potential crops from high-value crops on a priority basis for the next five years).
- Wasteful use of water to efficient use of water and develop 24 agriculture corridors along 24 main canals and focus on integrated rural development in these corridors.
- All departments coordinate and implement integrated action plans by using the maximum agriculture potential.

5. METHODOLOGY

This section provides detail about the methodology used for the analysis:

01

Spatial Analysis

Mapping of agricultural data like crop zoning, Spatial decision support systems, and Remote Sensing

02

Quantitative/Qualitative Analysis

Field Data Collection: Preliminary meetings, Stakeholders Consultations, Desk Research

03

Report Writing

A compilation of the regional development plan of the Agriculture and Livestock sector

5.1. DATA ANALYSIS

Once the data is gathered by the team, it undergoes a comprehensive discussion and analysis. The collected information is then cleaned, integrated, and verified to identify and address any potential gaps. Supplementary data is obtained through electronic correspondence and telephonic exchanges with the Agriculture and Livestock departments. Descriptive maps for the anticipated Rabi and Kharif crops are generated using field data and agro-ecological conditions. The Agriculture and Livestock team then conducts a thorough examination of the results.

5.2. IDENTIFIED POTENTIAL CROPS IN THE D.G. KHAN DIVISION

The importance of Value Chain Development through Crop Zoning and Specialized Support Systems as key initiatives to boost productivity and profitability in the D.G. Khan Division is clear from the variety of potential crops in the region.

VALUE CHAIN DEVELOPMENT

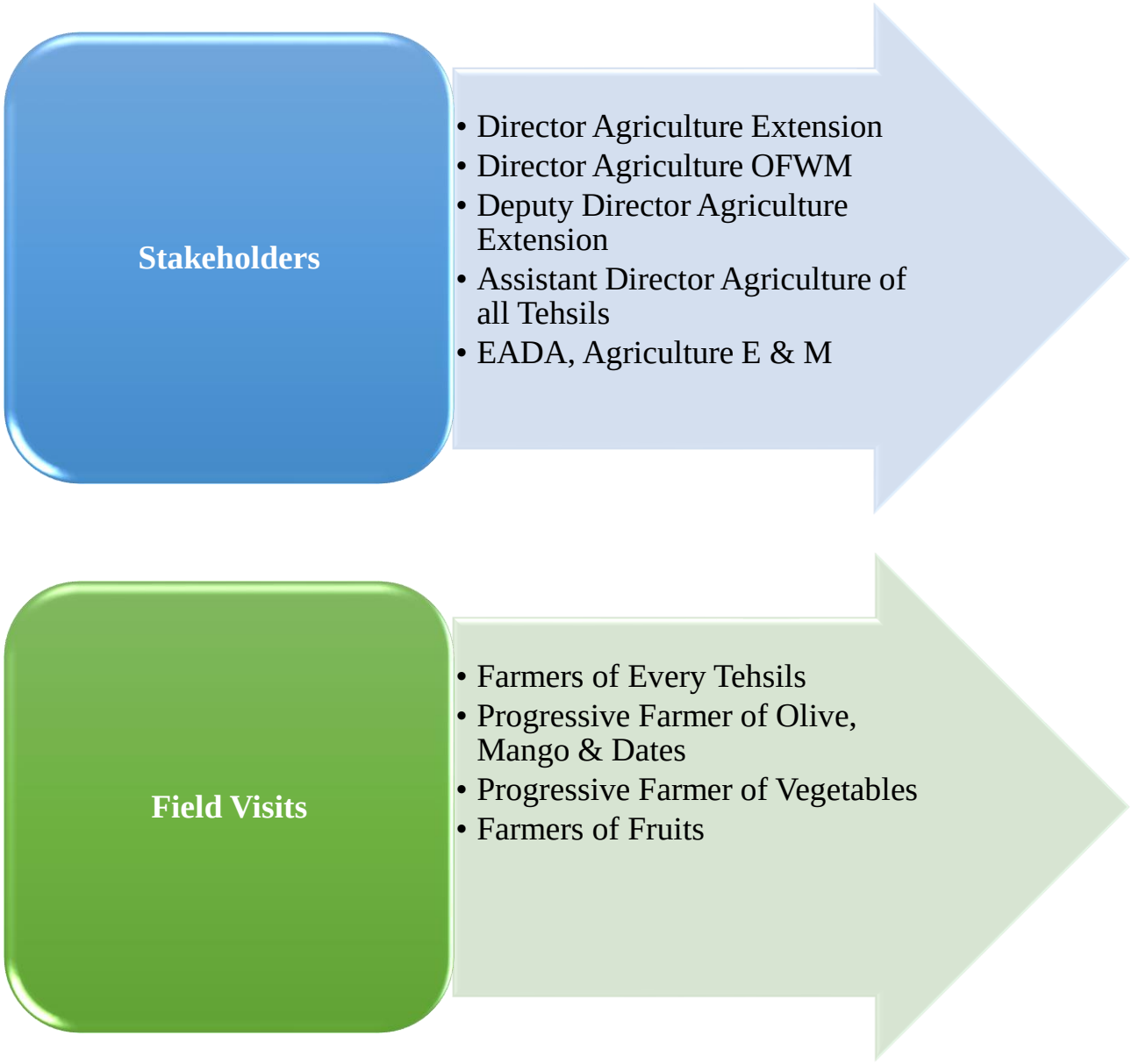
01

CROP ZONING

02

SPECIALIZED SUPPORT SYSTEMS

03


Stakeholders
• Director Agriculture Extension
• Director Agriculture OFWM
• Deputy Director Agriculture Extension
• Assistant Director Agriculture of all Tehsils
• EADA, Agriculture E & M
Field Visits
• Farmers of Every Tehsils
• Progressive Farmer of Olive, Mango & Dates
• Progressive Farmer of Vegetables
• Farmers of Fruits

RAPID ASSESSMENTS – FIELD VISITS

The Urban Unit Agriculture sector teams visited the D.G. Khan division in April-May, 2024.

6. D.G. KHAN AGRICULTURE SNAPSHOT

6.1. D.G. KHAN DIVISON AGRICULTURE PROFILE

The total reported area of the district is 7,785,440 acres, with 4,507,750 acres being cultivated (Figure 16).

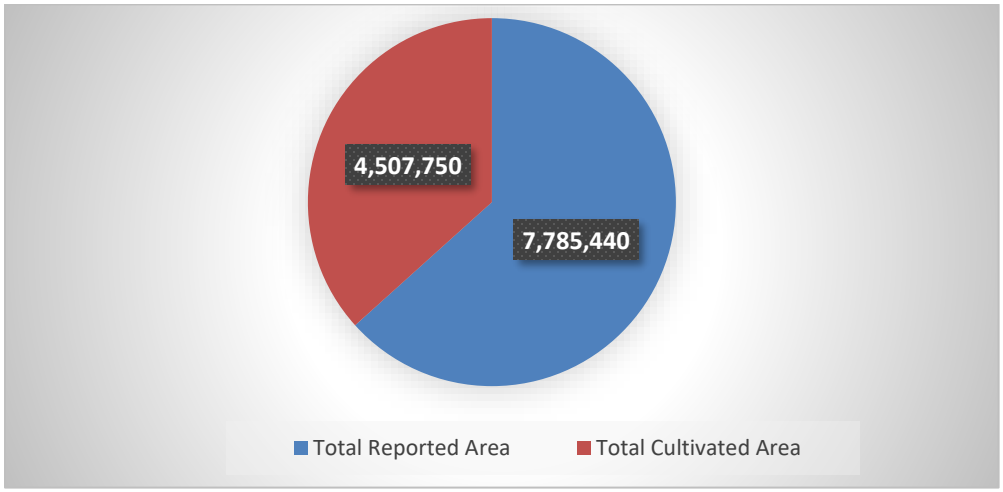


Figure 16: Geographical area distribution in D.G. Khan Division (acres)

Source: PDS 2022

6.2. PRODUCTION OVERVIEW

Based on following graphical data, crop production in the D.G. Khan Division plays a crucial role in Punjab's overall agricultural output. Tobacco leads with a contribution of 76%, followed by sunflower at 55% and losan at 48%. However, vegetable and fruit crops, with the exception of mangoes at 26%, make relatively minor contributions. It is critical to improve crop production by introducing specialized support systems and modern agricultural technologies for cultivating high-value crops, while optimizing the use essential resources. Given the current crop patterns, it is evident that D.G. Khan holds significant potential to substantially increase its crop yields.

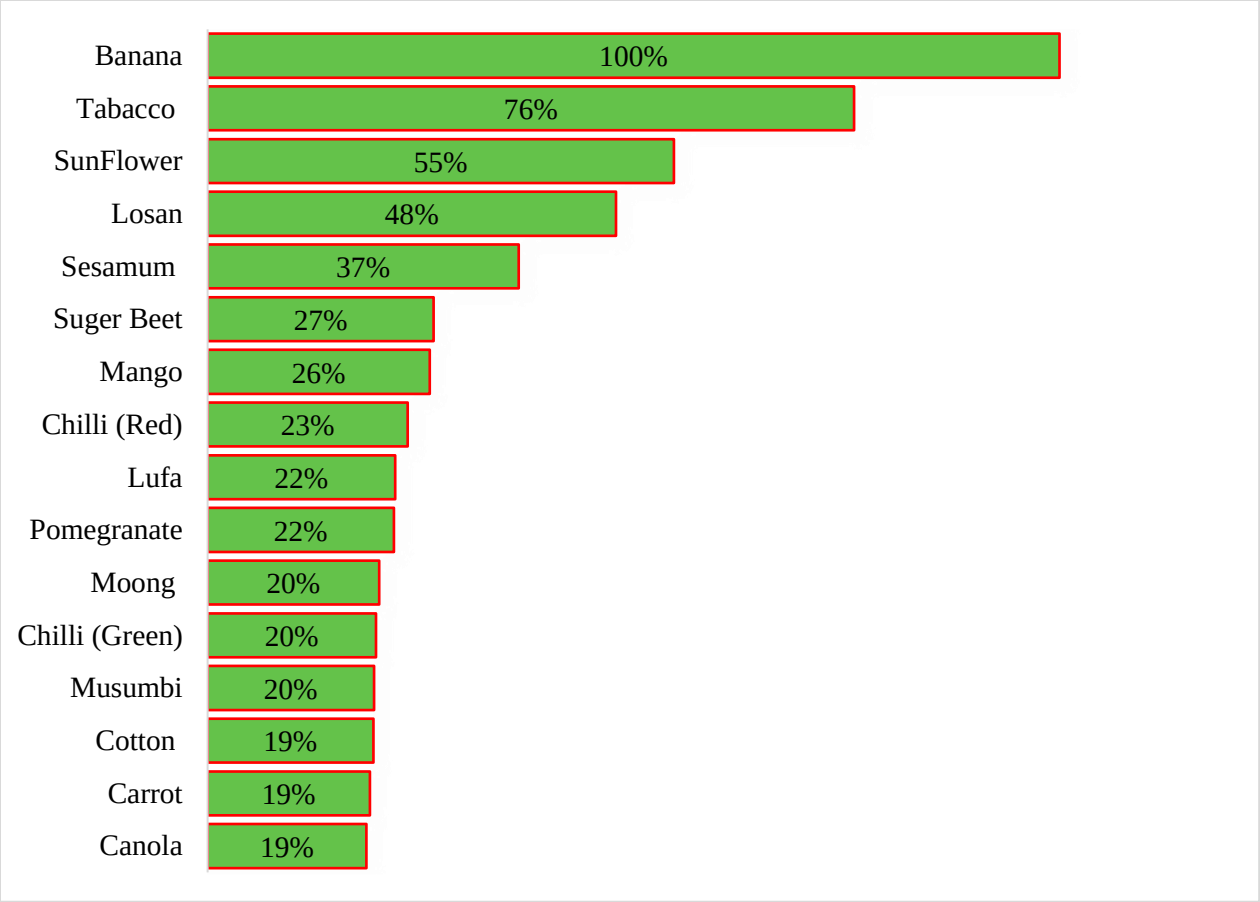


Figure 17: Production contribution as a percentage of Punjab's total

Source: Crop Reporting Service

6.3. CURRENT CROPPING PATTERN

The Rabi and Kharif cropping patterns in the D.G. Khan division of Pakistan refer to the seasonal cultivation of crops. Rabi crops are typically planted in the winter and harvested in the spring, while Kharif crops are planted in the summer and harvested in the fall.

In Dera Ghazi Khan, the reported area is 7,785,440 acres, of which 4,507,750 acres are cultivated. During the Rabi season, a total of 3,519,750 acres are utilized, leaving 988,000 acres vacant. Despite the significant cultivation, the output during the Rabi season remains modest, yielding only Rs. 70,000 per acre. The distribution of area under different crops during rabi season is shown in following graph:

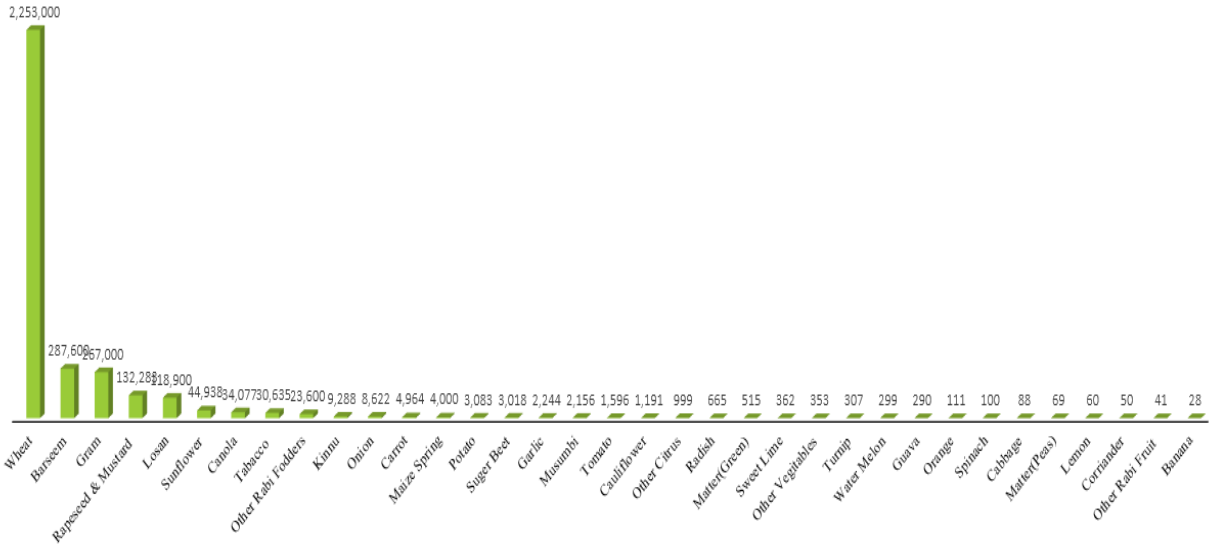


Figure 18: Current Cropping Pattern in Rabi season (acres)

Source: Crop Reporting Service

Similarly, in D.G. Khan, out of the 4,507,750 acres of cultivated land, only 2,316,860 acres are used during the Kharif season, leaving 2,190,890 acres vacant. Farmers are generating only Rs. 97,000 per acre during kharif season. The distribution of area under different crops during the Kharif season is shown in the following graph:

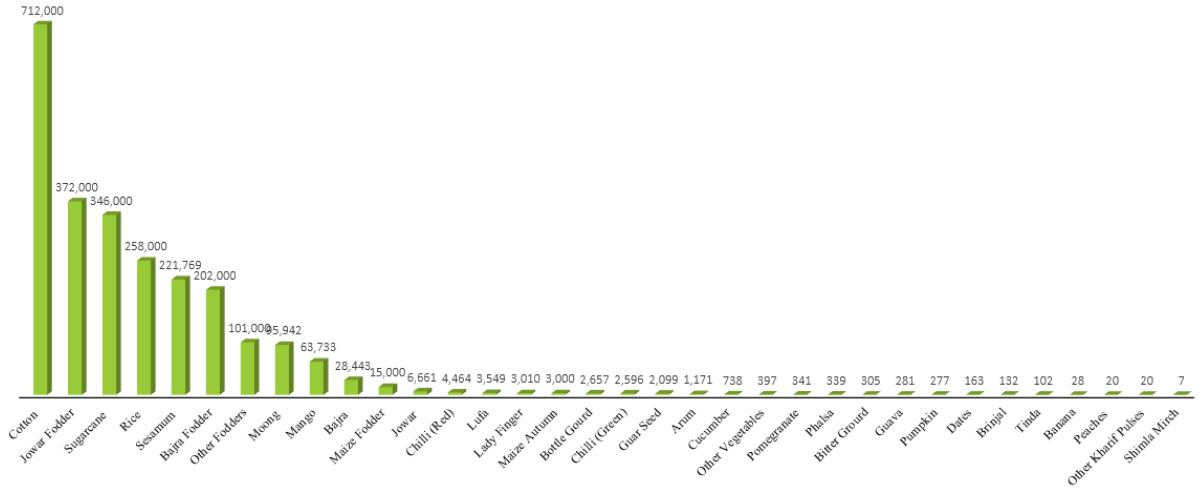


Figure 19: Current Cropping Pattern in Kharif season (acres)

Source: Crop Reporting Service

7. ISSUES AND CHALLENGES OF AGRICULTURE

Pakistan's agriculture faces significant difficulties in meeting the nation's food needs as a result of the population's growth, the irregular climate, and low crop production. The management of crop production presents many challenges for Pakistani farmers, including the absence of soil testing on farms, the unavailability and poor quality of fertilizers, loss during harvest, a lack of warehouses, machinery, and equipment, and, above all, a deterioration in soil fertility. In Pakistan, only tractors and cultivators are used for agricultural mechanization. The country is experiencing major issues with the production gap as a result of conventional farming methods and a lack of creative technology use. Production and average yield are vastly different. Furthermore, the country's food security policies are seriously in danger due to the sharp rise in population. A significant increase in agricultural output is essentially needed to ensure the nation's agricultural future. To increase agricultural output and close yield gaps, the agricultural sector should utilize the most recent technological advancements. Land, design, farm equipment, seeds, fertilizer, irrigation, transport, and other resources are needed for agricultural operations. Farmers need to have simple access to finance in order to quickly and conveniently acquire these supplies. Because our farmers are so poor, the loans that banks offer to them are insufficient.

7.1. ISSUES AND CHALLENGES IN THE D.G. KHAN DIVISION

SEED AND INPUT ISSUES:

Limited Access to Quality Inputs:

Farmers struggle to access high-quality seeds, fertilizers, and pesticides, reducing crop yields and quality.

Lack of Germplasm and Seed Copying:

The region has a shortage of germplasm, leading seed producers to copy existing seeds, undermining seed quality and genetic diversity, and affecting crop productivity.

Seed Theft:

Seed theft is prevalent, causing unauthorized seed distribution. This undermines seed producers' intellectual property rights and floods the market with uncertified, low-quality seeds, reducing crop productivity.

Inadequate Seed Storage:

The lack of proper seed storage, like seed banks, reduces the availability of high-quality seeds, impacting agricultural productivity.

Heavy Reliance on Imported Seeds:

D.G. Khan Division relies heavily on imported seeds for vegetables like onions and chilies, facing issues with quality control, adaptability, and cost, limiting local self-sufficiency and efforts to develop locally adapted seeds.

Insufficient Institutional Seed Production Capacity:

Public seed production institutes in the D.G. Khan division struggle with financial, human resource, and infrastructural challenges, limiting their capacity.

Water Scarcity and Sustainability:

Limited water for irrigation, inefficient flood irrigation, and overreliance on groundwater threaten long-term water security, requiring sustainable water management practices.

Insufficient Adoption of Modern Agricultural Technologies:

Despite proven benefits, the adoption of modern agricultural technologies is limited due to financial constraints, lack of access, and inadequate guidance. Small farmers need education and training to adopt new technologies.

Imbalanced Fertilizer Use:

Farmers are often unaware of the recommended fertilizer doses for their crops, leading to misuse. Over-application can cause nutrient imbalances and environmental pollution, while under-application results in nutrient deficiencies and reduced yields.

Unavailability of Seeds:

The region has potential for crops like date palm and soybean, but local seeds are unavailable. This forces farmers to rely on imported seeds, which is costly and sometime it may not be well-suited to local conditions, resulting in lower yields and higher costs.

PRODUCTION, HARVESTING AND MARKETING ISSUES

Limited Access to Credit:

Small-scale farmers struggle to access credit and agricultural extension services, hindering adoption of modern techniques, input purchases, and productivity improvements.

Market Access and Price Fluctuation:

Farmers face challenges accessing markets and fair prices due to the lack of government markets in the region especially in DG Khan and Rajanpur Districts.

Post-Harvest Losses:

Poor storage and processing infrastructure cause significant post-harvest losses, especially in oilseeds and mangoes, reducing productivity and income.

Value Chain Gaps:

The absence of processing and value-addition facilities for fruits and vegetables limits farmers' income potential. Without these facilities, farmers are forced to sell their produce at low prices in its raw form, missing out on opportunities to increase earnings.

Export Bottlenecks:

The lack of structured export mechanisms for mangoes restricts farmer's access to international markets and income opportunities. Without established channels for export, farmers struggle to reach global buyers and maximize the value of their produce. This limitation hampers their ability to capitalize on demand from international markets, resulting in missed revenue potential.

Climate Change Effects:

Altered weather patterns and extreme conditions have a detrimental effect on agricultural productivity. Unpredictable weather events such as droughts and floods disrupt planting schedules, damage crops, and reduce yields. Shifts in temperature and rainfall patterns also affect crop growth cycles, leading to decreased productivity and quality. Farmers face challenges in adapting their farming practices to these changing conditions, resulting in increased vulnerability to climate-related risks.

Unavailability of Modern Machinery:

The absence of advanced equipment, such as oil extraction units, hampers efficient processing. Without these modern tools, farmers cannot increase their income by preparation value added products.

Diseases and Insect Attacks:

Bacterial blight in pomegranates and sudden death disease in mangoes are detrimental to crop health. Bacterial blight causes wilting, leaf spots, and fruit rot in pomegranates, leading to yield losses and reduced fruit quality. Sudden death disease in mangoes results in the rapid decline of trees, affecting fruit production and orchard longevity. These diseases not only diminish yields but also experience additional costs for disease management and prevention measures.

Unavailability of Mandis:

The absence of government mandi (marketplace) in D.G. Khan has led to various challenges for farmers and traders. Without a centralized platform for trading agricultural produce, farmers may struggle to get fair prices for their crops, while buyers may face difficulties in sourcing quality produce.

Soil salinity:

The high soil salinity in Kot Sarwar Shaheed poses significant obstacles to large-scale cultivation. Excessive salt levels can inhibit plant growth and reduce crop yields, making it challenging for farmers to sustain profitable agricultural operations. As a result, agricultural productivity in the area is likely limited, impacting both local livelihoods and regional food production.

No Crop Rotation:

Farmers' lack of awareness about the benefits of crop rotation has resulted in a pattern of continuous mono-cropping. Without rotating crops, soil fertility declines, pest and disease pressure increases, and yields can stagnate or decrease over time.

Unavailability of Resources:

Farmers need water earlier than those in upper Punjab due to climatic patterns, but it is not available.

Unregistered Arhties:

Unregistered arhties in D.G. Khan contribute to market irregularities by operating outside of regulatory oversight, leading to reduced transparency and fair pricing. Without proper monitoring, these unregistered traders may engage in practices that disadvantage farmers, such as offering lower prices or manipulating market dynamics.

INFRASTRUCTURE AND EXTENSION RELATED ISSUES

Unavailability of Research Centers:

The lack of adequate institutions for agricultural research and development focused on crops like date palm and sesame poses a significant challenge. Without dedicated research facilities and funding, there is limited innovation and progress in enhancing crop productivity, disease resistance, and marketability.

Limited Awareness and Poverty:

Farmers lack awareness of modern agricultural technology, hindered by small landholdings and poverty.

Lack of Extension workers:

DG Khan faces a severe shortage of extension workers in this region. Extension workers face limited growth opportunities and outdated promotion systems, with ineffective performance monitoring.

Lack of Departmental Integration:

Poor coordination among agricultural departments hinders information, resources, and services flow.

Challenges in Research and Extension Services:

Insufficient research and extension services slow technological progress and the adoption of modern techniques.

Modern Agricultural Education Gaps:

Inadequate education and training reduce productivity, with inactive extension services failing to guide on modern practices.

Insufficient Capacity Building:

The absence of training programs hampers extension workers' ability to acquire essential knowledge and skills needed to effectively assist farmers. Without proper training, extension workers may struggle to stay updated on the latest agricultural practices, technologies, and research findings. This deficiency limits their capacity to provide accurate and valuable information to farmers, hindering agricultural development and productivity.

Unavailability of Modern Equipment:

Agricultural extension offices face challenges due to a lack of essential equipment such as soil pH meters and mobile labs. Without these tools, extension workers may struggle to provide accurate and timely advice to farmers regarding soil health and nutrient management. This deficiency hampers the effectiveness of extension services in addressing agricultural challenges and supporting farmers in making informed decisions.

Costly Irrigation Systems:

Farmers face challenges affording high-efficiency irrigation systems such as drip and sprinkler irrigation due to their initial investment costs. These systems often require substantial upfront expenses for equipment and installation, which may be prohibitive for many farmers, particularly

those with limited financial resources. As a result, farmers may continue to rely on traditional irrigation methods that are less efficient, leading to water wastage.

Housing Development:

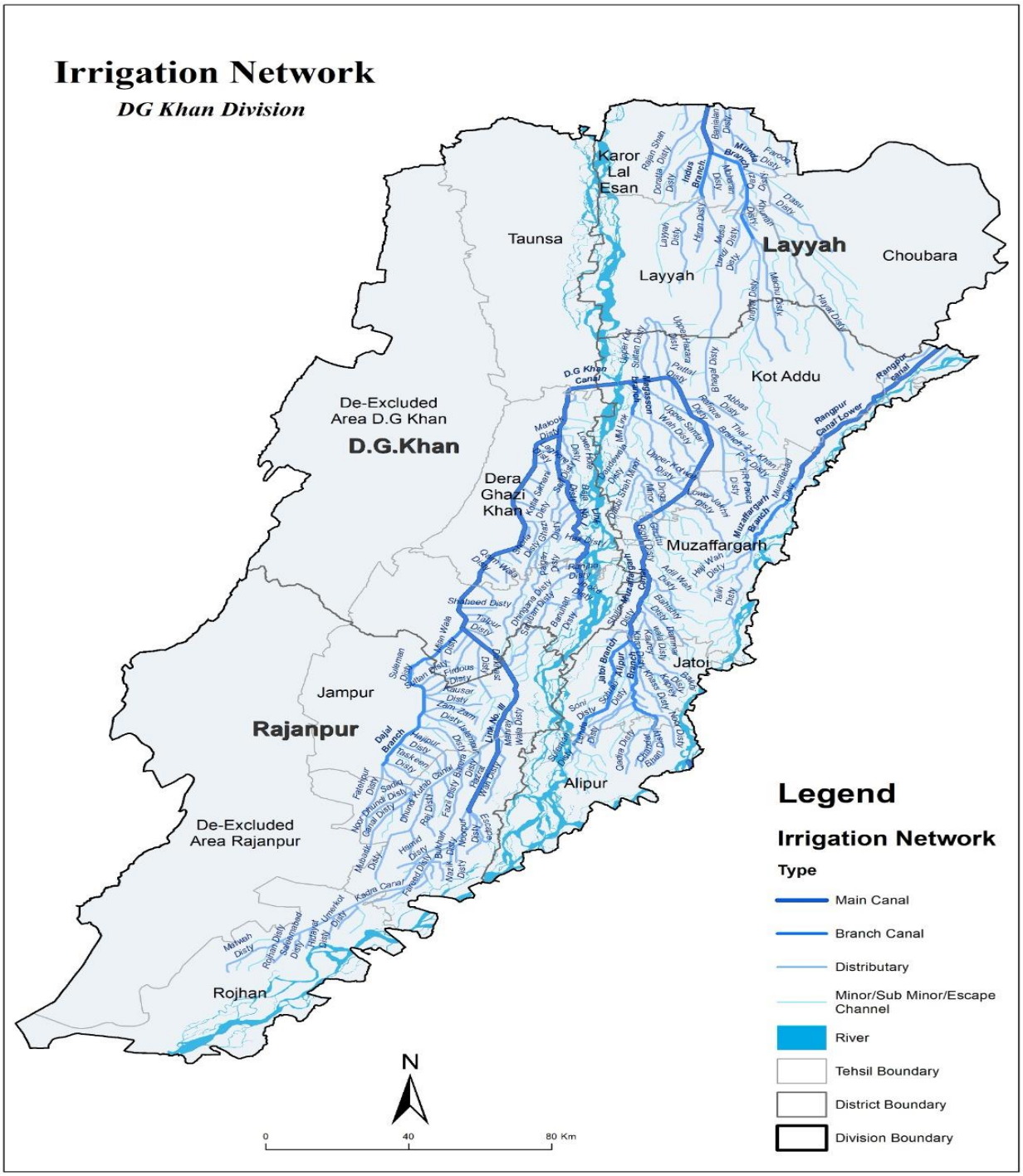
The expansion of housing societies onto fertile agricultural land poses significant threats to agricultural land. As urbanization encroaches upon arable land, valuable resources for food production are lost, exacerbating land scarcity and driving up food prices. Additionally, the conversion of agricultural land into residential areas contributes to habitat loss, soil degradation, and reduced biodiversity.

Road Inaccessibility:

Lack of a bridge (Sheikh Khalifa Bridge) across the Indus River creates logistical challenges for Rojhan farmers accessing Rahim Yar Khan Mandi.

IRRIGATION NETWORK IN D.G.KHAN DIVISION

The irrigation network in D.G. Khan Division includes a main canal that distributes water from the primary source to distributaries, which in turn branch into smaller branch canals. These channels ensure precise water delivery to individual fields via minor and sub-minor channels, as depicted on the following map.



Map I: Irrigation network of DG Khan

Source: The Urban Unit

7.2. SURFACE WATER AVAILABILITY IN THE DIVISION

The average surface water allocation in Punjab is 2.7 ft/acre. In comparison: The D.G. Khan Canal has 3.28 ft/acre, which is significantly higher than the provincial average. However, this allocation is not sufficient for the D.G. Khan and Rajanpur districts according to their cropping patterns.

Additionally, there is a large area (more than 200 thousand acres) along the right bank of the canal from Tounsa to Rajanpur up to the Koh-e-Suleman boundary that remains vacant due to the non-availability of water.

The Muzaffargarh Canal receives 2.81 ft/acre, which is slightly above the Punjab average. The Thal Canal has 1.95 ft/acre, which is considerably lower than the provincial average, leading to severe water shortages for farmers in the Layyah District.

Problems related to irrigation are:

- Low capacity of the canal
- Farmers are converting to solarized tubewells which can affect groundwater depth.
- Timely water supply is unavailable. Areas like Rojhan need water resources earlier than upper Punjab because the climatic conditions of this region need early crop cultivation.
- Farmers at the tail end of irrigation systems are particularly affected.
- Shoria minor is available in tehsil Jampur but there is no availability of water.
- Brackish water is also a major problem in district Rajanpur, especially in Rojhan

INEFFICIENT WATER MANAGEMENT & POOR GROUNDWATER SUITABILITY

The D.G. Khan division, situated within a multi-cropping zone, primarily relies on canals and groundwater for its water supply. However, the heavy dependence on groundwater is causing significant depletion of reservoirs, which are rapidly decreasing. Additionally, some areas of D.G. Khan are grappling with brackish water, further complicating the water scarcity issue and affecting the overall quality of the water supply. This pressing water scarcity issue extends far beyond immediate concerns, significantly impacting the growth and development of crucial crops. The

inability to access water in a timely manner creates adverse effects on agricultural practices within the region.

The groundwater depths across various districts in the D.G. Khan division have shown notable changes from 2010 to the present. In D.G. Khan District, the depth has increased from 59 feet in 2010 to 72 feet currently. Similarly, in district Layyah, the depth has risen from 15 feet to 23 feet. District Rajanpur has seen an increase from 37 feet to 40 feet, while in District Muzaffargarh, the depth has grown from 21 feet to 33 feet. On average, the division's groundwater depth has increased from 33 feet in 2010 to 42 feet currently. These figures indicate a consistent trend of declining groundwater levels across the region over the years.

Table 5: Ground Water Depth in D.G. Khan Division

District	Ground Water depth (ft) in 2010	Current Ground Water depth (ft)
D.G. Khan	59	72
Layyah	15	23
Rajanpur	37	40
Muzaffargarh	21	33
Average of Division	**33**	**42**

Source: Collected Questionnaire data taken from Agriculture/Irrigation Department

POOR FARM MECHANIZATION

Poor farm mechanization in Dera Ghazi Khan Division poses a multifaceted challenge rooted in the limited adoption of modern agricultural machinery and technology. Despite the region's fertile soil and agricultural potential, farmers face significant barriers in accessing and utilizing advanced farming equipment. The reliance on manual labor persists due to the high cost and limited availability of mechanized tools such as tractors, harvesters, and irrigation equipment. This reliance not only increases production costs but also leads to inefficiencies in farm operations, affecting both the quality and quantity of agricultural output. Furthermore, the absence of mechanization hampers timely planting, irrigation, and harvesting cycles, thereby reducing overall crop yields and profitability for farmers. Addressing the issue requires strategic investments in infrastructure, subsidies for machinery procurement, and training programs to educate farmers on

the benefits of mechanized farming practices. By enhancing farm mechanization, Dera Ghazi Khan Division can unlock its agricultural potential, improve economic outcomes for farmers, and ensure sustainable agricultural growth in the region.

To enhance agricultural productivity and efficiency, it is recommended to invest in specialized machinery for different crop types and farming practices. For small-seeded crops such as sesame, the provision of seed sowing drills, threshers, dehullers, and cleaning machines is essential. In all districts, the introduction of modern spray machines, including drones, is crucial for optimizing orchard management. Additionally, for rhodesgrass cultivation in Jatoi, the acquisition of advanced machinery such as a 180 HP tractor, baler, liner, spreader, and dryer is necessary to improve operations and yield quality.

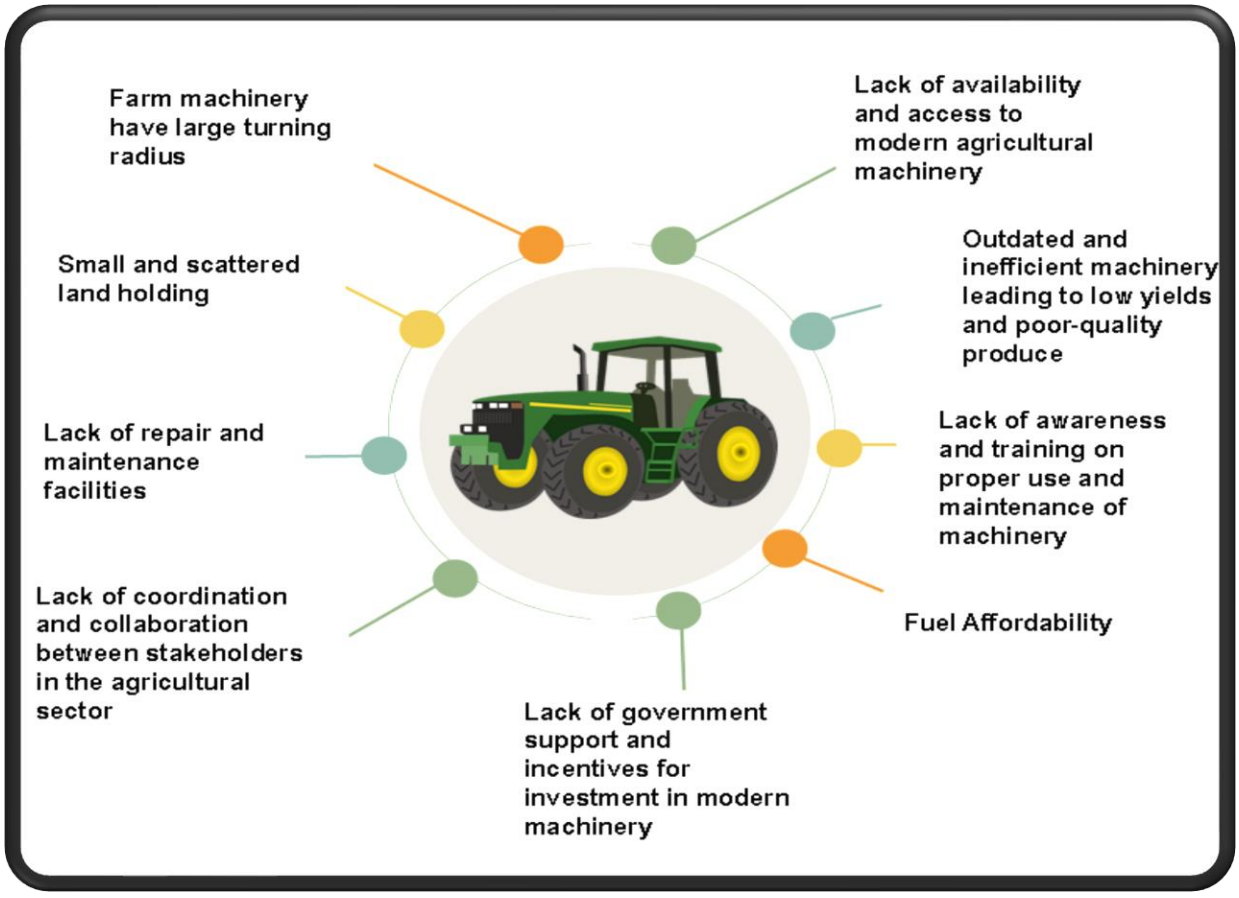
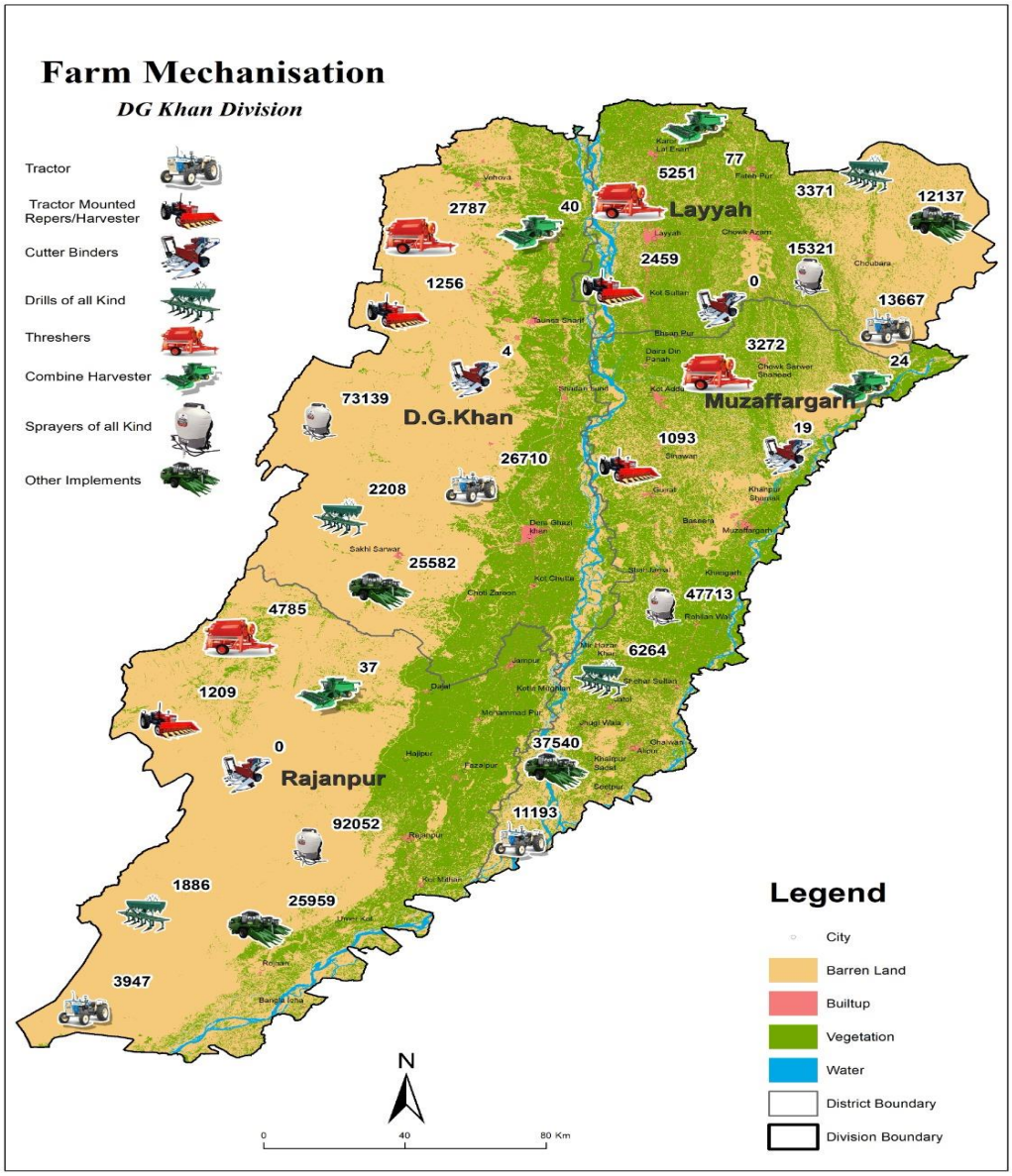


Figure 20: Problems of Poor Farm Mechanization in D.G. Khan Region

Source: Urban Unit



Map II: Poor Farm Mechanization

Source: Punjab Development Statistics (2019)/ Urban Unit

MECHANIZATION GAP IN PUNJAB

The mechanization gap in Punjab's agriculture is significant, with many farmers still using outdated methods due to high costs and limited financing. This reliance on traditional practices reduces efficiency and productivity, especially during peak seasons with labor shortages.

Following table highlights the mechanization gap between Punjab and Indian Punjab, revealing that Punjab has significantly lower coverage of implements such as the chisel plough, rotavator, and disc harrow. To address this gap, it is essential to deploy smart tools and establish service centers in each crop zone to promote mechanization. This also indicates that extension services are insufficient, as many farmers are not aware of modern agricultural practices, including the use of agrochemicals, improved crop varieties, and fertilizers. Enhancing these services and increasing farmer awareness is key to improving mechanization and agricultural productivity in Punjab.

Table 6: Mechanization Gap in Punjab

Implement	**Applicability**	***Punjab*** **(Per 10,000 acres)**	***Indian Punjab*** **(Per 10,000 acres)**	**Existing Coverage As % of Indian Punjab**
Tractors	All Crops	*140*	*295*	*47%*
Chisel Plow	Cotton Sugarcane	*2*	*28*	*8%*
Cultivator	All Crops	*102*	*224*	*46%*
Disc Harrow	All Crops	*5*	*118*	*4%*
Rotavator	All Crops	*14*	*155*	*9%*
Seed Drill	Wheat	*21*	*124*	*17%*
Ridger cum Fertilizer	Sugarcane Cotton	*22*	*56*	*38%*

Source: Punjab Development Statistics (2019)

AVAILABILITY OF MACHINERY

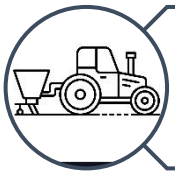
Threshers: There is a relatively low ratio of farmers to threshers, with 48 farmers sharing a single thresher. This indicates limited availability and potentially slower processing of harvested crops.

Self-Propelled Combine Harvester: The ratio of farmers to self-propelled combine harvesters is higher compared to threshers, with 4,362 farmers per machine. This suggests a relatively better availability of this advanced machinery for harvesting purposes.

Tractor Mounted Reapers/Harvester: The ratio of farmers to tractor-mounted reapers/harvesters is 129 farmers per machine. While the availability is better than threshers, it is still relatively limited, indicating potential challenges in harvesting efficiency.

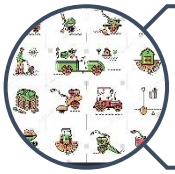
Cutter Binders: With a ratio of 33,756 farmers per machine, the availability of cutter binders seems to be higher compared to other machinery types. This indicates a relatively better provision of equipment for cutting and binding harvested crops.

Sprayers of all Kind: The ratio of farmers to sprayers is 3 farmers per machine. This suggests a relatively low availability of sprayers, which could impact the ability to effectively apply pesticides or fertilizers.



Drills of all Kind: The ratio of farmers to drills is 57 farmers per machine. While not as low as sprayers, the availability of drills for seeding or planting purposes appears to be limited.

Tractor: The ratio of farmers to tractors is 14 farmers per machine. While the availability seems better compared to some other machinery types, it still suggests that access to tractors might be limited for a significant portion of farmers.



Other Implements: The category of "Other Implements" has a ratio of 8 farmers per machine. It encompasses various agricultural implements, indicating a relatively limited availability across different types of equipment.

Table 7: Availability of Machinery in D.G. Khan Division

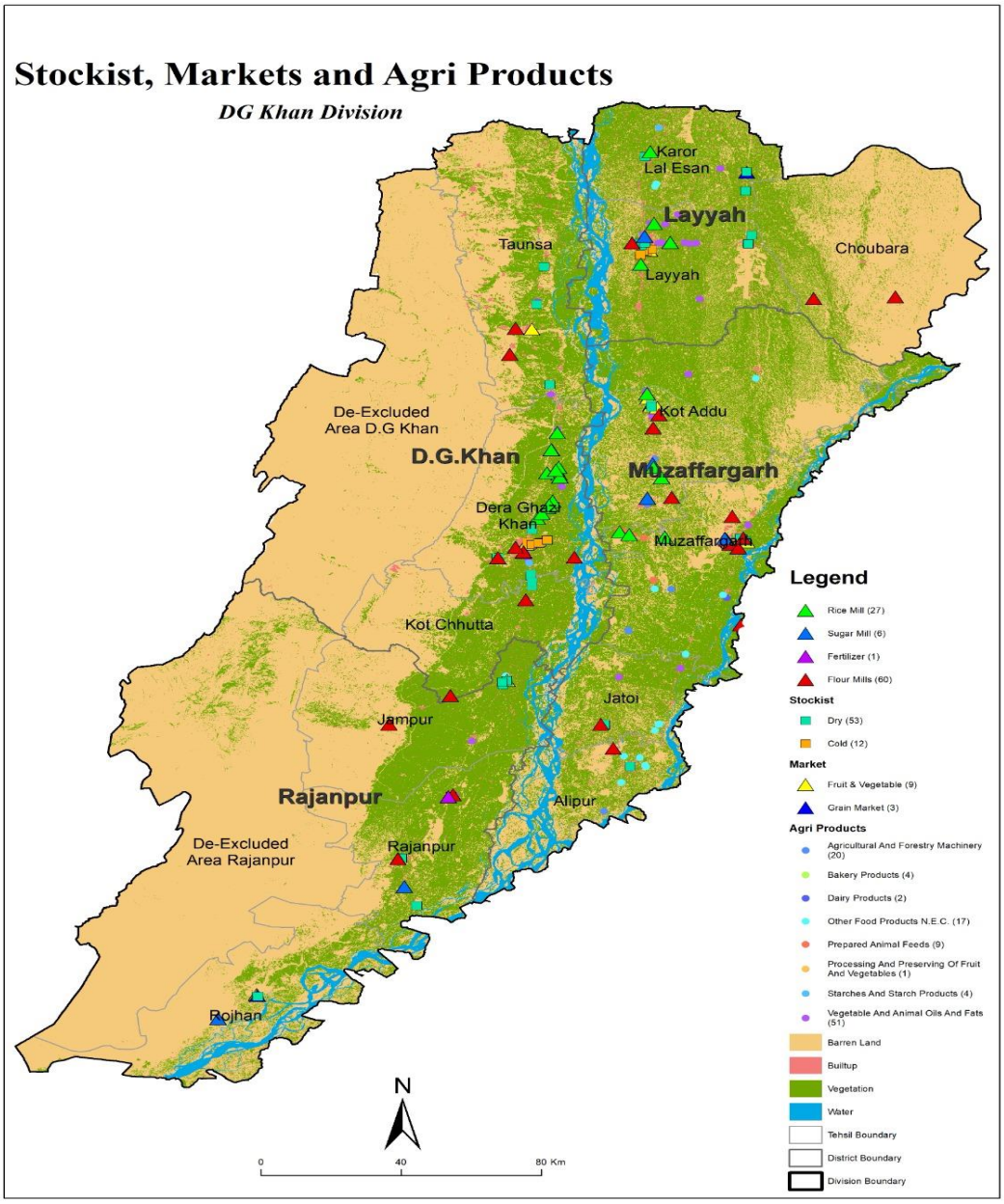
Agriculture Machinery	Farmers/Machine	Acres / Machine
Threshers	48	244
Self-Propelled Combine Harvester	4,362	22,088
Tractor Mounted Reapers/Harvester	129	653
Cutter Binders	33,756	170,939
Sprayers of all Kind	3	17
Drills of all Kind	57	286
Other Implements	8	39
Tractor	14	71

Source: Punjab Development Statistics (2019)

LOW-VALUE ADDITION & EXISTENCE OF TRADITIONAL AGRO-BASED INDUSTRY

The D.G. Khan division shows a vibrant combination of agricultural fertility and industrial potential. Bridging a diverse landscape that includes rice mills, sugar mills, and flour mills, the region plays a pivotal role in the agricultural processing sector. However, alongside these strengths, significant gaps in infrastructure and industrial development are evident. Key challenges include the absence of critical industries like ginning and spinning for cotton, necessary for enhancing value and competitiveness in textiles. Moreover, the division lacks essential facilities such as mango pulp industry, essential for processing and preserving abundant mango harvests effectively. In Rojhan, the absence of a daal preparation unit highlights the need for localized processing infrastructure to maximize pulse cultivation benefits. Furthermore, shortages in dryer and oil extraction units hinder the optimization of agricultural commodities' value chain. Addressing these deficiencies through strategic investments in processing, storage, and grading units for vegetables and oilseeds, along with the establishment of tissue culture facilities for date palms, is crucial for unlocking D.G. Khan Division's full economic potential. District wise detailed distribution of stockiest, markets and agricultural products in D.G. Khan Division is given in following map.

Despite land being purchased for a government mandi in D.G. Khan, it remains unavailable, and the region also lacks a grain market in Jatoi. The grain market construction in Alipur, which began in 1971, has not become operational despite the completion of its structure. Similarly, the mandi approved for Taunsa in 2011 has yet to be established. The existing compatibility of three fruits and vegetables markets with just one grains market does not meet the region's needs, highlighting the necessity for more state-of-the-art storage and markets. There is also a pressing need for markets for crops like Kalwanji and Belongwa, as well as local outlets for vegetables and fruits. The complicated procedure to establish mandis further exacerbates these challenges, hindering the development of essential agricultural markets in the region.



Map III: Agro-Industry in D.G. Khan Division

Source: Urban Unit

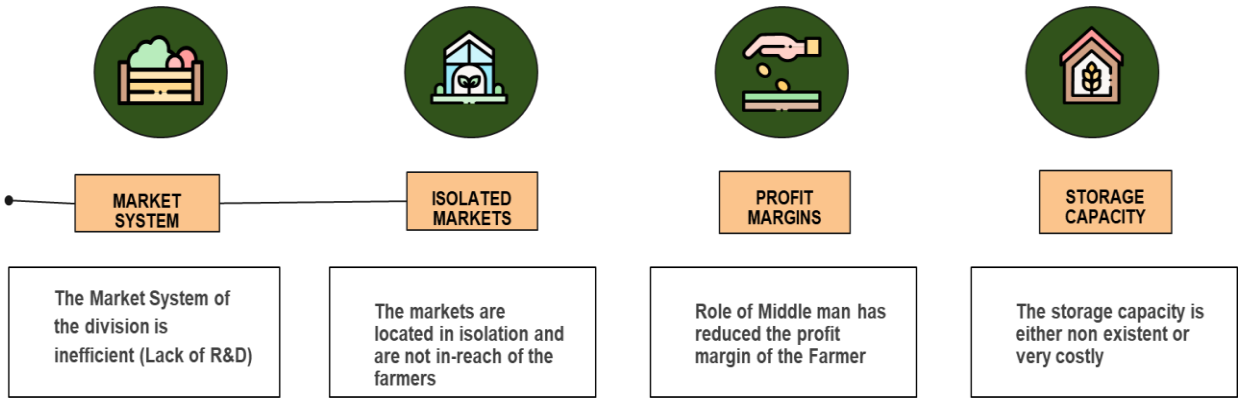
REASONS FOR INEFFICIENT AGRICULTURAL MARKETS

The agricultural markets in Dera Ghazi Khan Division suffer from several systemic inefficiencies primarily due to a lack of research and development (R&D) initiatives. Firstly, the markets are geographically isolated and often inaccessible to farmers, impeding their ability to efficiently transport and sell their produce. This isolation exacerbates the role of middlemen, who capitalize

on the fragmented market structure to negotiate lower prices, thereby reducing the profit margins of farmers. Additionally, inadequate storage facilities further compound these challenges; either non-existent or prohibitively expensive, they fail to accommodate seasonal surpluses or stabilize prices effectively. As shown in the table below, crop prices fluctuate significantly, reflecting the unstable and inefficient market dynamics within the D.G. Khan region.

Table 8: Difference between Farm gate, Retail & Wholesale Prices of Essential Food Commodities

Commodity	Farm gate price (PKR/kg)	Wholesale Market (PKR/kg)	Retail Price (PKR/kg)
Chilli (Green)	30	75	110
Mango	120	150	190
Onion	60	110	150



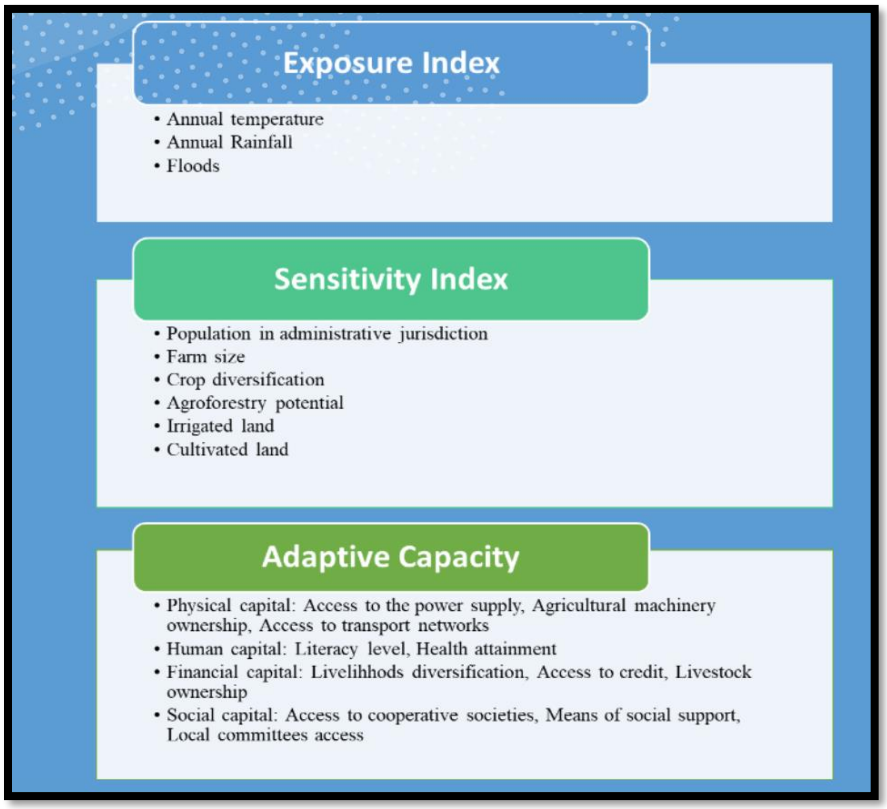
AGRICULTURAL VULNERABILITY TO CLIMATE CHANGE

The article by Nadeem et al., (2022) examines the agricultural vulnerability to climate change across districts in Punjab province and identifies the significance of adaptive capacity in mediating district-level vulnerabilities. The findings highlight the need for policies that prioritize building adaptive capacity in vulnerable regions of Punjab and suggest that a one-size-fits-all adaptation policy that does not account for local variations in the causes of vulnerability is unlikely to be effective. The study employs a livelihoods approach and statistical associations to identify factors

that shape adaptive capacity, such as human, financial, and social capital, and underscores the importance of effective government policies in supporting such factors. To inform top-down policy initiatives, there is a need to integrate climate change policies with general economic and social development policies in Punjab, with a focus on socio-economic aspects that account for place-based biophysical features and local-scale information.

VULNERABILITY INDEX OF AGRICULTURE IN THE D.G. KHAN DIVISION

The assessment of the vulnerability of agriculture includes the following variables in the respective dimension in the D.G. Khan division:



$$\text{Vulnerability Index (V)} = f\,(PI - AC)$$

Where, Potential Impact (PI) = exposure + sensitivity

Adaptive capacity (AC)

Table 9: Vulnerability indexes of all districts of DG Khan Division

Indicators	D.G. Khan	Layyah	Rajanpur	Muzaffargarh
Exposure Index	(0.40 - 0.59)	(0.40 - 0.59)	(0.80 - 1.00)	(0.80 - 1.00)
	Moderate Exposure	Moderate Exposure	Very High Exposure	Very High Exposure
Sensitivity Index	(0.40 – 0.59)	(0.20 – 0.39)	(0.40 – 0.59)	(0.20 – 0.39)
	Moderate Sensitivity	Low Sensitivity	Moderate Sensitivity	Low Sensitivity
Adaptive Capacity Index	(0.00 – 0.19)	(0.20 - 0.39)	(0.00 - 0.19)	(0.20 - 0.39)
	Very Low adaptive capacity	Low Adaptive capacity	Very Low Adaptive capacity	Low Adaptive capacity
Vulnerability index	(0.60 - 0.79)	(0.40 - 0.59)	(0.80 - 1.00)	(0.80 - 1.00)
	High Vulnerability	Moderate Vulnerability	Very High Vulnerability	Very High Vulnerability

Source: (Nadeem et al., 2022)

8. CLIMATE SMART AGRICULTURE

Global warming is an indisputable scientific fact indicated by decades of meteorological observations. Greenhouse gas (GHG) emitted by human activities traps heat in the atmosphere, leading to increases in global average temperature, and consequently global climate change. Climate smart agriculture (CSA) commit to transform and reposition agricultural development to meet the climate change challenges. The CSA framework provides a platform for assessing how livelihood assets operate and how they are affected by policy processes and structures, as well as the technologies needed for restorative agricultural transformation. CSA seeks to intensify linkages among global, national, and local agricultural stakeholders by accelerating cross-scale adaptation and mitigation synergies. Therefore, CSA presents a triple win effect, which can

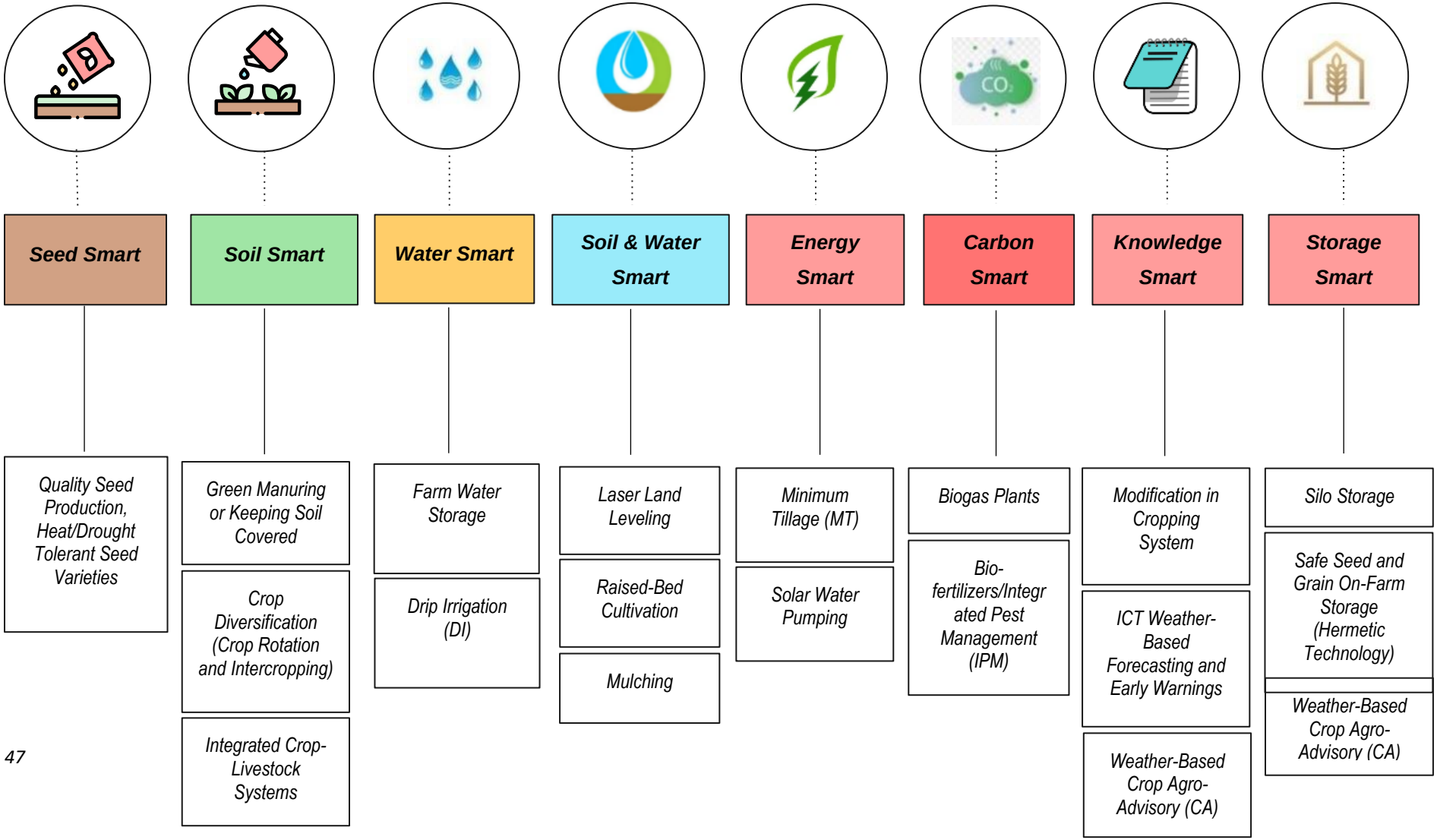
continuously improve agricultural production capacity, income, and adaptability to climate change, reduce and even eliminate GHG emissions, and thus promote the realization of national food security and sustainable development goals, providing a solution concept for the problems faced by global agricultural development. The development of CSA in the future will carry the sustainable development of agriculture forward and achieve the multiple goals of food security, climate adaptation, and GHG emission reduction. Improvement of cropping patterns and management techniques contributes to the realization of CSA in the future.

To improve agriculture, it is essential to adopt a comprehensive approach. This involves implementing regulatory reforms, investing in infrastructure, educating and training farmers, promoting sustainable farming practices, investing in research and development, and fostering partnerships between the government and private sector. However, some challenges must be overcome, such as inefficient crop clusters, lack of innovation, and ineffective marketing. To address these challenges, it is necessary to take a comprehensive approach that includes investing in infrastructure, adopting new technologies and best practices, and creating supportive policies that promote sustainable agriculture.

8.1. IDENTIFIED TECHNOLOGIES AND PRACTICES FOR CSA

The diagram below highlights the identified technologies and practices for Climate-smart agricultural plan of D.G. Khan Division.

Figure 21: Identified technologies and practices for Climate-smart agricultural plan of D.G. Khan Division



9. PRODUCTIVITY COMPARISION OF AGRICULTURE SECTOR

Agricultural productivity varies widely due to factors like climate, soil quality, technology, and practices. Developed countries generally have higher productivity due to advanced technologies, efficient irrigation, and genetically modified crops. In contrast, developing countries often face lower productivity due to limited access to modern equipment and infrastructure. Government policies and investment in agricultural research significantly impact productivity, with developed countries achieving high output through substantial subsidies and funding.

9.1. CROP YIELD

Following graph shows the yield performance of different crops in D.G. Khan Division is compared with benchmarks set by progressive farmers and global best practices. Each crop is represented by bars showing the yield achieved in D.G. Khan Division, alongside yields achieved by progressive farmers and world best practices.

For instance, in the case of chillies, farmers in D.G. Khan achieved a yield of 182 monds per acre, while progressive farmers achieved 300 monds per acre, and the world best yield was 700 monds per acre. This comparison underscores a significant productivity gap in chilli production between D.G. Khan Division, progressive farmers, and global benchmarks.

Similar patterns are observed across other crops such as onion, citrus, mango, sunflower, sesamum, rapseed and cotton. These differences can be attributed to varying levels of adoption of modern agricultural practices, disparities in soil fertility, and local climate conditions.

To enhance crop yields across all crops, D.G. Khan Division should focus on improving irrigation efficiency, adopting advanced farming technologies, and promoting soil health management practices. By aligning local agricultural practices with global best practices, the region can potentially narrow the productivity gap, achieve higher yields, and contribute more significantly to its economic growth through agriculture.

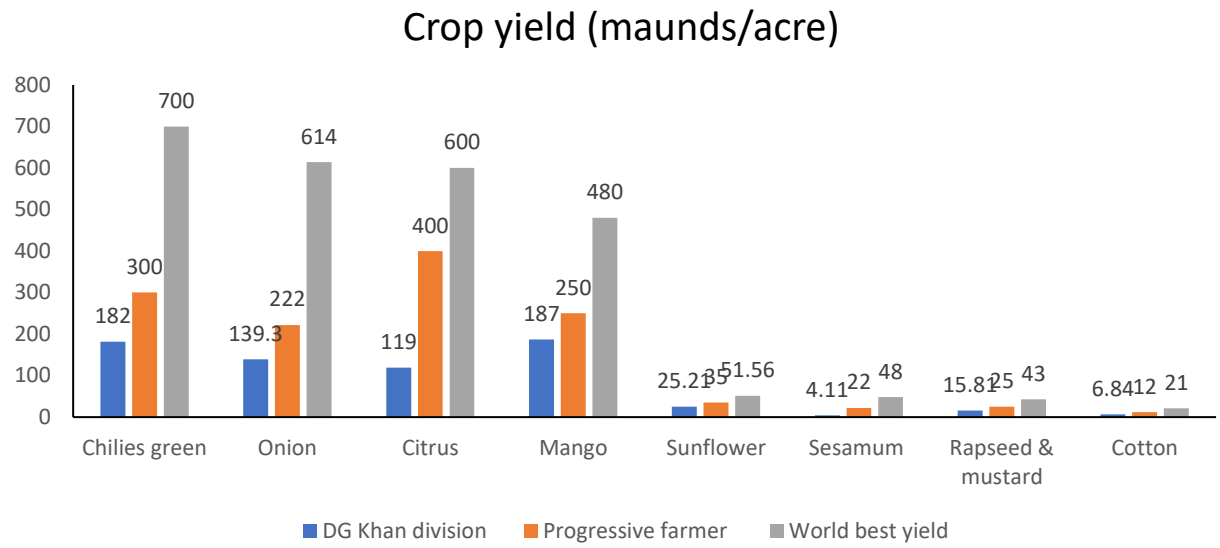


Figure 22: Yield Comparisons (Munds/Acre)

Source: FAO and Crop Reporting Service

10. AGRO-ECOLOGICAL CONDITIONS

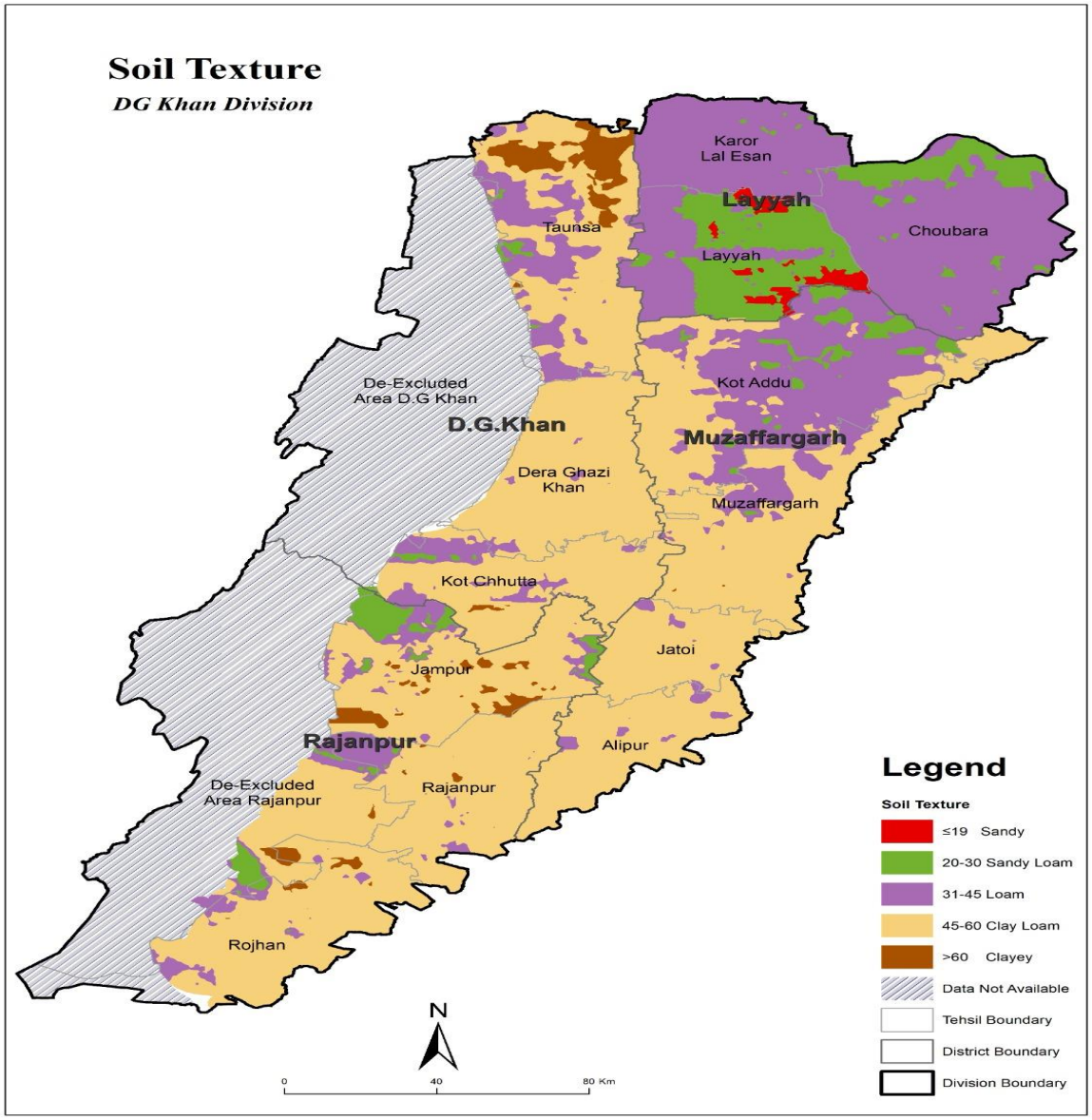
Climate stands as a critical factor significantly impacting vegetation, soil quality, and water reservoirs. The evolving climate is expected to heighten the susceptibility of agricultural systems (Rosenzweig et al., 2013), primarily due to rising temperatures, alterations in rainfall distribution, and an increased occurrence of extreme weather phenomena globally (IPCC, 2014). Pakistan has notably experienced evident shifts in its weather patterns (Ahmad et al., 2015). Consequently, this climate change and variability have had repercussions on crop production and could potentially drive changes in cropping patterns within certain districts of the D.G. Khan division.

Consequently, the urban unit has identified different Agro-ecological zones in the D.G. Khan division based on Agro-climatic and Edaphic variables through which crop zoning has been identified;

- Identified suitability of crops in AEZs for sustainability.
- Assessment of Agro-economic performance in delineated agro-ecological zones.

Dera Ghazi Khan is situated on the western bank of the Indus River which is primarily composed of sandy, sandy loam, loam, clay loam and clayey soil. The exact soil texture in the region can vary depending on the specific location, as well as the type of crop being grown.

The soil texture map of D.G. Khan Division categorizes the region into different soil types based on their composition and characteristics. Sandy soils are prevalent in certain areas, known for their low organic matter content and excellent drainage properties, suitable for crops that thrive in well-drained conditions. Sandy loam soils, found in other parts of the division, offer a balanced mix of sand and silt, providing moderate drainage and nutrient retention capabilities. Loam soils, characterized by a mixture of sand, silt, and clay, are fertile and versatile, supporting a wide range of agricultural crops. Clay loam soils, with a higher clay content, have good water retention but can be prone to compaction. Finally, clayey soils are heavy and retain water well, suitable for crops requiring consistent moisture levels.

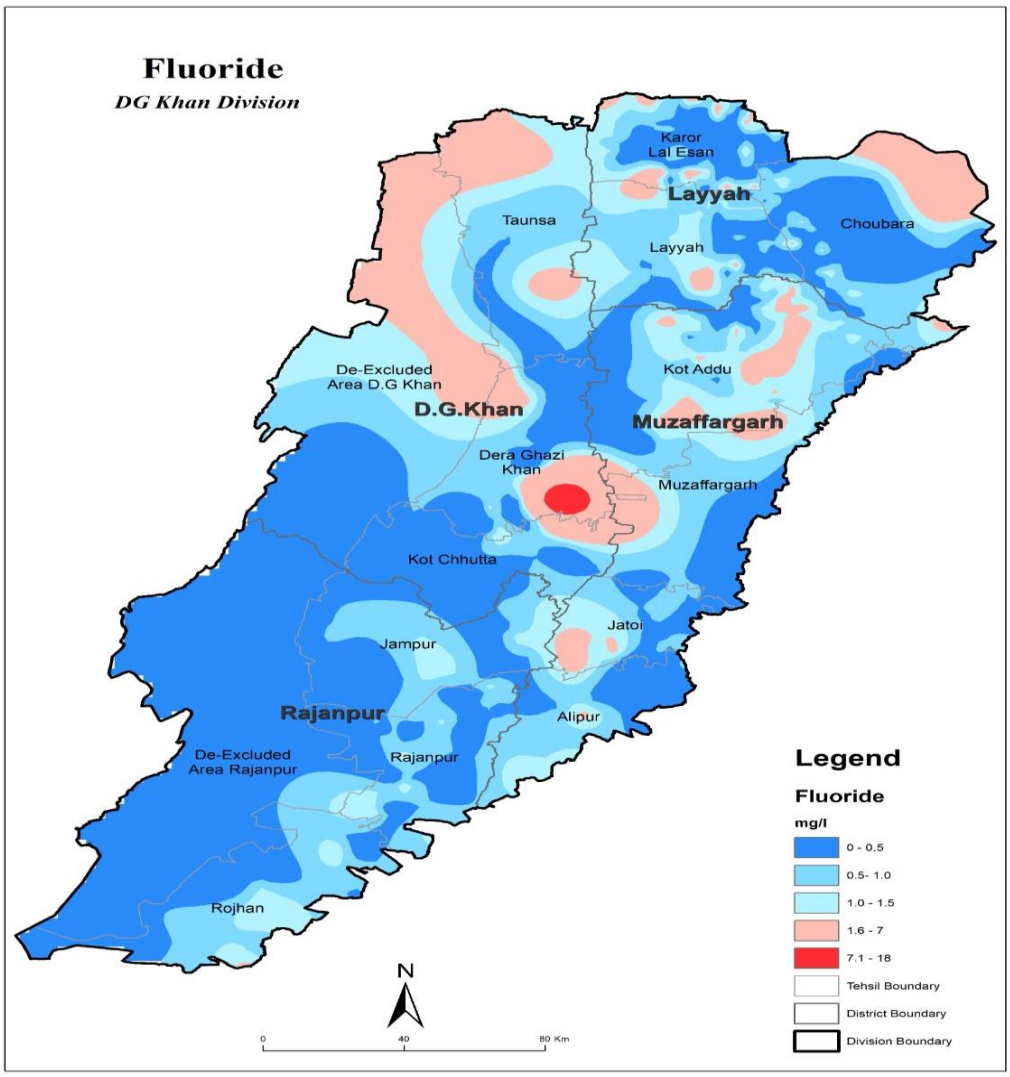


Map IV: Soil Texture of D.G. Khan Division

Source: Urban Unit

Fluoride content is one of the major pollutants in groundwater, and a high concentration of fluoride in groundwater is reported in many countries (Craig et al., 2015). The World Health Organization (2011) reported that high concentrations of fluoride and other potentially toxic elements of health concerns have rendered many groundwater sources unsuitable for drinking purposes in different parts of the world (Xiao et al., 2022). According to the WHO, the permissible limit for fluoride concentration in groundwater is < 1.5 mg/L. The concentration

of fluoride in groundwater in the D.G. Khan division of Pakistan can vary depending on the specific location and geological conditions.



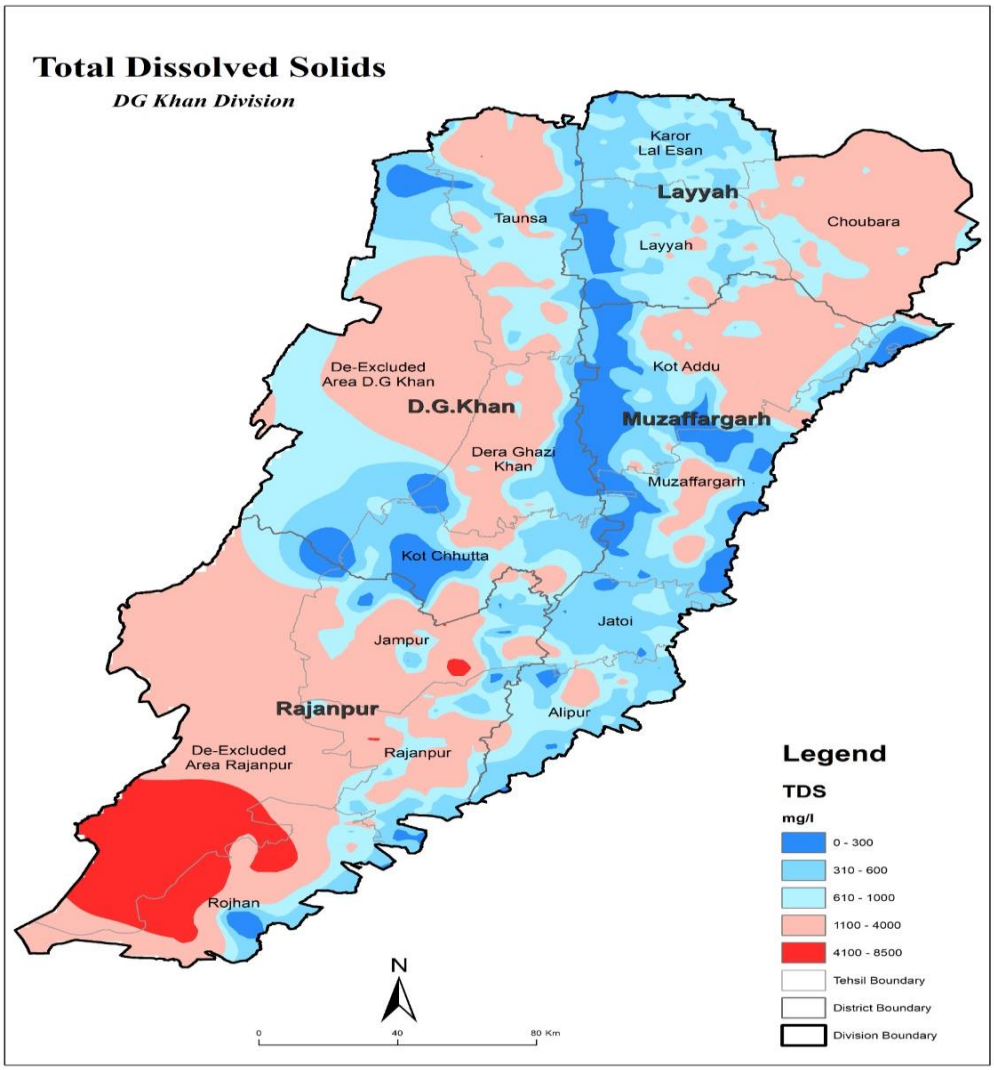
Map V: Total Water Availability

Source: The Urban Unit

TDS is a known physical water quality parameter [Adjovu et al.,2023], categorized by the United States Environmental Protection Agency (US EPA) in its secondary drinking water regulations (SDWRs) with an allowable limit in drinking water set to 500 mg/L [Adjovu et al.,2023]. These SDWRs are described as nonenforceable federal guidelines that cause cosmetic and aesthetic effects. Cosmetic effects include skin or tooth discoloration while aesthetic includes tastes, color [Mejía et al., 2022]. High levels of TDS in the water can cause

scaling and corrosion of cooling systems and boilers. TDS levels in the water are influenced by natural sources, urban runoff, industrial and municipal waste, and chemicals used in water treatment [Hach Solids, 2023]. Other sources of TDS in water bodies include mineral dissolution, desorption of ions, sediments, atmospheric precipitation, chemical, and biological occurrences, and processes including pH, organic carbon, temperature, and rock decomposition [Butler and Ford, 2018].

Groundwater in the D.G. Khan division of Pakistan can contain varying levels of TDS, which is shown in following map:

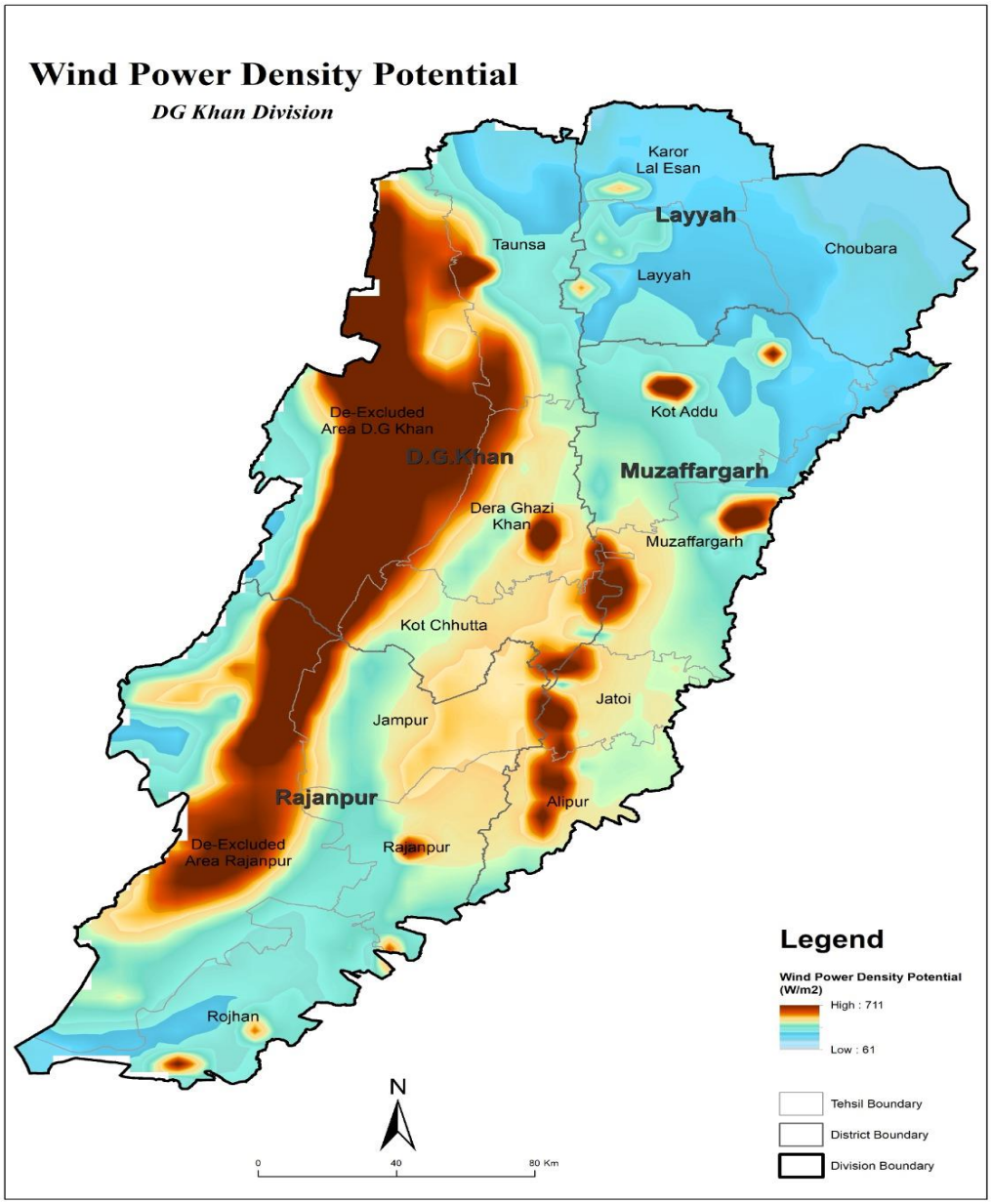


Map VI: Groundwater (TDS)

Source: Urban Unit

The spatial distribution of weather station data points is used in the regional plan. The weather stations used for the collection of weather data include wind power, average yearly temperature, and solar irradiance.

Following map displays the observed wind power density potential (W/m2) in the D.G. Khan region, varying from a high of 711 to a low of 61 density potential.

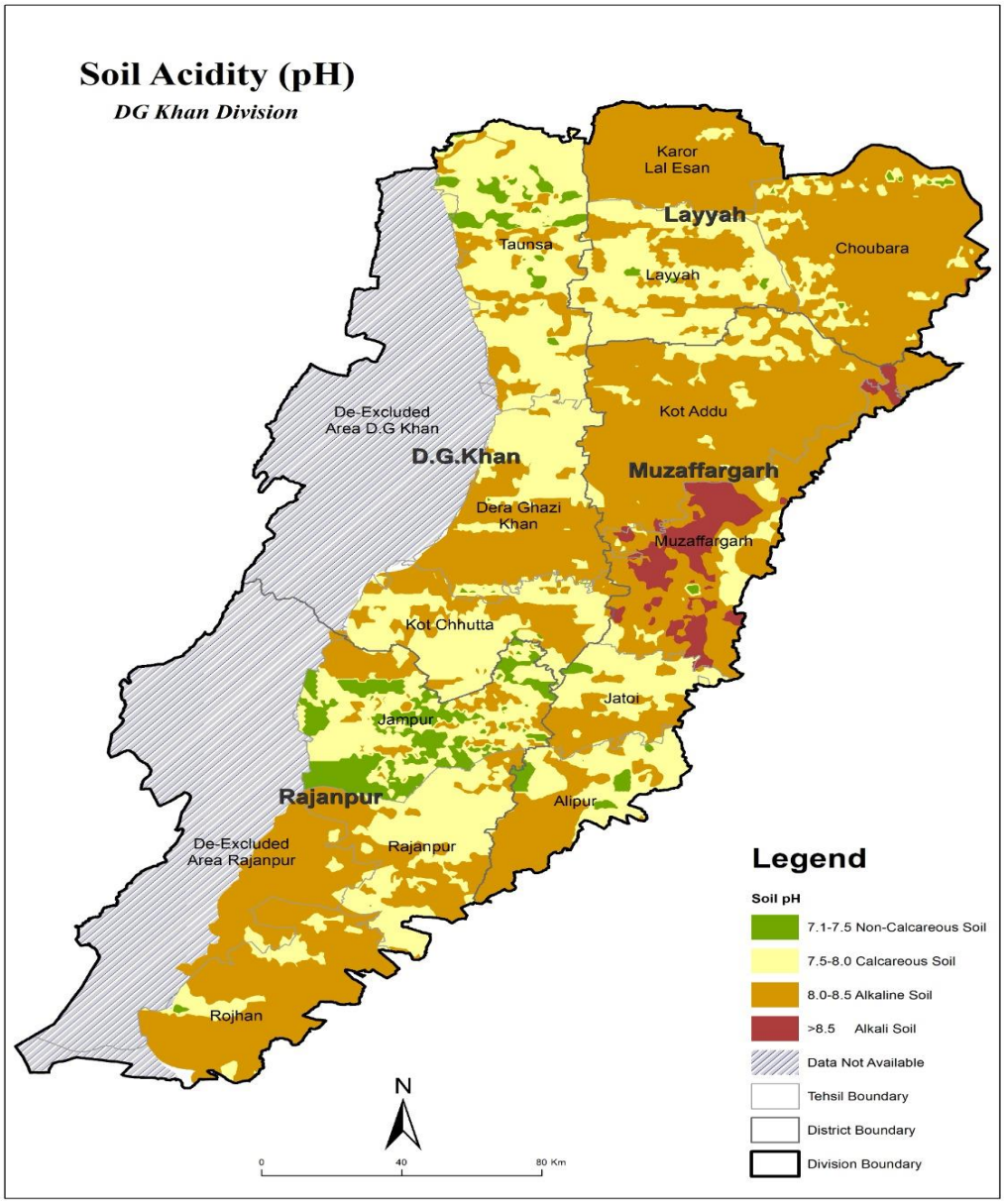


Map VII: Wind Power

Source: Urban Unit

In the natural environment, the pH of the soil has an enormous influence on soil biogeochemical processes. Soil pH is, therefore, described as the "master soil variable" that influences myriads of soil biological, chemical, and physical properties and processes that affect plant growth and biomass yield [Minasny et al., 2016]. Soil pH is compared to the temperature of a patient during medical diagnoses because it readily gives a hint of the soil condition and the expected direction of many soil processes (lecture statement, Emeritus Prof. Eric Van Ranst, Ghent University). For instance, soil pH is controlled by the leaching of basic cations such as Ca, Mg, K, and Na far beyond their release from weathered minerals, leaving H^+ and Al^{3+} ions to dominant exchangeable cations; the dissolution of CO_2 in soil water producing carbonic acid, which dissociates and releases H^+ ions; humic residues from the humification of soil organic matter, which produces high-density carboxyl and phenolic groups that dissociate to release H^+ ions; nitrification of NH_4^+ to NO_3^- produces H^+ ions; removal of N in plant and animal products; and inputs from acid rain and N uptake by plants [White, 2006].

Soil pH significantly influences nutrient availability, microbial activity, and soil structure. Essential nutrients like nitrogen, phosphorus, and potassium are most accessible at a soil pH of 6.0 to 7.0, with availability decreasing outside this range, leading to potential nutrient deficiencies (Zhang et al., 2016). Microbial activity thrives between pH 6.0 and 7.5, and deviating from this range reduces soil health (Dong et al., 2017). Soil structure is optimal at a pH of 6.0 to 7.0, and extremes in pH can lead to erosion and diminished water-holding capacity (Brevik & Burgess, 2014). The Soil pH in D.G. Khan Division, indicating specific ranges (7.1 to 8.5) as outlined below in map.



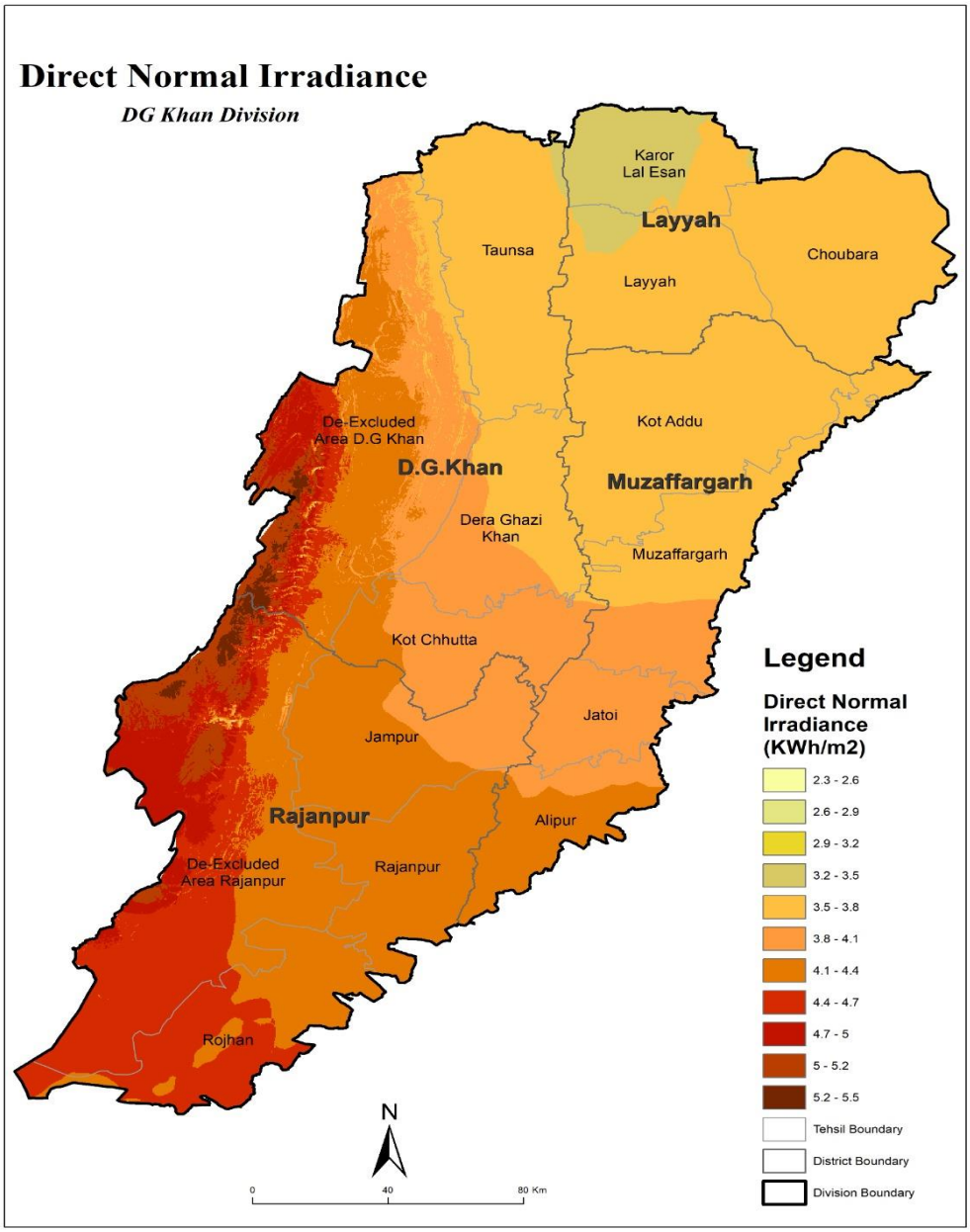
Map VIII: Soil pH

Source: Urban Unit

Direct normal irradiance (DNI) is the amount of solar radiation intercepted per unit area of a surface, which is held at right angles to the rays that propagate in a straight line from the sun at its instantaneous position in the sky. However, the position of the sun varies with time. In view of this, the surface has to be mounted on a solar tracking system. In this case, the surface follows the sun on daily (one-axis) or daily and seasonal (two-axis) basis to maintain normal incidence of the beam radiation.

The amount of direct solar normal irradiance received in the D.G. Khan division of Pakistan can vary depending on several factors, including the time of year, the latitude of the area, and the weather conditions. Dera Ghazi Khan is located at 30'03" N and 70'38" E. . These coordinates cover various areas within the division, experiencing similar climatic conditions with hot and dry summers and relatively cool winters.

DNI values for the D.G. Khan Division can vary based on specific locations and seasonal changes. On average, DNI values in this region range between 2.3 to 5.5 kWh/m² per day. However, actual irradiance levels are influenced by local weather conditions, such as cloud cover, atmospheric stability, air pollution, and the orientation and tilt of receiving surfaces.



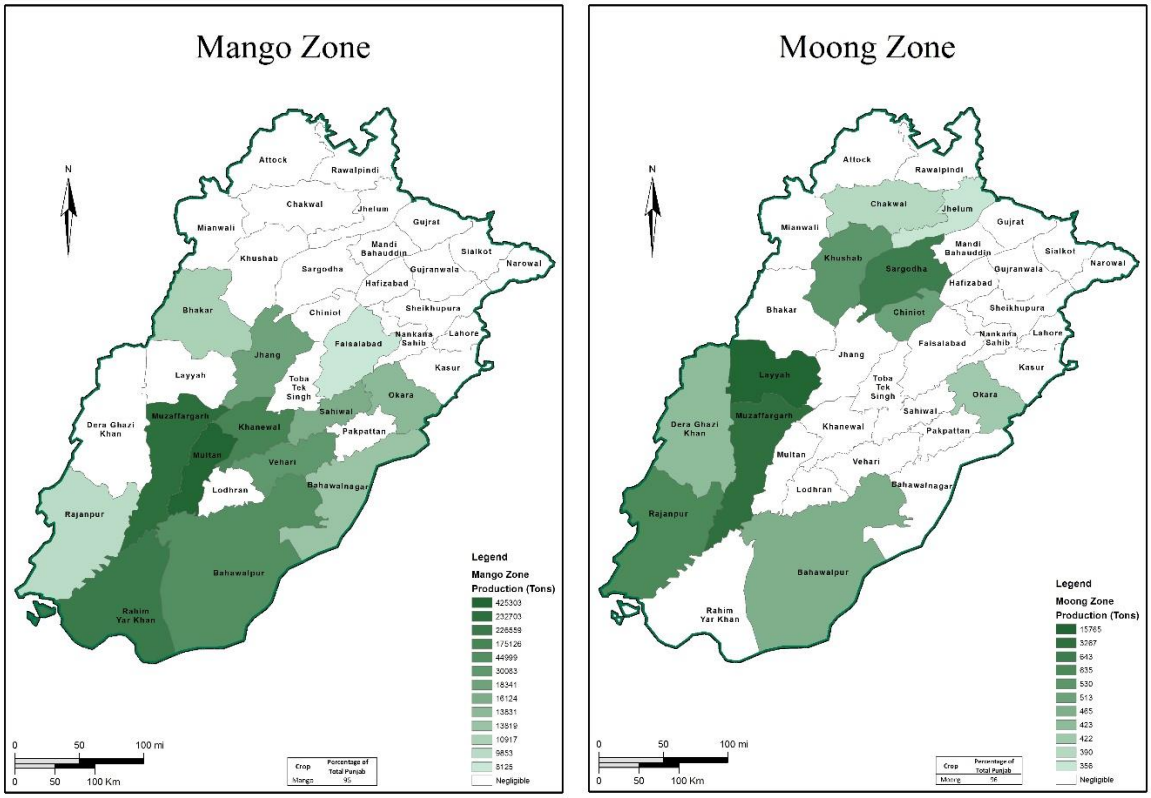
Map IX: Solar Irradiance

Source: Urban Unit

11. PRODUCTION ANALYSIS

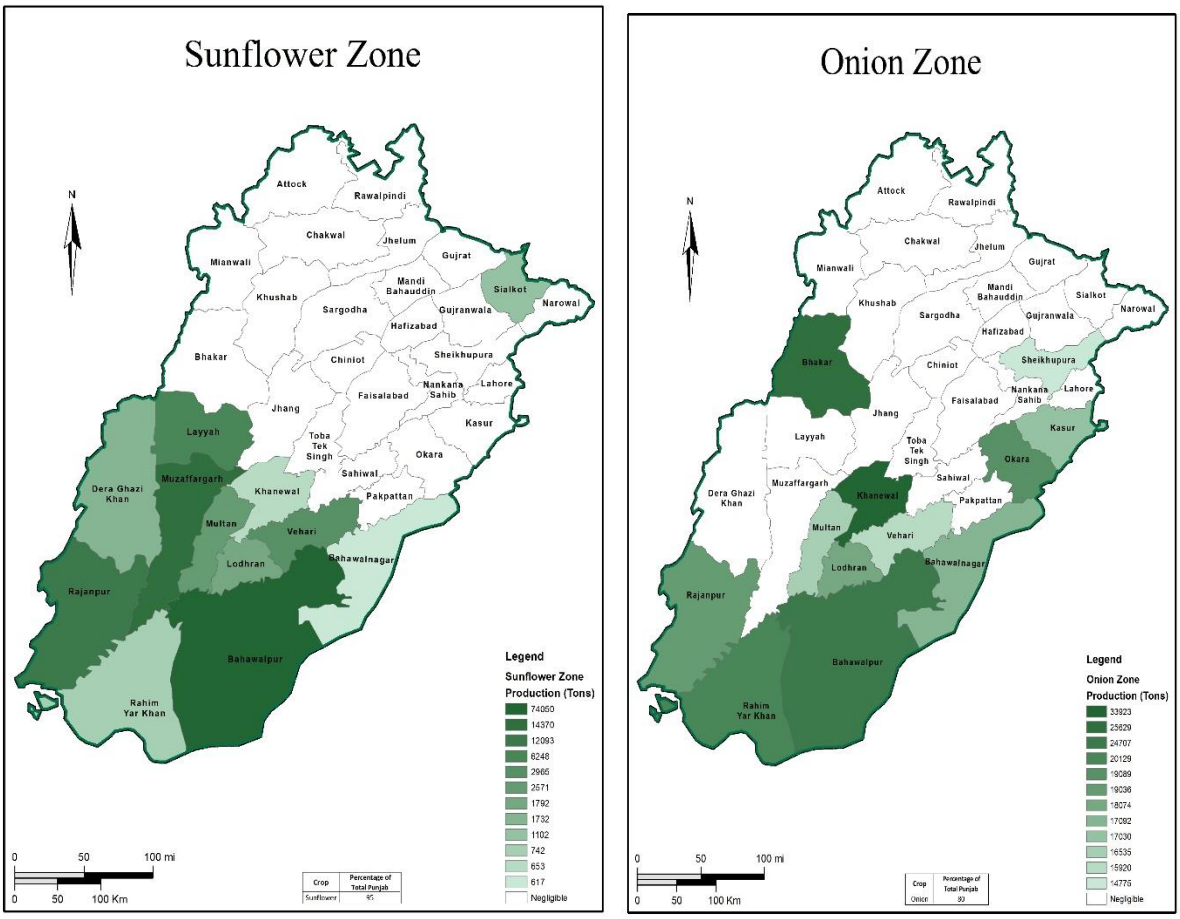
The potential crops zone based on these agroecological conditions is shown on the map (figure 16). These zones are identified based on comparative advantages in yield, production, and agroecological conditions.

11.1. PRODUCTION AREA MAPPING



Map X: Production Area Mapping (Mango and Moong zones)

Source: Urban Unit



Map XI: Production Area Mapping (Sunflower and Onion Zones)

Source: Urban Unit

12. WAY FORWARD

The agriculture sector is vital for ensuring food security and driving the growth of other economic sectors. Currently, the D.G. Khan region requires a high-priority focus on sustainable agricultural growth and the implementation of appropriate interventions to achieve optimal results. Enhancing the Rabi and Kharif cropping patterns in D.G. Khan is essential to improve agricultural output and provide capacity-building training for farmers. Emphasis should be placed on using high-quality seeds and modern technologies to enhance agricultural productivity and ensure food security.

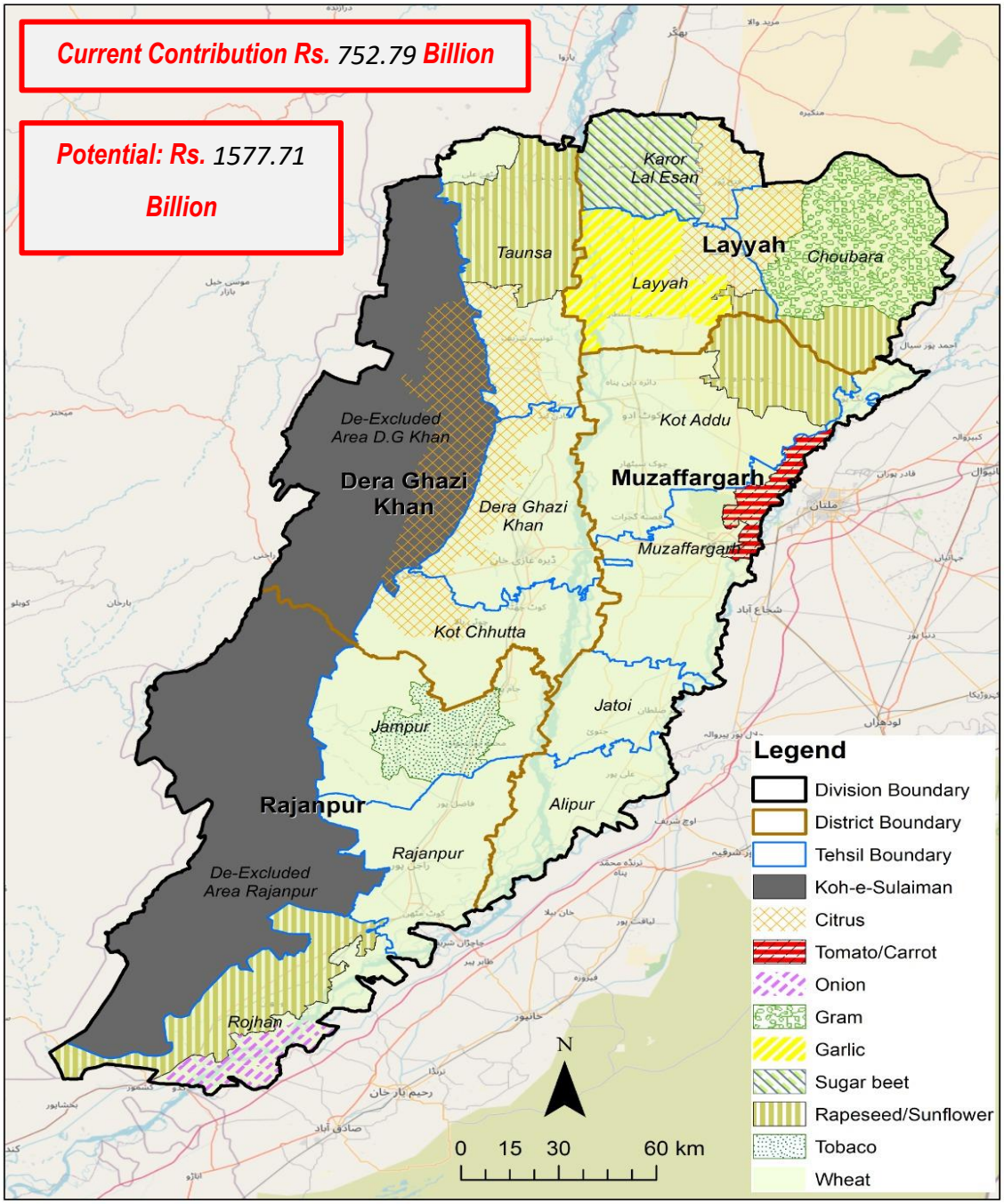
13. PROPOSED CROPPING PATTERN

Based on the agro-ecological conditions, production, yield, value, and logistics analysis, 17 crops are recommended for both the Rabi and Kharif seasons in the D.G. Khan Division. For the Rabi season, the recommended crops include citrus, tomato, carrot, onion, gram, garlic, sugar beet, rapeseed, sunflower, tobacco, and wheat. These crops have been identified based on their suitability to the region's climate and soil conditions, as well as their economic value and potential yield. The map highlights specific clusters within D.G. Khan where each of these crops can be cultivated most effectively.

In the Kharif season, the recommended crops are date palm, olive, moong, chilies, mango, and cotton. These crops were chosen for their adaptability to the hot and humid conditions typical of the Kharif season and their significant contribution to the region's agricultural economy. The map outlines designated areas within the division where these crops are best suited for cultivation.

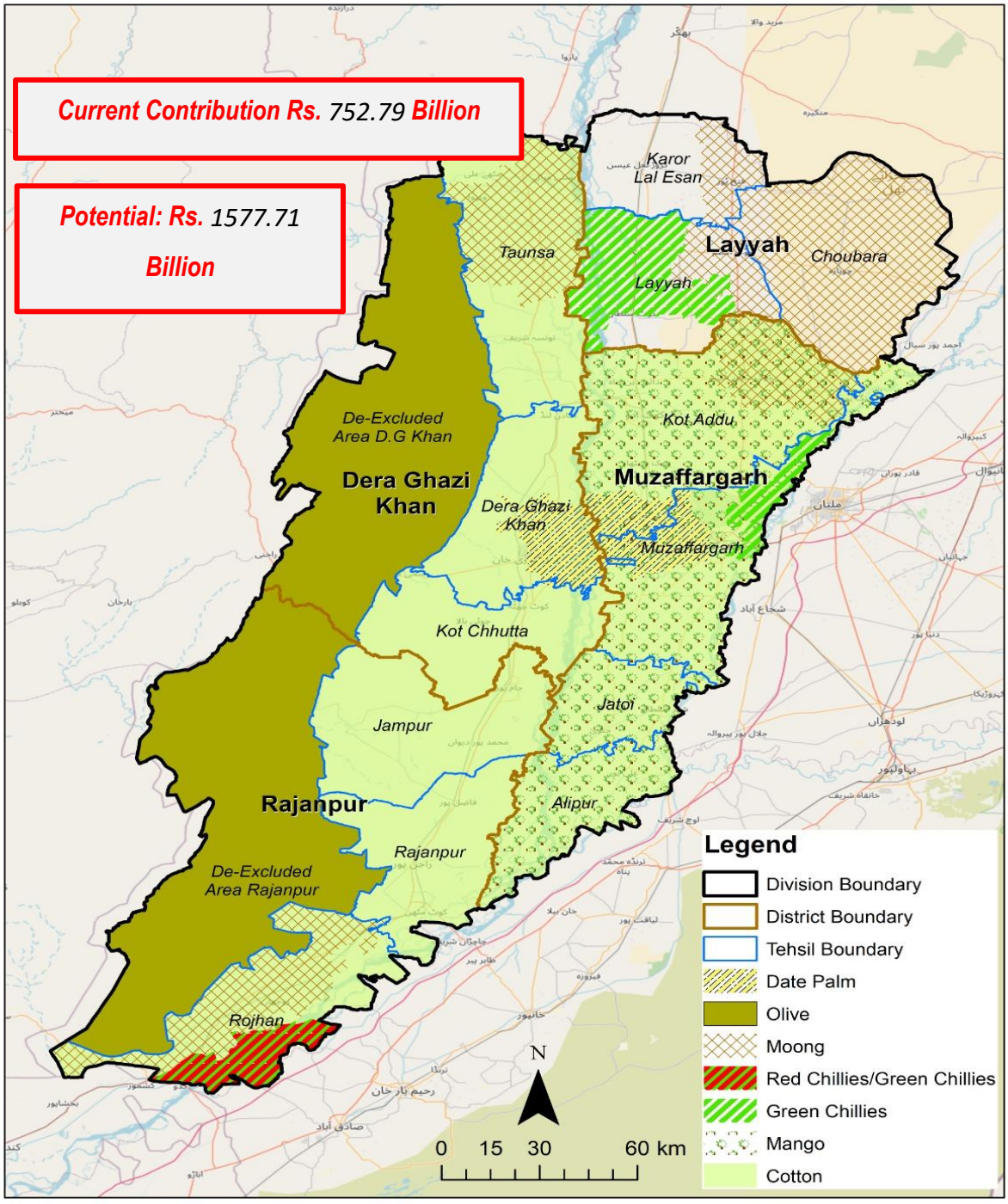
By focusing on these 17 crops across both seasons, the proposed value chains aim to optimize agricultural production and enhance the economic stability of farmers in the D.G. Khan Division. The current contribution of the Rabi and Kharif season crops is Rs. 752.79 billion, with a potential to reach Rs. 1577.71 billion.

These strategic recommendations ensure that each crop is cultivated in areas where it can thrive, leading to improved yields, better resource utilization, and increased profitability for the farming community.



Map XII: Proposed Cropping Pattern of Rabi Crops

Source: Urban Unit



Map XIII: Proposed Cropping Pattern of Kharif Crops

Source: Urban Unit

14. VALUE CHAIN ANALYSIS

A value chain is a set of linked activities that work to add value to a product; it consists of actors and actions that improve a product while linking commodity producers to processors and markets.

Value chains work best when their actors cooperate to produce higher-quality products and generate more income for all participants along the chain, as opposed to the simplest kinds of value chains, in which producers and buyers exchange only price information — often in an adversarial mode. Value chains differ from supply chains, which refer to logistics: the transport, storage and procedural steps for getting a product from its production site to the consumer.

The agricultural value chain concept has been used since the beginning of the millennium, primarily by those working in agricultural development in developing countries. Although there is no universally accepted definition of the term, it normally refers to the whole range of goods and services necessary for an agricultural product to move from the farm to the final customer or consumer. Similarly, an agricultural value chain is defined as the people and activities that bring a basic agricultural product like maize or vegetables or cotton from obtaining inputs and production in the field to the consumer, through stages such as processing, packaging, and distribution.

Following value chains of the recommended crops in this region are discussed below.

14.1. SESAME

Sesame (Sesamum indicum L.) is regarded as an important oilseed crops. Owing to its high quality oil besides high content of protein (22.0%) it is described as the queen of oil crops. Its oil content ranges from 50-58%. It is cultivated in hot, dry climates for its oil and protein-rich seeds. In addition to raw food and confectionary purposes, sesame seeds are used in sweets and bakery products, as well as soaps, perfumes, vegetable oil and in carbon paper as well.

WORLD LEADING SESAMUM PRODUCING COUNTRIES

The graph showcases Sudan as the world's leading sesamum producer with 1.23 million tons, followed by India with 0.70 million tons, and Pakistan with 0.15 million tons. India remains a

major player due to its efficient farming practices and government support, while Pakistan, though producing less, continues to contribute to the global sesame market.

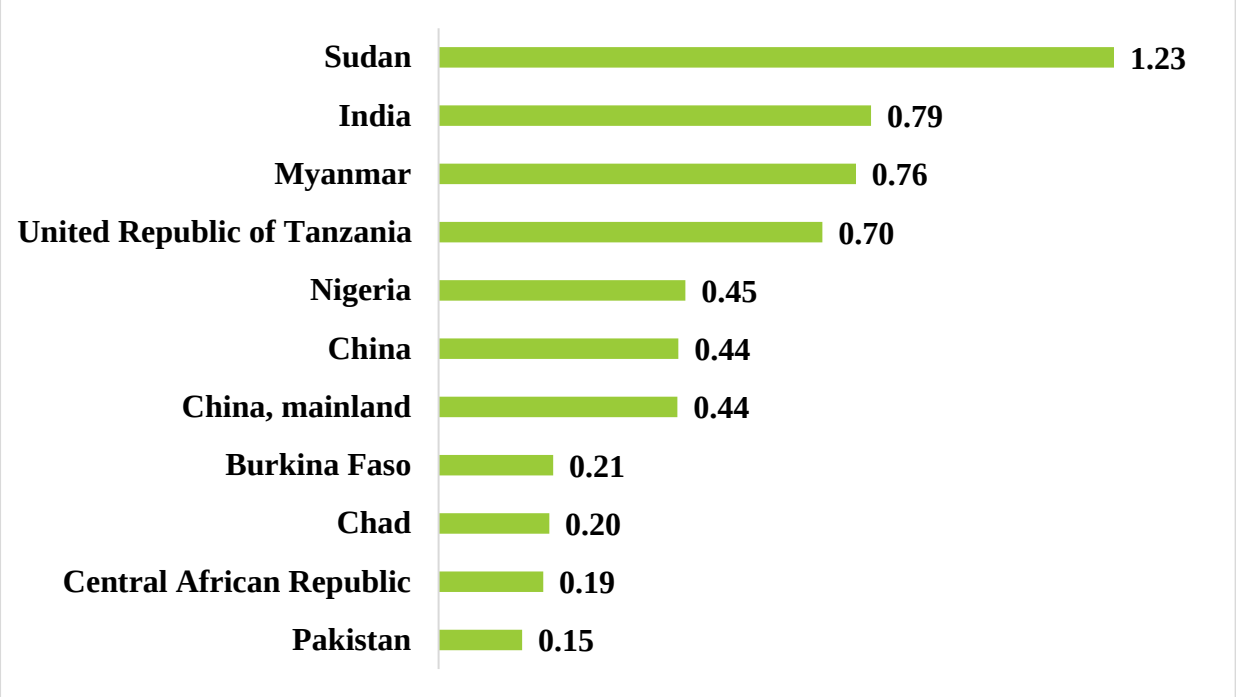


Figure 23: World Leading Sesamum Producing Countries (Million Tons)

Source: Trade Map, 2022-23

14.1.1.1. WORLD LEADING SESAMUM EXPORTING COUNTRIES

The graph clearly illustrates that Sudan is the world's leading sesamum exporter with an export volume of 356,643 tons. Nigeria follows closely with 297,022 tons, and Pakistan exports 96,410 tons. Sudan's dominance in the sesamum export market is a result of its high production levels and efficient export infrastructure. Nigeria, while slightly behind Sudan, is a significant player due to its considerable export volume. Pakistan, although exporting less, still holds an important position in the global sesamum trade.

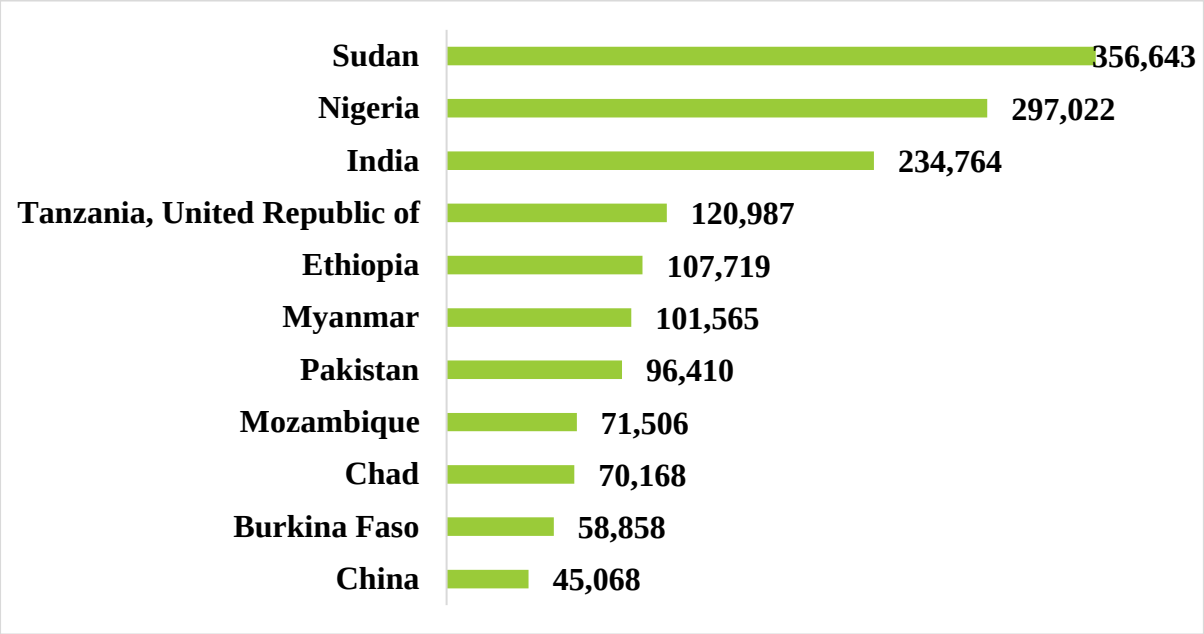


Figure 24: World leading Sesamum Exporting Countries (Tons)

Source: Trade Map, 2022-23

WORLD LEADING SESAME IMPORTING COUNTRIES

The graph shows the top countries importing sesame seeds. China is the biggest importer, needing large amounts for making sesame oil and for cooking. Turkey is the second largest, using sesame seeds in many traditional dishes. Other major importers include Japan, South Korea, and Iran, where sesame seeds are popular in the food industry.

Figure 25: World Leading Sesame Importing Countries (Tons)

Source: Trade Map, 2022-23

SESAMUM EXPORT STATUS IN INTERNATIONAL MARKET

The line graph shows that Pakistan's sesame exports peaked in 2021, reflecting a significant increase in global demand. This peak likely resulted from higher sesame yields due to favorable weather, improved agricultural practices, high yielding varieties, and better market access. This flow highlights Pakistan's growing importance in the global sesame market and its ability to meet international demand effectively.

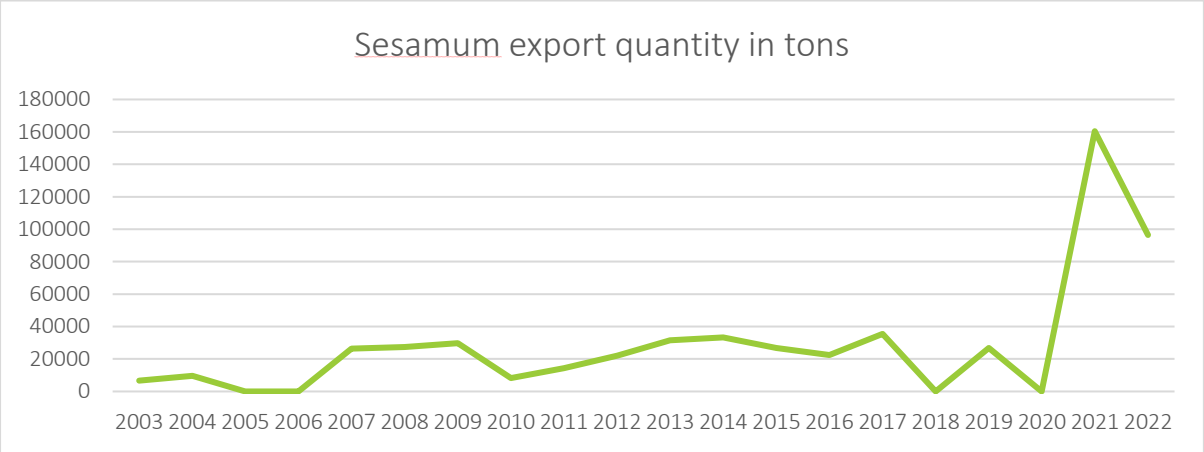


Figure 26: Sesamum Export Status in International Market

Source: Trade Map, 2022-23

PAKISTAN SESAMUM EXPORT BY COUNTRIES

Pakistan exported a total of 96,410 tons of Sesamum globally. China led with 59,286 tons, highlighting its substantial demand for sesame seeds. Kazakhstan followed with 8,507 tons, and Afghanistan imported 6,027 tons. These figures underscore Pakistan's significant role in supplying sesame seeds to international markets, particularly to China, Kazakhstan, and Afghanistan, for various culinary and industrial uses.

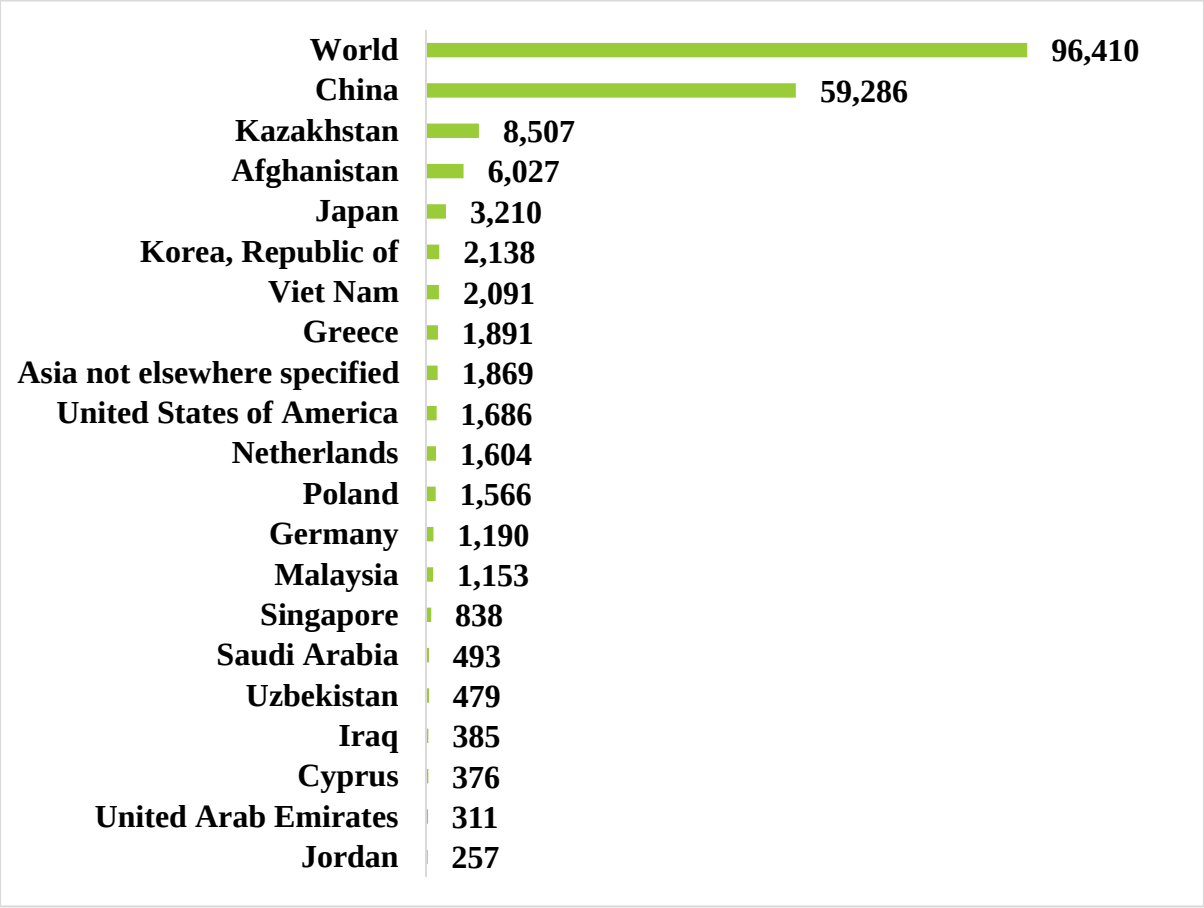


Figure 27: Sesamum Export Status in International Market

Source: Trade Map, 2022-23

PAKISTAN SESAMUM EXPORT BY COUNTRIES VALUE

The graph on Pakistan's Sesamum export values by country shows that Poland led with a value of 2,340 USD per ton, followed closely by the Netherlands at 2,269 USD per ton. The global average export value stands at 1,536 USD per ton. These figures indicate that Poland and the Netherlands pay a premium for Pakistani sesame seeds compared to the global average, reflecting possibly higher quality demands, specific market preferences, or value-added processing.

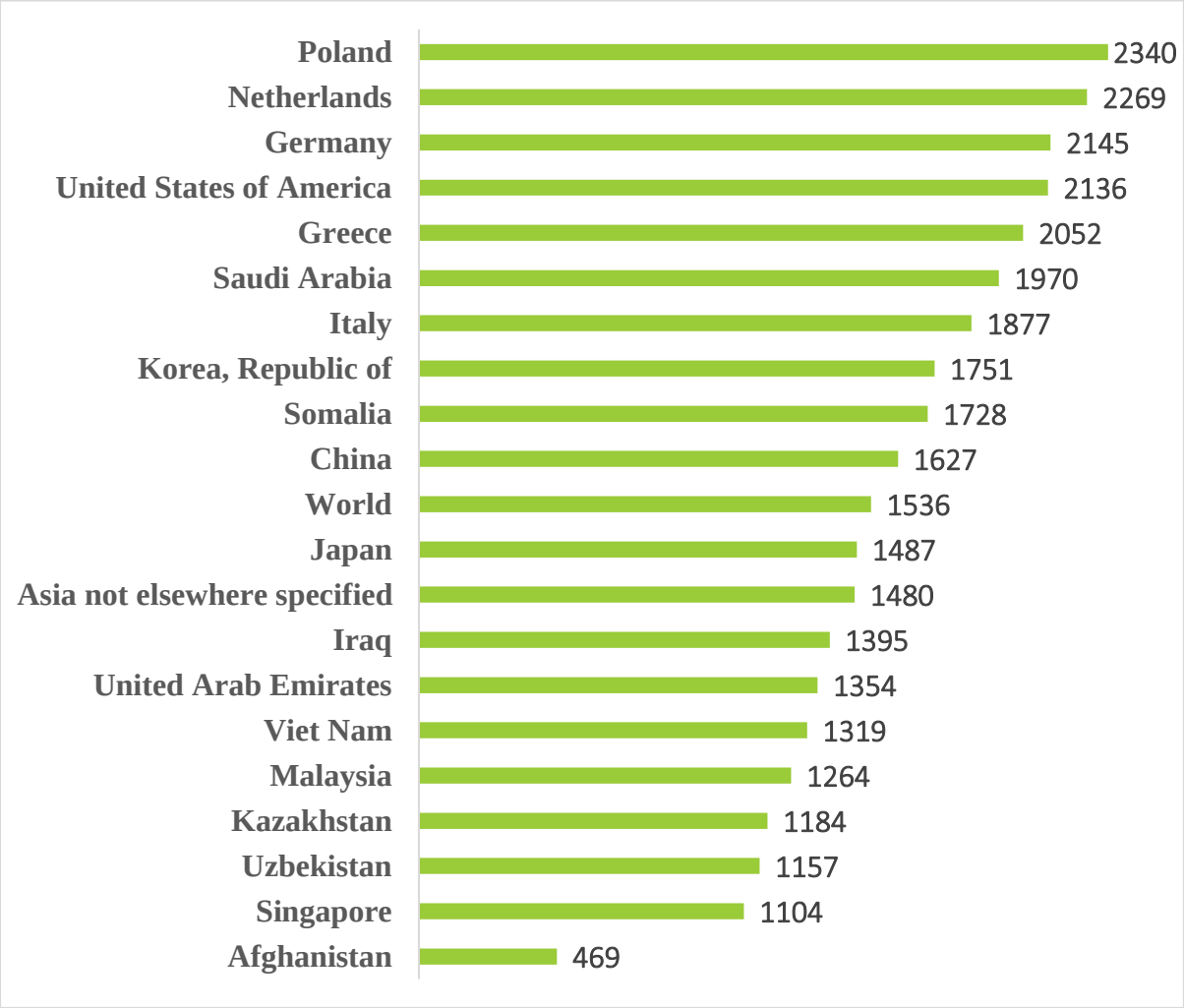


Figure 28: Sesamum Export Status in International Market

Source: Trade Map, 2022-23

SESAMUM YEARLY COMPARISON BETWEEN PUNJAB AND PAKISTAN

From 2012-13 to 2021-22, both Punjab and Pakistan have seen an increase in sesamum cultivation area. The cultivation area for sesamum in Punjab was more than triple in size, growing from 141.1 thousand acres in 2012-13 to 437 thousand acres in 2021-22. The primary cultivation area is in D.G. Khan Division, which covers 2,104,440 acres. During this period, the cultivation area in Pakistan has grown from 175.2 to 493.95 thousand acres, with Punjab showing the most rapid growth.

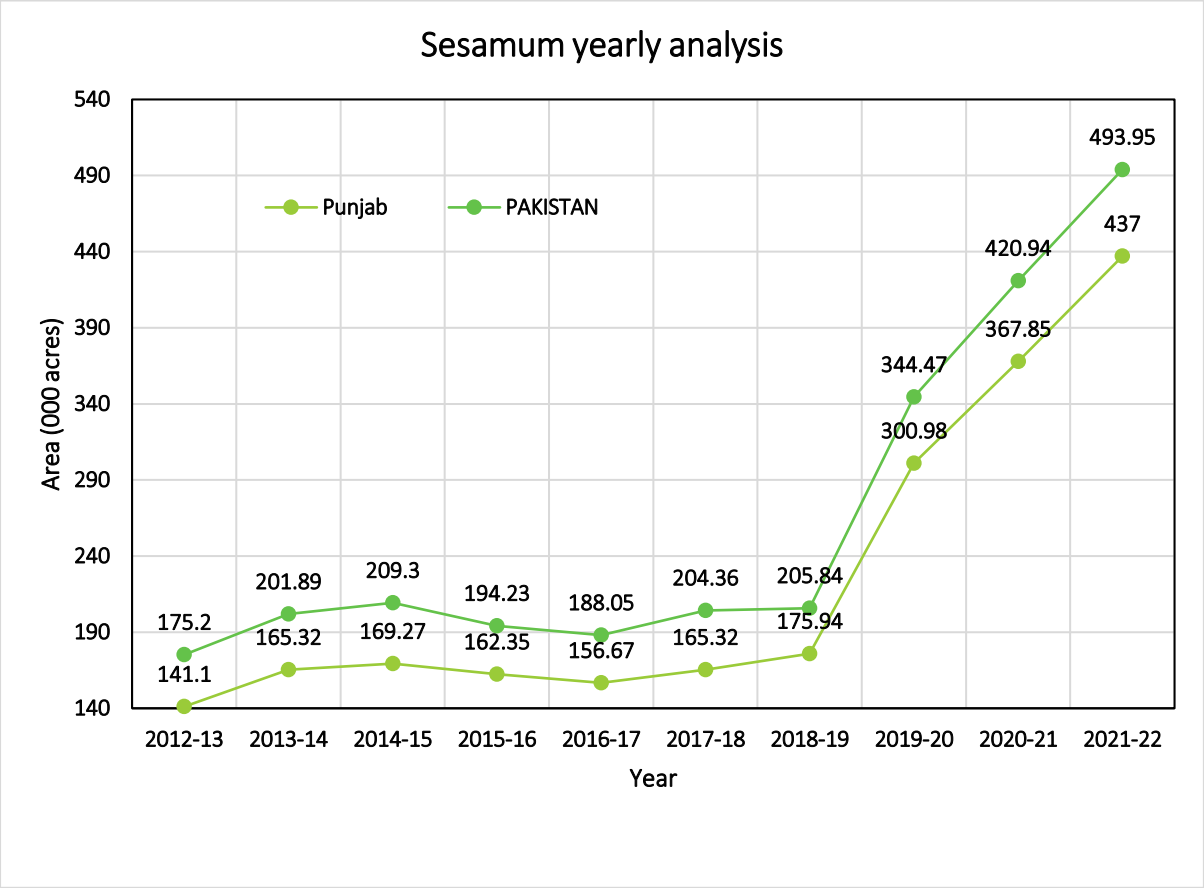


Figure 29: Sesamum Yearly Area (000 acres) Comparison between Punjab and Pakistan

Source: AMIS

In case of sesame production, Punjab's generally follows the same trend as the national production, it often produces a larger quantity. The production gap between Punjab and Pakistan is particularly notable in 2020-21 and 2021-22, indicating Punjab's increasing dominance in sesame production.

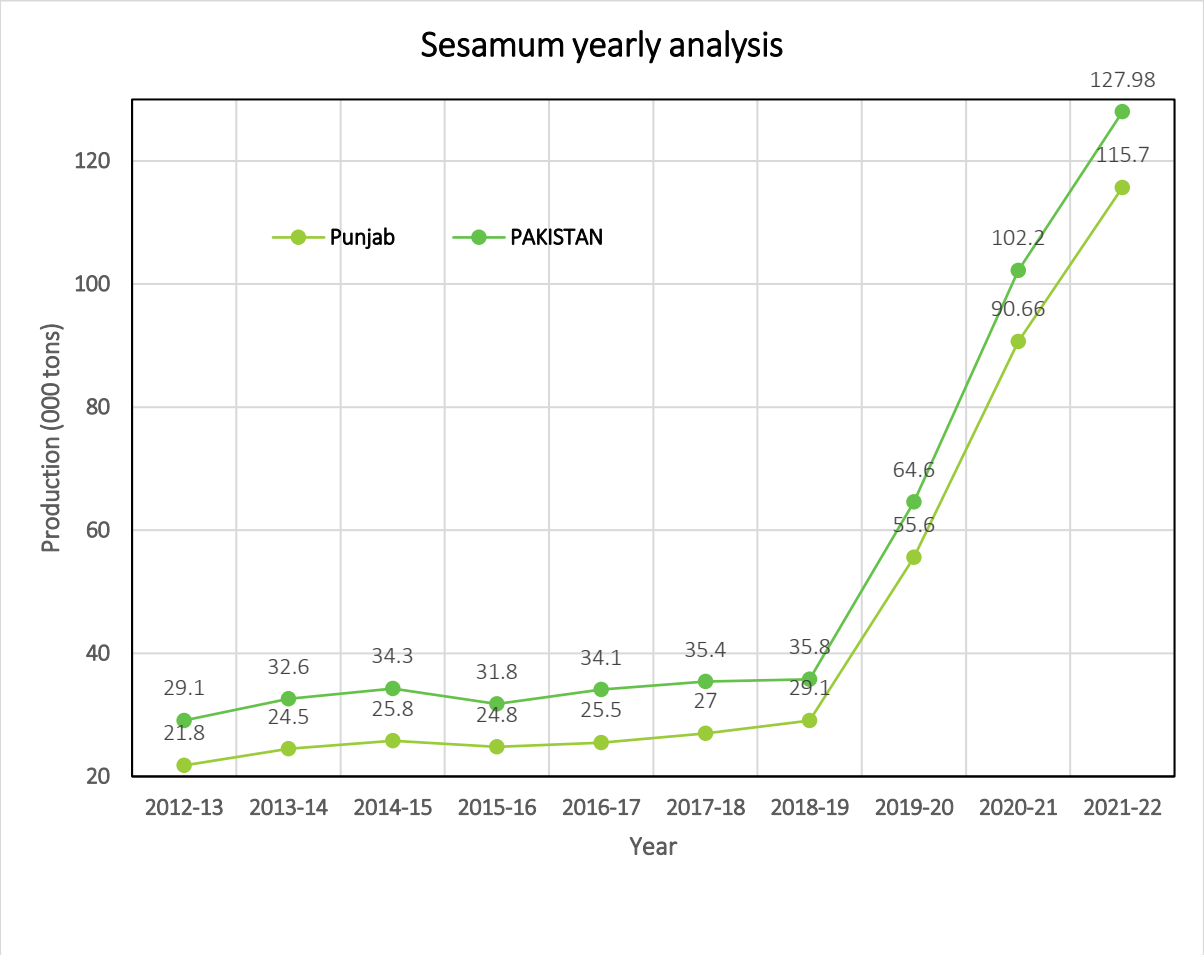


Figure 30: Sesamum Yearly Area (000 acres) Comparison between Punjab and Pakistan

Source: AMIS

Punjab, has consistently produced higher agricultural yields of sesamum compared to other provinces in the country. This could be attributed to a number of factors, such as favorable agro-climatic conditions, advanced farming practices, and access to improved technologies and inputs. The combination of these factors might have contributed to the province's sustained success in producing higher yields.

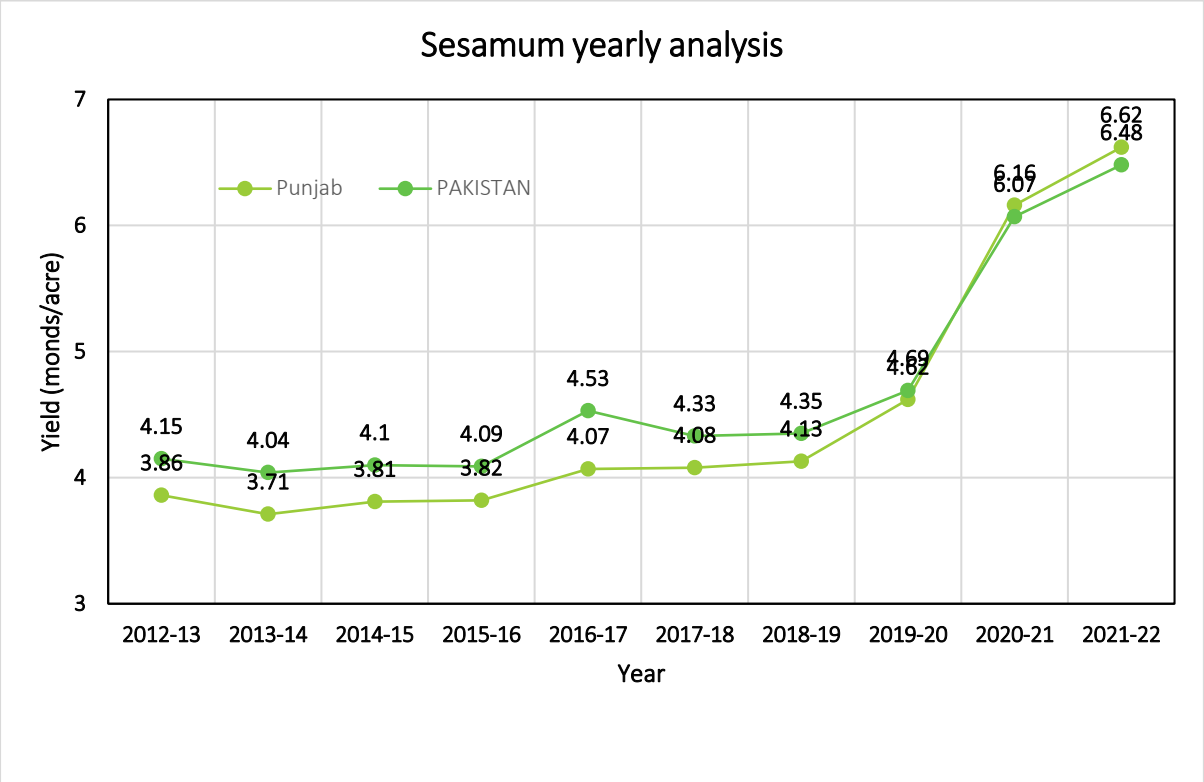


Figure 31: Sesamum Yearly Area (000 acres) Comparison between Punjab and Pakistan

Source: AMIS

ISSUES AND CHALLENGES FOR SESAMUM CROPS

SEED	FARM	HARVEST & LOGISTICS	PROCESS	MARKETS
• Unavailability of high-quality seed. • Varieties with low adaptability with climate. • Seed with less yield potential • Lack of improved varieties • Seed borne diseases	• Costly inputs • Unawareness about best management practices • Disease and insect attack • Difficulty in accessing high-quality inputs • Weeds problem • Sensitive to waterlogging • Lack of appropriate machinery for planting	• Shattering losses • Unavailability of technical labor • Presence of impurities like dirt, stones, and plant debris • Inadequate Storage Facilities	• Inefficient or Unavailability of oil extraction unit • Improper drying • No value addition • Inadequate packaging material	• Fluctuating market prices • Unavailability of state-of-the-art sesamum market.

INTERVENTIONS FOR SESAMUM CROPS

SEED	FARM	HARVEST & LOGISTICS	PROCESS	MARKETS
• Provision of high-quality seed. • Address low yields of sesamum crop by enhancing production both vertically and horizontally • Ensure Hybrid Seed Availability Through National and Multinational Seed Companies	• Subsidy on inputs to increase production of oil seed crop • Arrange seminars at the district level in sesamum districts to create awareness about best management practices/production technology for selected crops • Appreciation of best growers on the provincial and district level • Development of model farms • Provision of specialize extension services	• Promote mechanization for sesamum crop to minimize post-harvest losses and get good yields • Capacity building of local human resource • Strengthen the local research and development facilities in oilseed research institute for sesamum • Create new jobs in the public and private sector	• Oil extraction units in clusters • Promote value addition • Development of processing units in D.G.Khan division for sesamum export	• Incentivize the sesamum crop till market development. • Establishment of state-of-the-art sesamum market close to major road networks for ease of transportation

SESAMUM VALUE ADDED PRODUCTS

Sesame seeds are transformed into a variety of value-added products, utilizing their nutritional and versatile properties. These include sesame oil and paste, which are popular in cooking and baking. Sesame oil is also used in massage oils and as an ingredient in cosmetics and medical products. Additionally, sesame is used in agriculture for feed, fertilizer, and biodiesel, as well as in pesticides. The seeds are also used to decorate and enhance the flavor of various dishes.

Figure 32: Sesame value added products

14.2. CHILIES

Chili (Capsicum annuum L.) is considered one of the most essential spicy cash crops and is cultivated broadly all over the world (Venkateshalu et al., 2009). It constitutes a main commercial crop utilized as a fresh vegetable, condiment, and culinary supplement. Chillies are an imperative constituent in most global food items as they give colour, taste, flavour, and pungency to the food products. It possesses colossal profitable, nutritional, and medicinal values (Choudhary et al., 2009) such as digestive, carminative, thermogenic, antipyretic, stimulant, serdorific, cardiotonic, sialagogue and rubefacient.

WORLD LEADING CHILIES PRODUCING COUNTRIES

The graph shows the leading chili-producing countries by million tons: China leads with 16.84 million tons, followed by Mexico with 3.11 million tons, and Indonesia with 3.02 million tons. These figures highlight China's dominant position in global chili production, followed by

significant contributions from Mexico and Indonesia, reflecting their strong agricultural traditions and cultural importance of chili peppers.

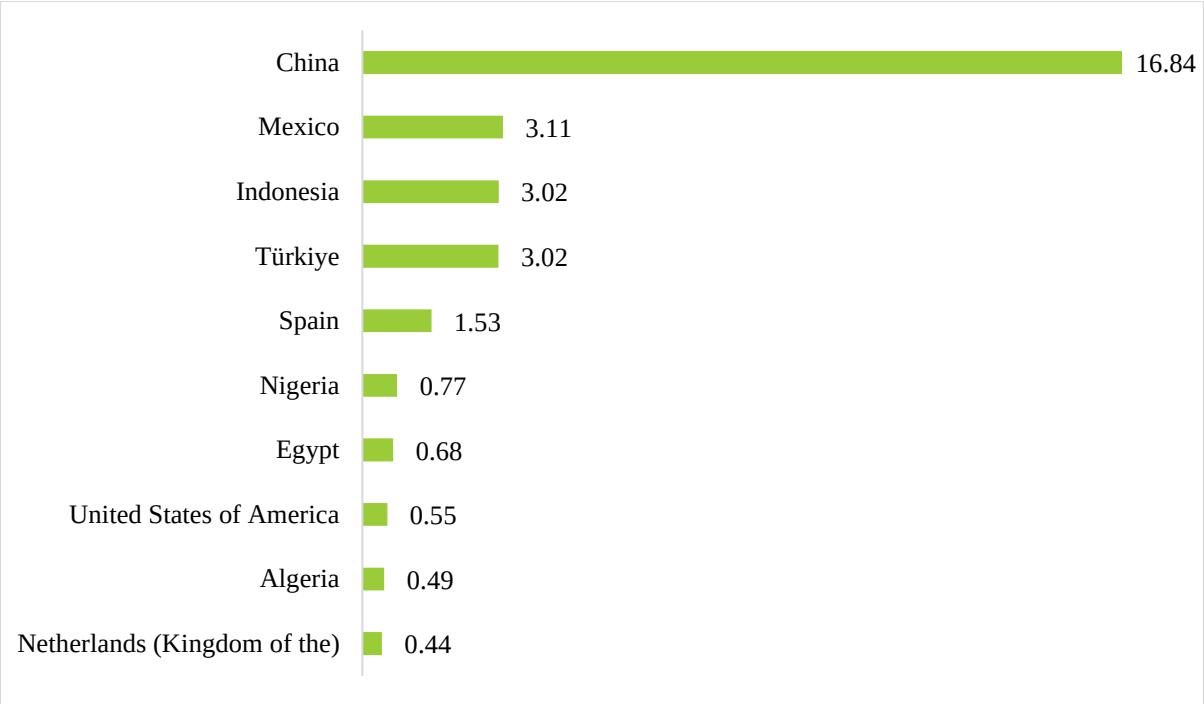


Figure 33: World Leading Chilies Producing Countries (Million Tons)

Source: Trade Map, 2022-23

WORLD LEADING CHILIES EXPORTING COUNTRIES

The graph highlights Mexico, Spain, and the Netherlands as leading chili-exporting countries. Mexico leads with its diverse chili varieties catering to global markets. Spain follows with high-quality chili exports across Europe, while the Netherlands serves as a pivotal distribution hub for chili peppers worldwide, showcasing their significant roles in the global chili trade.

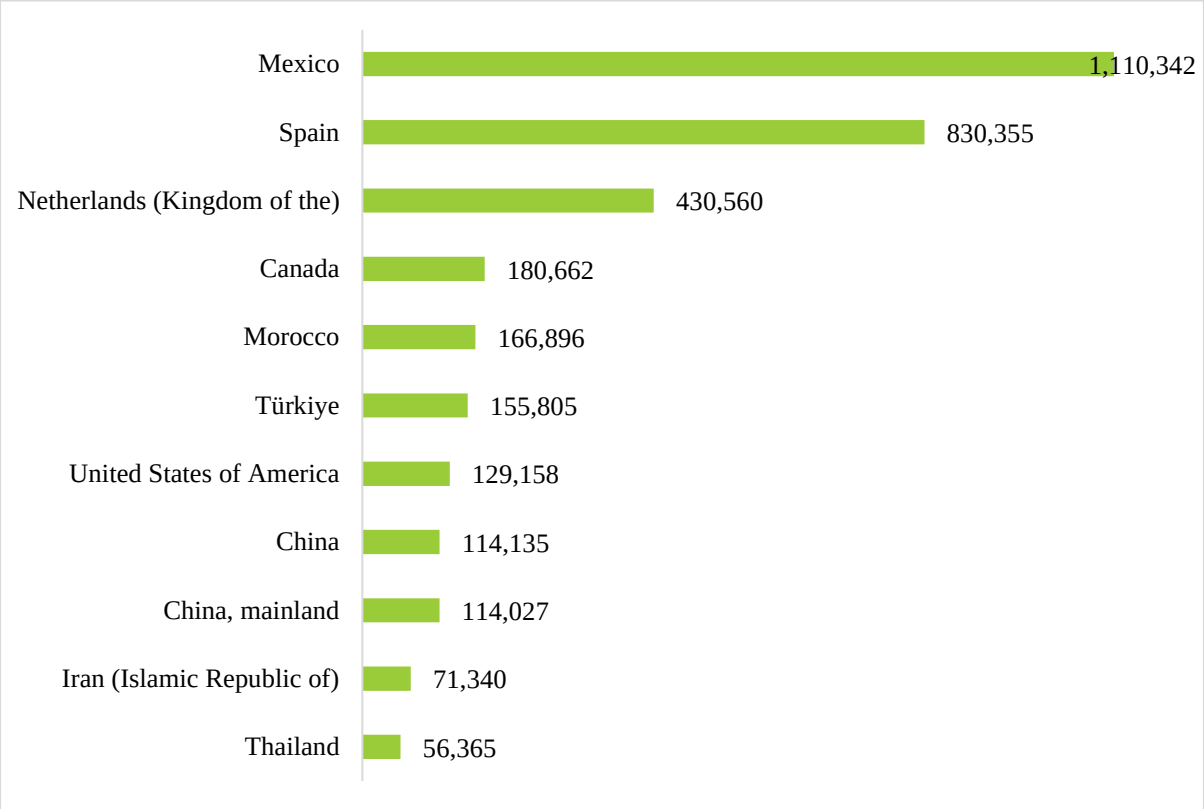


Figure 34: World Leading Chilies Producing Countries (Million Tons)

Source: Trade Map, 2022-23

WORLD LEADING CHILIES IMPORTING COUNTRIES

The United States and Germany are significant importers of chili peppers. The United States leads due to diverse culinary preferences, importing both fresh and processed chilies. Germany follows closely, relying on imports to meet its food processing needs and diverse culinary uses.

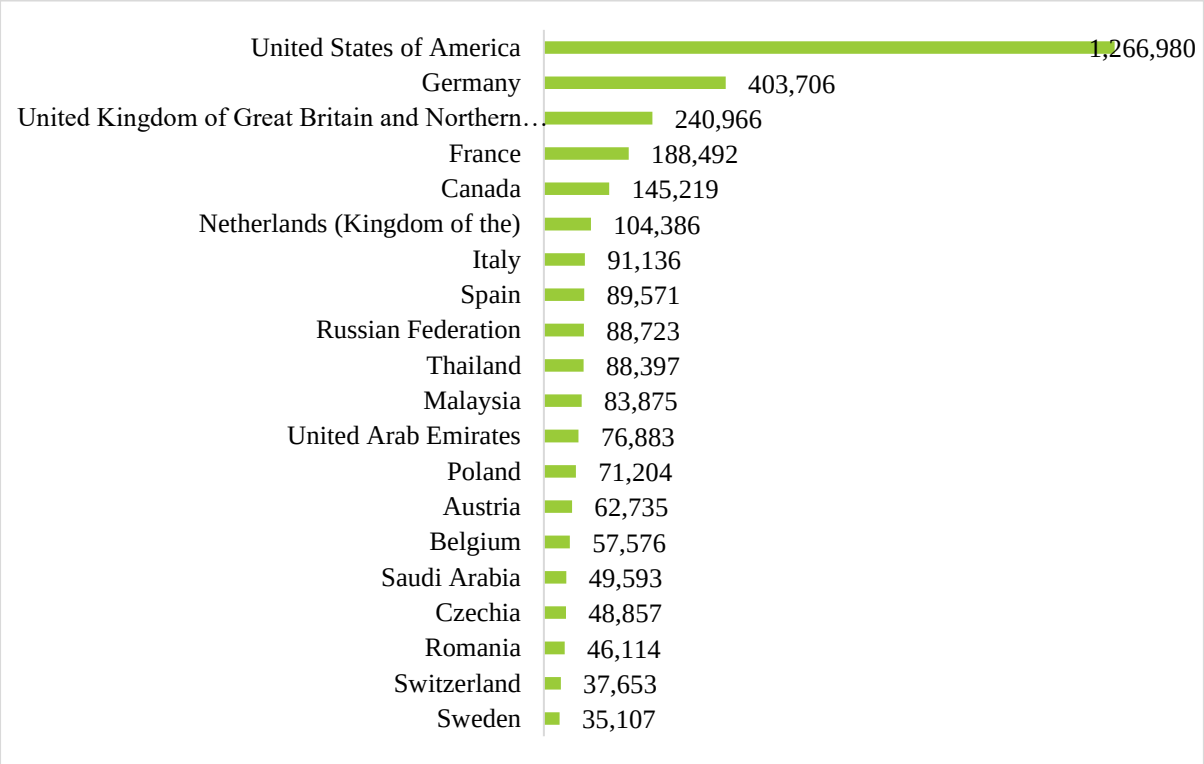


Figure 35: World Leading Chilies Producing Countries (Million Tons)

Source: Trade Map, 2022-23

WORLD LEADING CHILIES IMPORTING COUNTRIES VALUE

The graph illustrates the value of chili imports by key countries: the USA leads with significant expenditures driven by diverse culinary uses followed by Germany. The UK also imports chili peppers extensively, supporting diverse culinary applications despite a slightly lower import value compared to the USA and Germany.

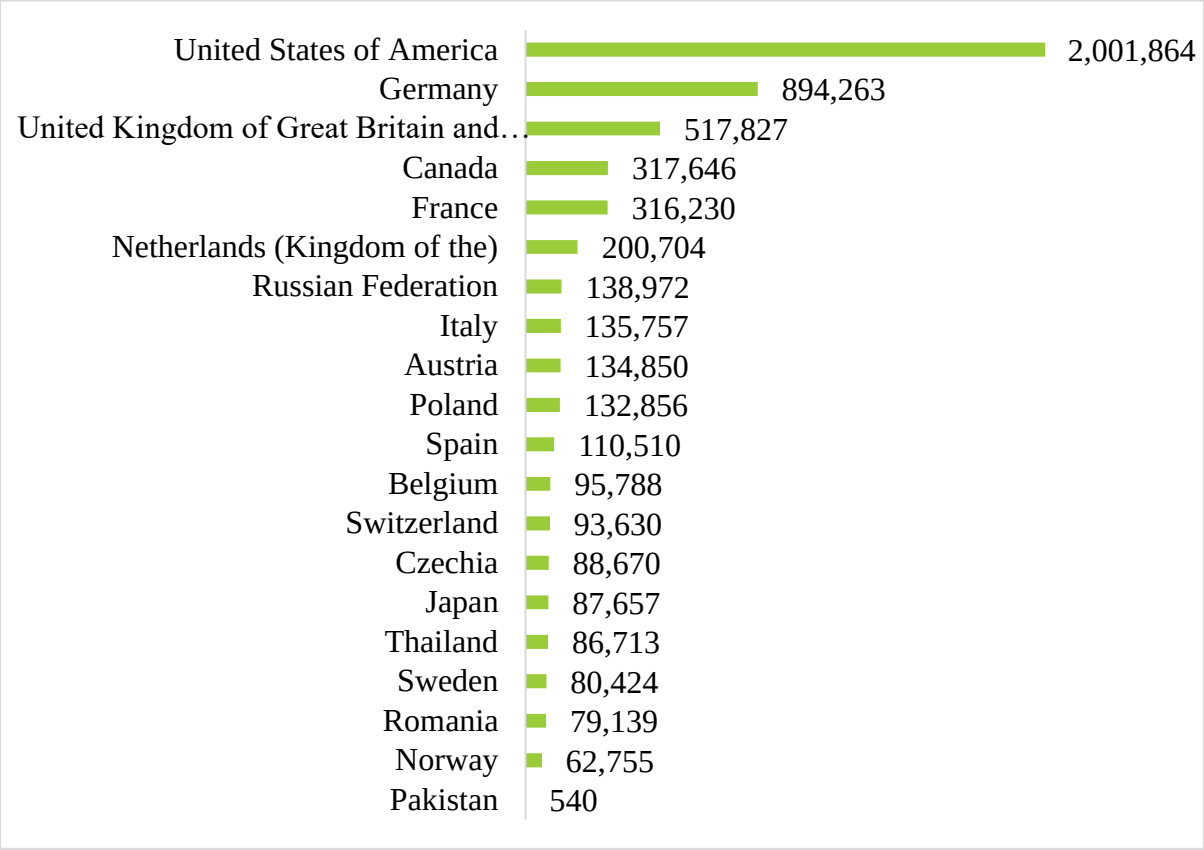


Figure 36: World Leading Chilies Producing Countries (Million Tons)

Source: Trade Map, 2022-23

WORLD LEADING CHILIES EXPORTING COUNTRIES VALUE

Spain leads in chili exports with high-value paprika and peppers, Mexico follows with diverse chili varieties, and the Netherlands plays a key role as a distribution hub despite minimal domestic production. These countries excel in global chili trade, driven by quality, culinary demand, and strategic market positioning.

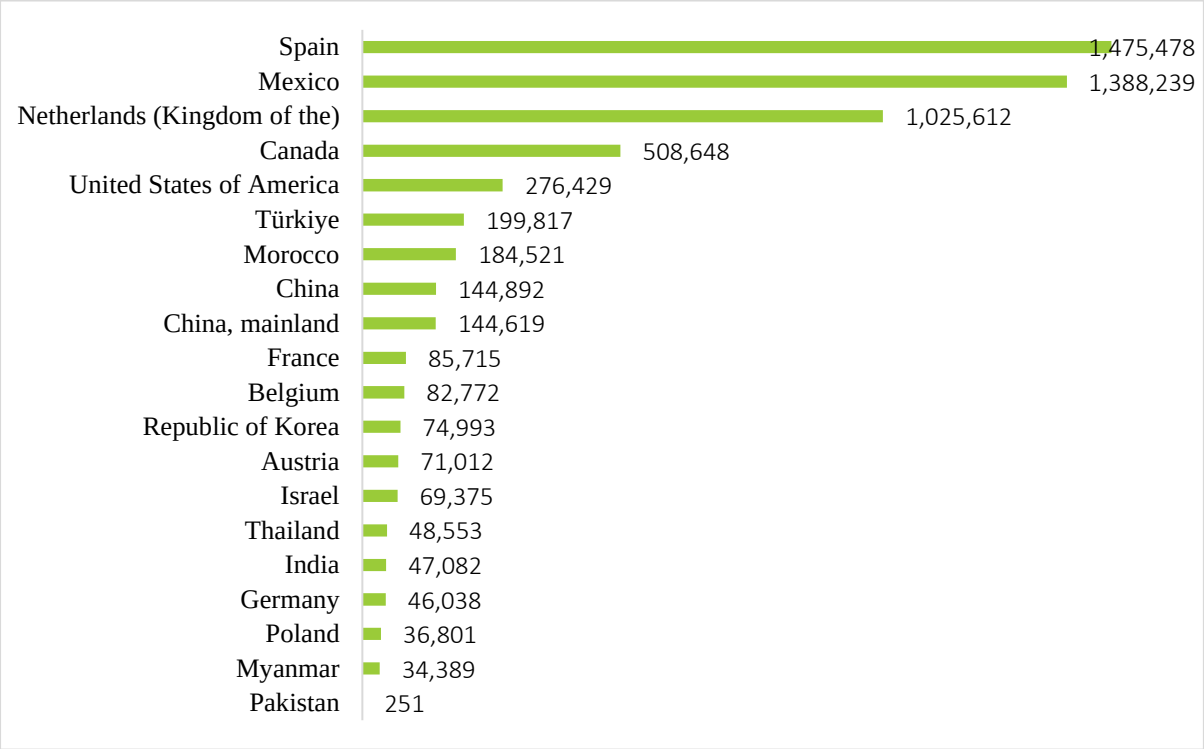


Figure 37: World Leading Chilies Exporting Countries Value (000 USD)

Source: Trade Map, 2022-23

CHILIES YEARLY COMPARISON BETWEEN PUNJAB AND PAKISTAN

From 2012-13 to 2021-22, Punjab showed little increase in chilies cultivation area but it was increased during 2018-19 in case of Pakistan. The cultivation area for chilies in Punjab was lesser in size, growing from 15.1 thousand acres in 2012-13 to 21.1 thousand acres in 2021-22. The primary cultivation area is in D.G. Khan Division, which covers 4,507,750 acres. During this period, the cultivation area in Pakistan has reduced from 157.2 to 143.6 thousand acres, with Punjab showing the reduced growth.

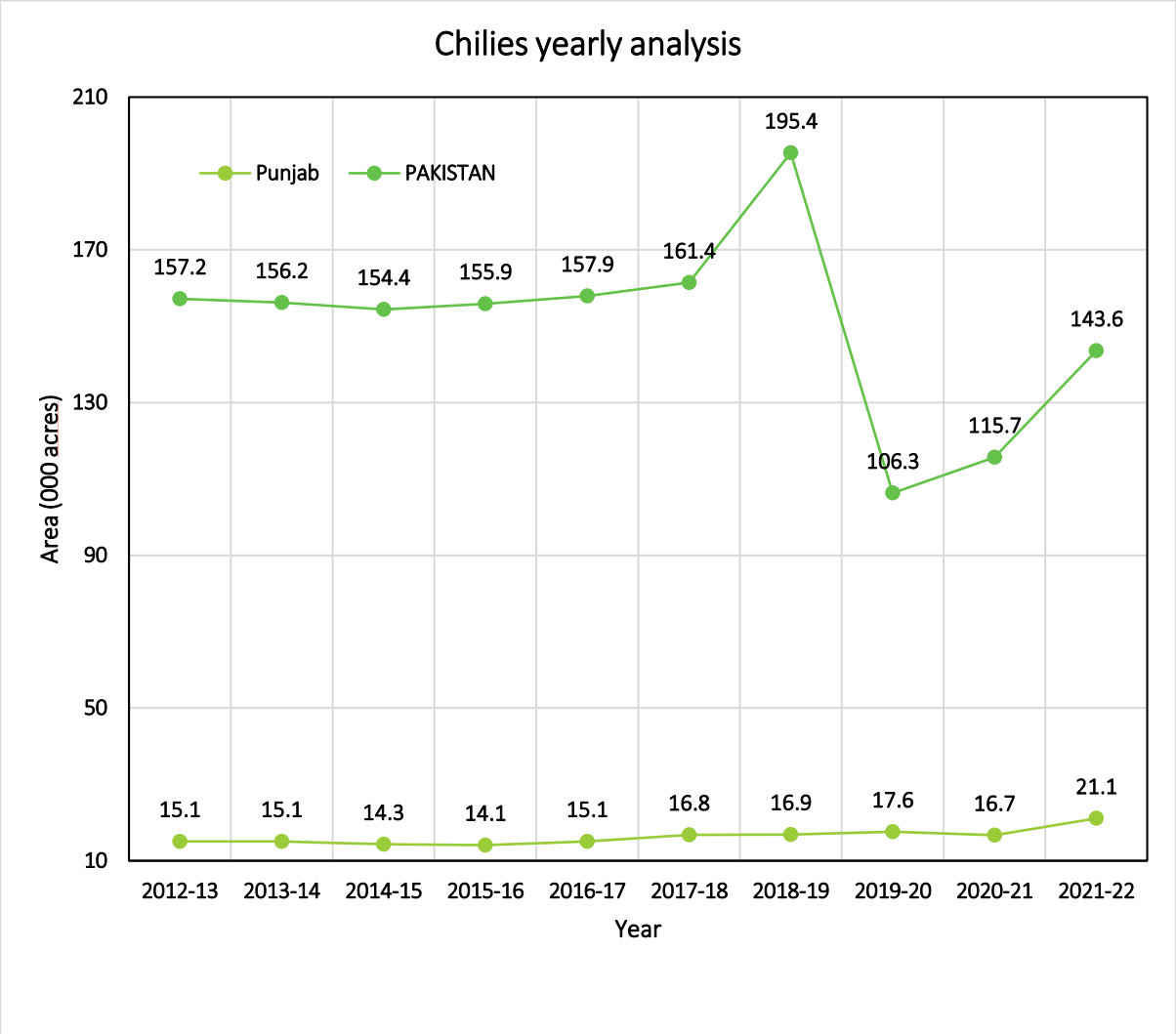


Figure 38: Chilies Yearly Area (000 acres) Comparison between Punjab and Pakistan

Source: AMIS

Regarding chilies production, Punjab's generally follows the different trend as the national production, it often produces a smaller quantity. The production gap between Punjab and Pakistan is particularly notable during all time period where the production of Punjab is continuously increasing.

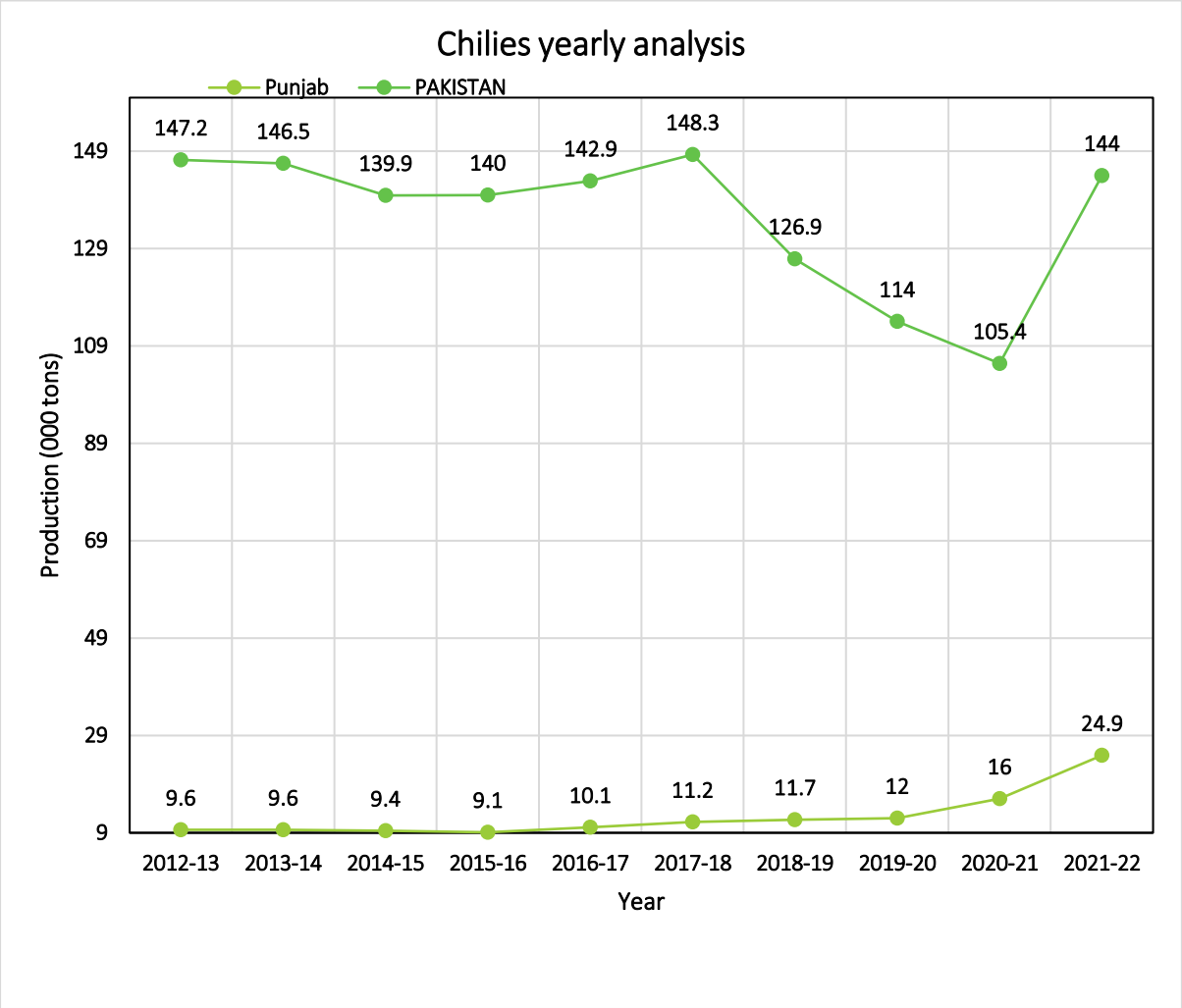


Figure 39: Chilies Yearly Production (000 tons) Comparison between Punjab and Pakistan

Source: AMIS

Punjab, has consistently produced higher agricultural yields of chilies compared to other provinces in the country except Sindh. This could be attributed to a number of factors, such as favorable agro-climatic conditions, advanced farming practices, and access to improved technologies and inputs. The combination of these factors might have contributed to the province's sustained success in producing higher yields.

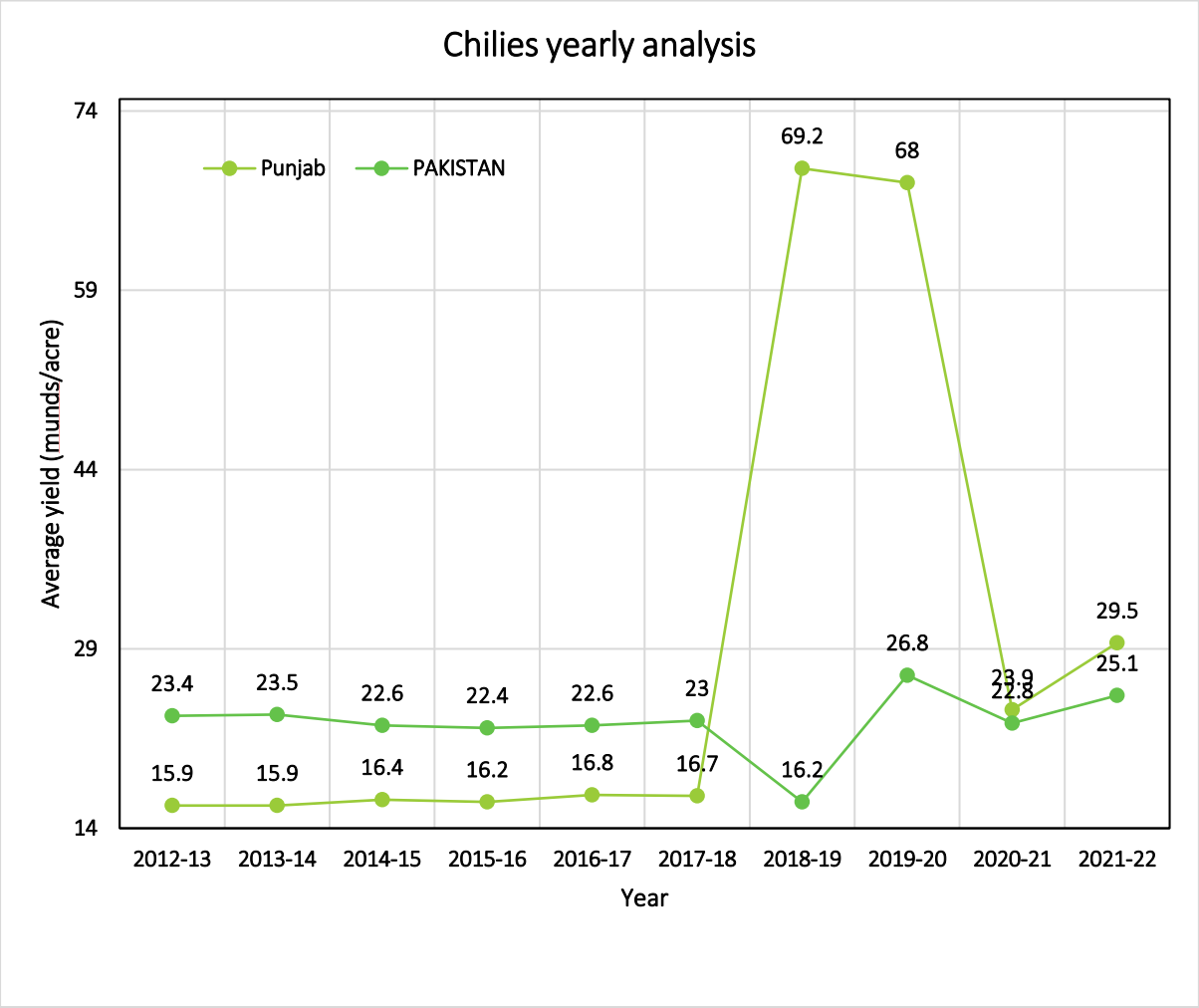


Figure 40: Chilies Yearly Yield (monds/acre) Comparison between Punjab and Pakistan

Source: AMIS

CHILIES VALUE CHAIN

The combination of various unit operations followed in dry chillies processing are shown in Figure. The maturity of chilli decides the pungency level, initial colour and retention properties. Pods left to ripen and to wither on plant parts are superior in these qualities to those picked when fully coloured but succulent. The perishability of chillies is higher, and hence it's processing, value addition and storage are considered essential to farmers, processors, exporters and consumers. Since the initial moisture content of freshly harvested red chilli is 65–80%, it becomes difficult to process or store. It is estimated that the shelf life at this moisture content is about 2–3 days at ambient conditions and 15 days at low-temperature storage

conditions (Chitravathi et al. 2015). To enhance the storage life of chillies and avoid the development of microflora and subsequent quality loss due to spoilage, reducing the moisture content is mandatory and simultaneously maintaining better aeration to the chillies after harvesting (Samreen and Rao 2017).

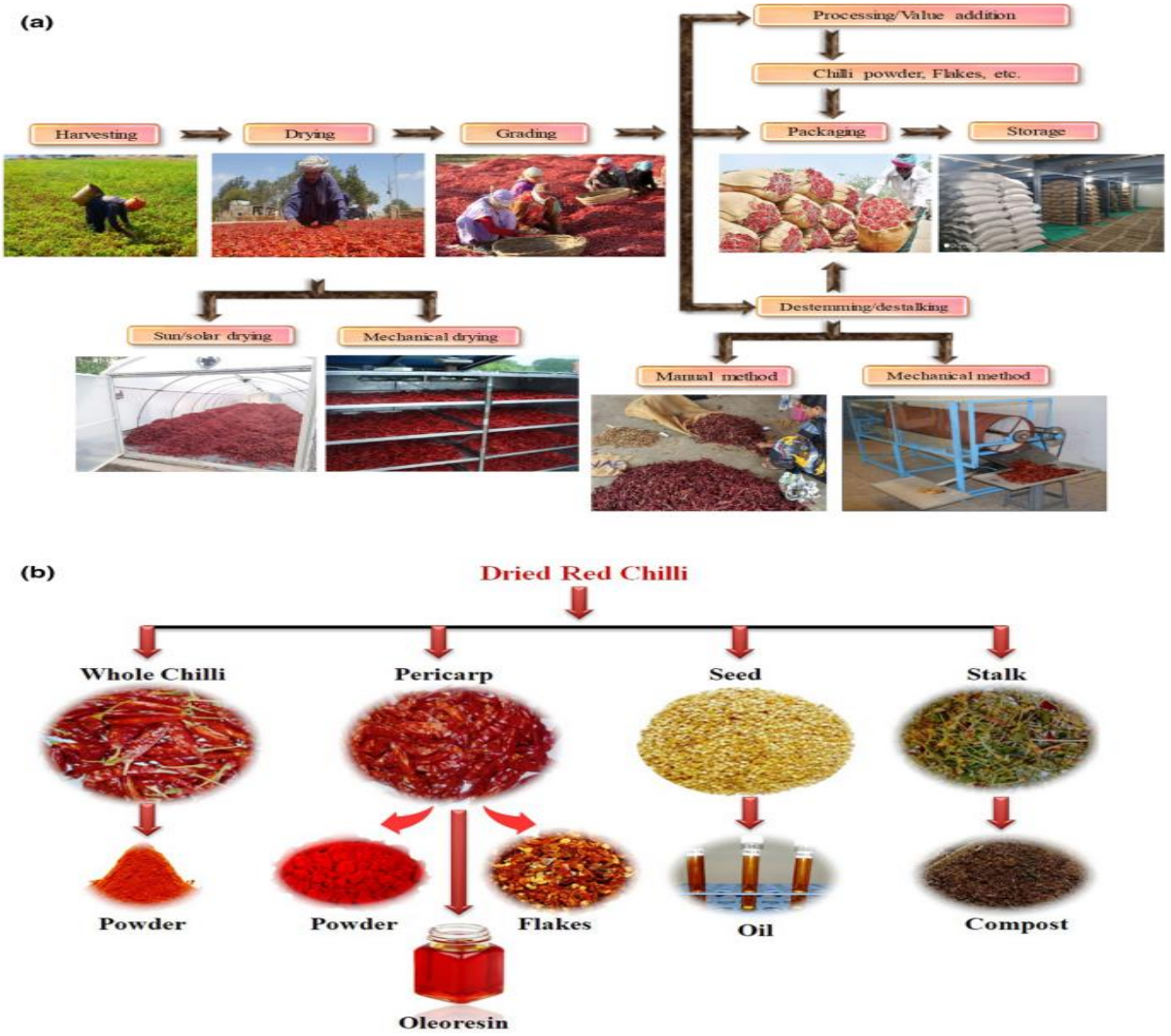


Figure 41: Chillies value chain

DRYING

Drying is the most prominent unit operation during dried chilli processing as it determines the product quality and its market significance. Traditionally, in most chilli-producing countries, red chillies were dried directly under the sun due to possible reasons, *viz*., natural and sustainable sources of drying, cost-effectiveness, and field-level drying. With the advancement

in research and development activities, advanced drying techniques were adopted for drying chillies that include sun drying, solar drying, greenhouse type solar drying, heat pump drying, microwave drying, fluidized bed drying, etc.

SORTING AND GRADING

External inspection is usually done according to size, colour, moisture content, and the stalk of the pods. The consumers categorize the variety of chillies as per their destined purpose. The end-users are primarily classified into domestic retail users and wholesale industrial users. For powder preparation, chillies with fleshy skin, uniform red colour, pungency, and fewer seeds are preferred by industrial people. There are multiple local and conventional grading practices followed by farmers, village merchants, and itinerant merchants. Visual assessment is used to decide the quality and, thereby, price in open and closed auctions. However, such methods have no well-defined grading standards (Karpate and Saxena 2009).

Grading is done at the producer/processing industries mainly for sorting chillies based on size and colour and discarding unripe, spoiled, damaged, and discoloured chillies. Generally, deep red and light red coloured chillies containing fewer seeds fetch a premium price. Good fruit length, high pungency, shining red colour, and the calyx's strong attachment are other vital factors for a higher price.

DESTALKING/DESTEMMING

At the commercial level, chilli is mostly consumed as powder; however, whole destalked chilli is used to prepare dishes like *chutney*, *sambhar*, etc. Destalking is considered of paramount importance for both these circumstances and is typically done after adequate drying and before storage/marketing. Also, for the industries where chillies are preferred for export purposes, removing the stalk is considered mandatory by the buyers. Some processing industries also perform manual destalking, which has very low efficiency and is a time-consuming exercise. Chilli being hot spice with a high pungency level, it becomes hard for the labourers involved in destalking. Destemming is a massive process, and approximately 106 lakh labour days are required to handle the country's total chilli production of 16 lakh metric tonnes (Kumar 2016).

PACKAGING

As a conventional practice, bulk packaging of well-dried chilli pods in gunny bags is performed for transporting up to the market. Usually, the gunny bags hold about 30 kg of dried chillies, and to accommodate more quantity in each bag, chillies are pressed by compaction. Further, for more compression, manually, it is rammed by labour, increasing the filling capacity to 50 kg per bag (Pandey et al. 2013).

STORAGE

Comparatively, the effect of packaging and storage are more prominent than the effect of drying temperature. Cold storage is the preferred mode of storage during the summer season, imparting colour retention and protection against infestation. Generally, the conditions (5–8 °C and 55–60% RH) are recommended for cold storage. If the cold storage temperature goes beyond 5 °C, condensation occurs, resulting in discoloration and decay of pods.

ISSUES AND CHALLENGES IN CHILLIES VALUE CHAIN

SEED	FARM	HARVEST & LOGISTICS	PROCESS	MARKETS
• Costly seed. • Unavailability of climate resilient chilies varieties • Limited farmer awareness on new seed technologies	• High Cost of Production • Unavailability of Inputs. • Attack of insects and fungal diseases • Inadequate use of fertilizers • Limited awareness on modern production technology	• Unavailability of modern harvesting machinery. • Use of manual labour • Inefficient transportation structure • Lack of storage facilities	• Unavailability of processing facilities • Limited access to modern and efficient processing equipment. • Dependence only on raw chilies as a product.	• Price Instability. • limited access to larger markets • No proper exporter setup. • Insufficient access to real-time market information.

INTERVENTIONS

SEED	FARM	HARVEST & LOGISTICS	PROCESS	MARKETS
• Development of hybrid chillies varieties and cultivation under controlled environment.	• Training of farmers in cultivation, harvesting, packing and storage of this crops. • Provision of inputs (Fertilizer, Pesticides and Implements) on subsidy.	• Capacity building and specialized labour for harvesting.	• Establishment of chillies processing unit (dry chilli, hot sauce & chilli powder).	• Establishment of chillies market in its cluster.

CHILIES VALUE ADDED PRODUCTS

Chillies are transformed into a wide array of value-added products, each showcasing their unique flavor and heat. These products include chili powder, red chili flakes, and chili oleoresin, which are essential for cooking and seasoning. Additionally, chillies are used to make chili paste, sauces, and pickled varieties. They are also crafted into chili oil, jam, and extracts. Beyond traditional uses, chillies feature in snacks and even chili-flavored beverages, highlighting their versatility and widespread appeal.

Figure 42: Chillies value added products

14.3. ONION

Onion (*Allium cepa*) occupies a significant position among vegetables as they are in constant demand, both in the domestic and international markets, due to their important role in the culinary practices and nutritional value (FAO, 2022). Moreover, the value addition and processing of onions in agro-based industries promote economic growth in rural areas (Ramandeep and Bhagawan, 2019). It is an important source of nutritional contents such as flavonoids. It is especially rich in three important phytochemicals, namely flavonoids, organosulfur compounds, and fructans. Such substances are known for their positive health benefits.

WORLD LEADING ONION PRODUCING COUNTRIES

China leads global onion production with advanced farming and favorable climate. Mali follows, leveraging agriculture for significant domestic and regional supply. Angola contributes with increasing onion output, supporting local markets and regional trade networks.

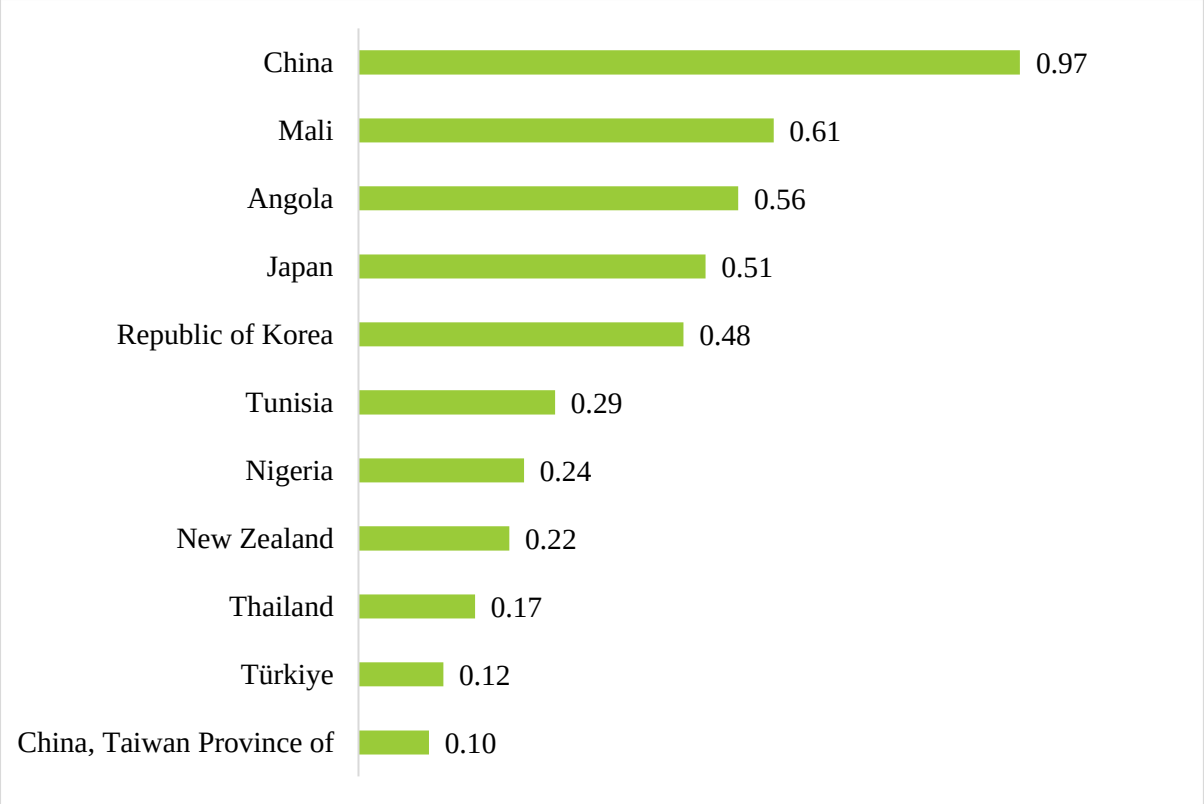


Figure 43: World Leading Onion Producing Countries (Million Tons)

Source: Trade Map, 2022-23

WORLD LEADING ONION EXPORTING COUNTRIES

India leads global onion exports due to extensive production and quality. The Netherlands serves as a European hub, re-exporting onions. China also contributes to international markets with increasing exports, reflecting growing agricultural output and trade capabilities. These countries play key roles in the global onion trade, driven by production capacity and market demand.

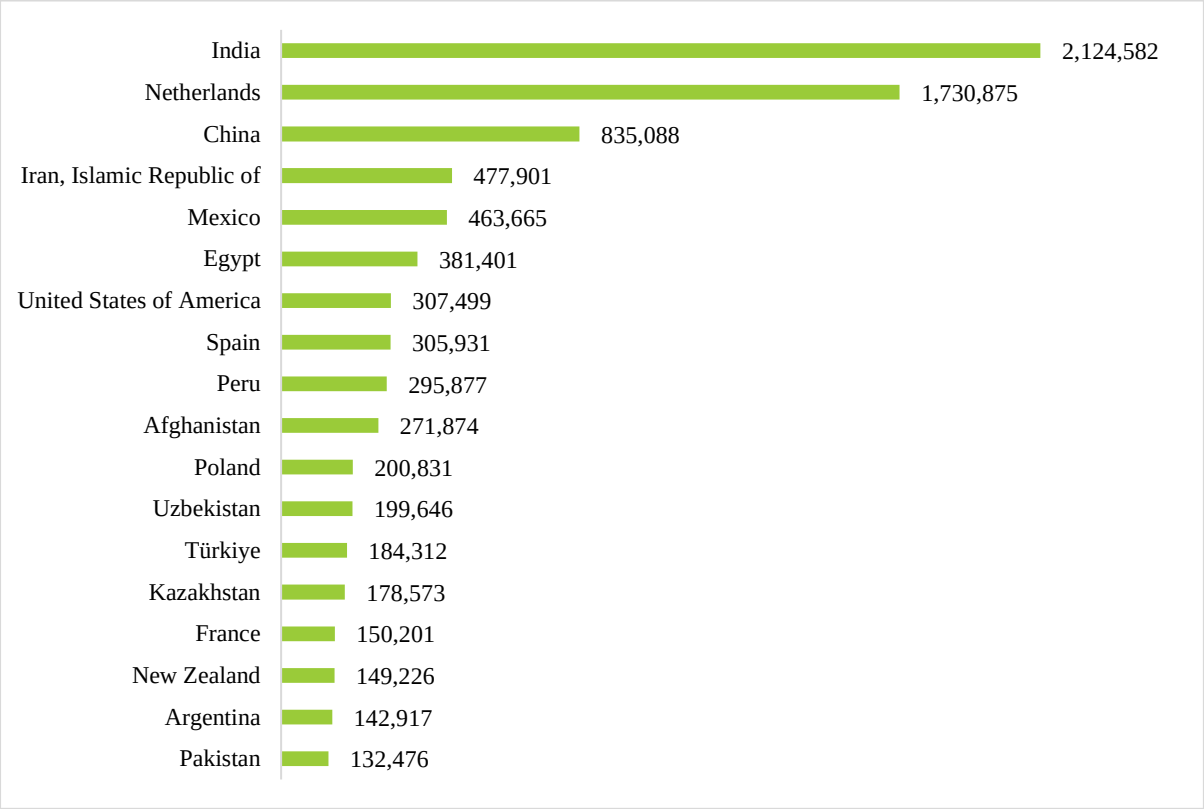


Figure 44: World leading Onion Exporting Countries

Source: Trade Map, 2022-23

WORLD LEADING ONION IMPORTING COUNTRIES

Bangladesh leads in onion imports to meet high domestic demand. The USA follows, importing extensively for culinary and industrial uses. Malaysia also imports onions for diverse culinary needs, while Pakistan supplements domestic production with imports to stabilize market supply. These countries demonstrate varied reasons for importing onions, from culinary preferences to industrial requirements, impacting global onion trade dynamics.

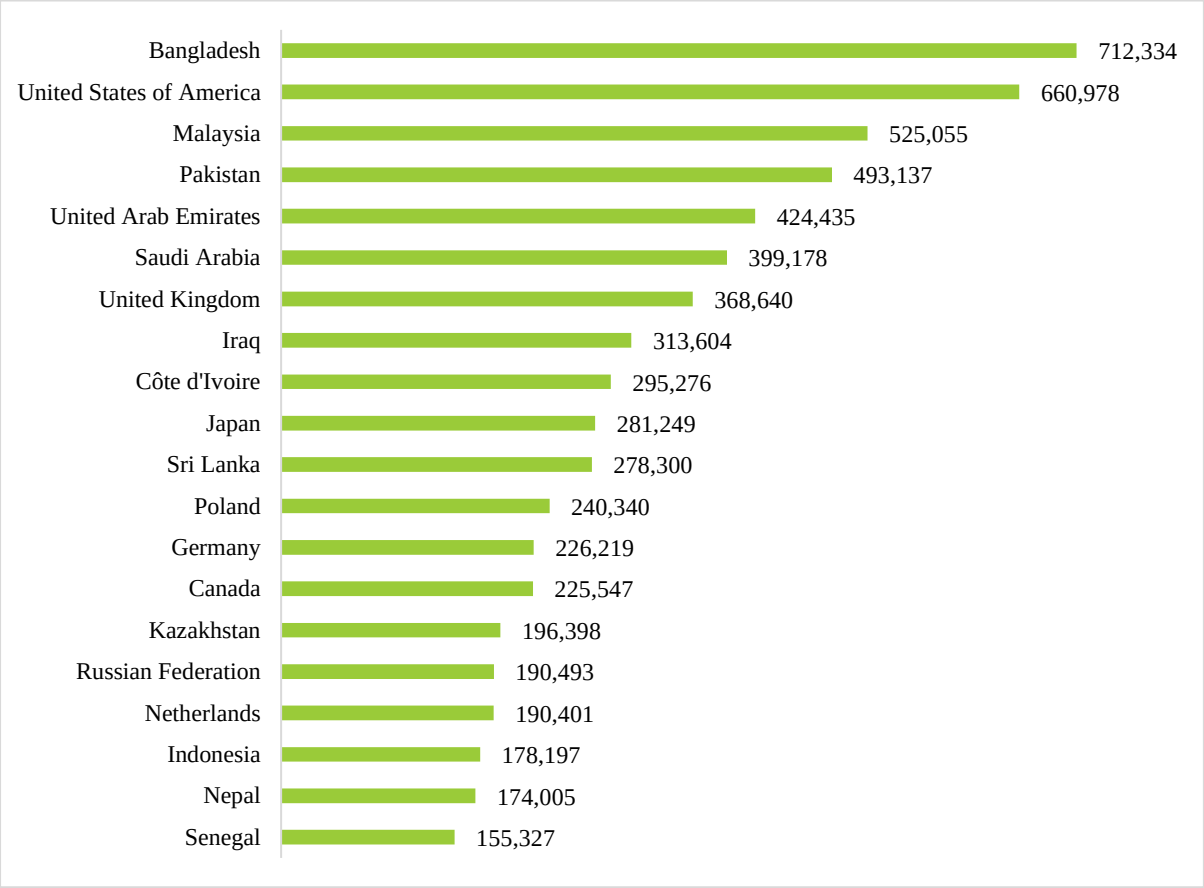


Figure 45: World Leading Onion Importing Countries (Tons)

Source: Trade Map, 2022-23

ONION EXPORT STATUS IN INTERNATIONAL MARKET

The graph shows fluctuations in onion exports, with a rise in 2021 followed by a decrease. The 2021 increase likely resulted from higher yields and increased global demand. The subsequent decline may be due to adverse weather, changes in market demand, trade restrictions, or competition.

Figure 46: Onion Export Status in International Market

Source: Trade Map, 2022-23

PAKISTAN ONION EXPORT BY COUNTRIES

The graph on Pakistan's onion export by countries in quantities (tons) shows that Pakistan exported a total of 132,476 tons of onions globally. The largest importer was Malaysia, with 38,377 tons, highlighting Malaysia's significant demand for Pakistani onions to meet its culinary and industrial needs. Sri Lanka followed with 33,109 tons, reflecting strong trade ties and the importance of onions in Sri Lankan cuisine. The UAE imported 29,389 tons, driven by its diverse population and high consumption of onions in various foods.

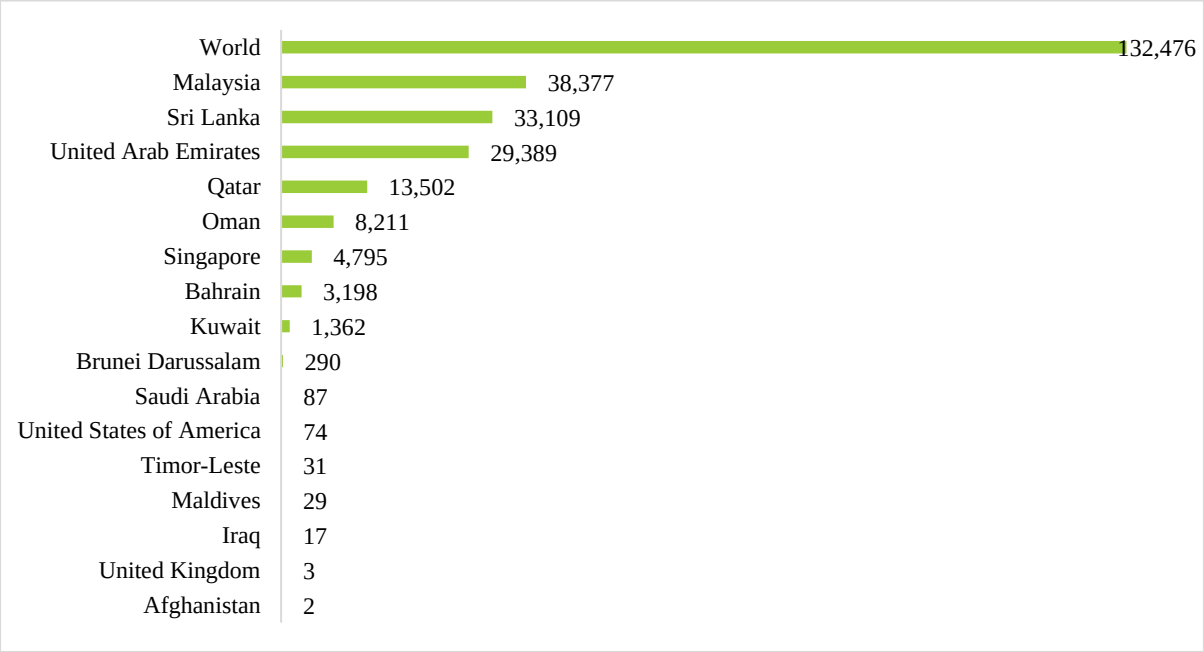


Figure 47: Pakistan Onion Export by Countries (Quantities in Tons)

Source: Trade Map, 2022-23

PAKISTAN ONION EXPORT BY COUNTRIES VALUE

The graph on Pakistan's onion export value by countries (USD/ton) highlights the different prices at which onions are sold in various markets. The USA leads with the highest value at 459 USD per ton, indicating strong demand for Pakistani onions, possibly due to quality standards and higher market prices. The Maldives follows with 379 USD per ton, reflecting its reliance on imports for food supplies and the premium paid for imported produce. Brunei Darussalam is next with 359 USD per ton, showing a similar reliance on imports and willingness to pay a higher price for quality onions.

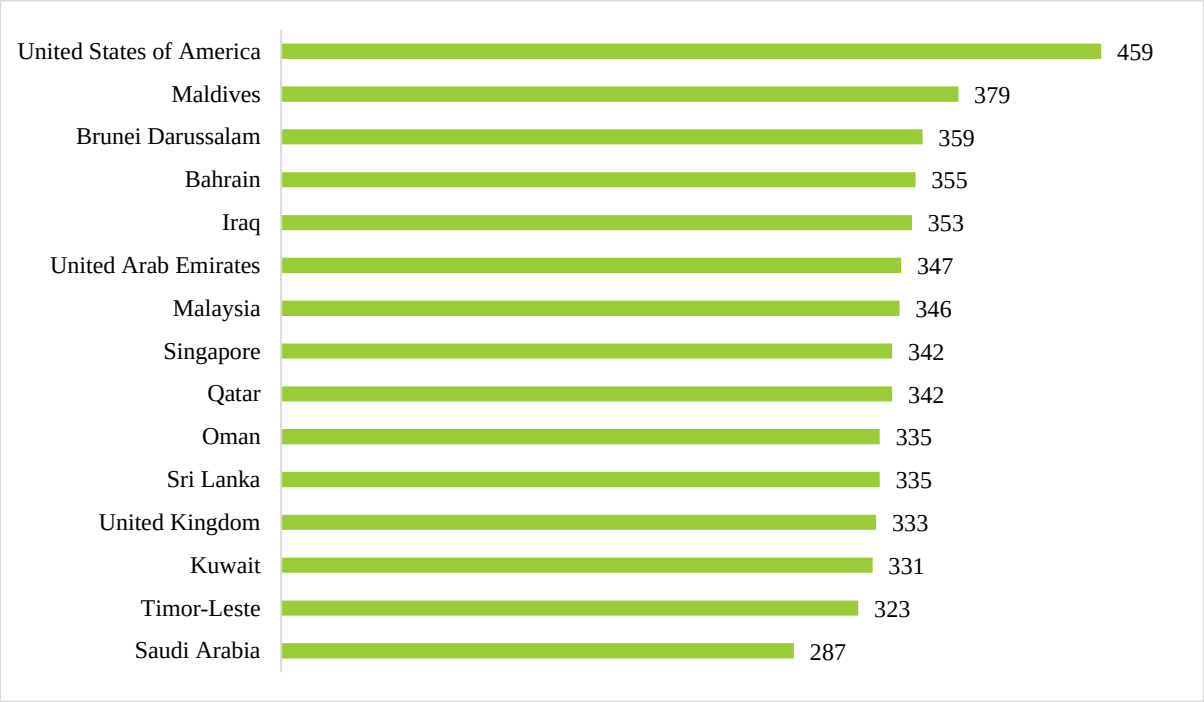


Figure 48: Pakistan Onion Export by Countries Value (USD/Ton)

Source: Trade Map, 2022-23

ONION YEARLY COMPARISON BETWEEN PUNJAB AND PAKISTAN

From 2012-13 to 2020-21, both Punjab and Pakistan have seen an increase in Onion cultivation area but it decreased in 2021-22. The cultivation area for onion in Punjab was 102.3 thousand acres in 2012-13 and 67.7 thousand acres in 2021-22. The primary cultivation area is in DG Khan Division, which covers 4,507,750 acres. During this period, the cultivation area in Pakistan has grown from 311.36 to 348.42 thousand acres, with Punjab showing its growth.

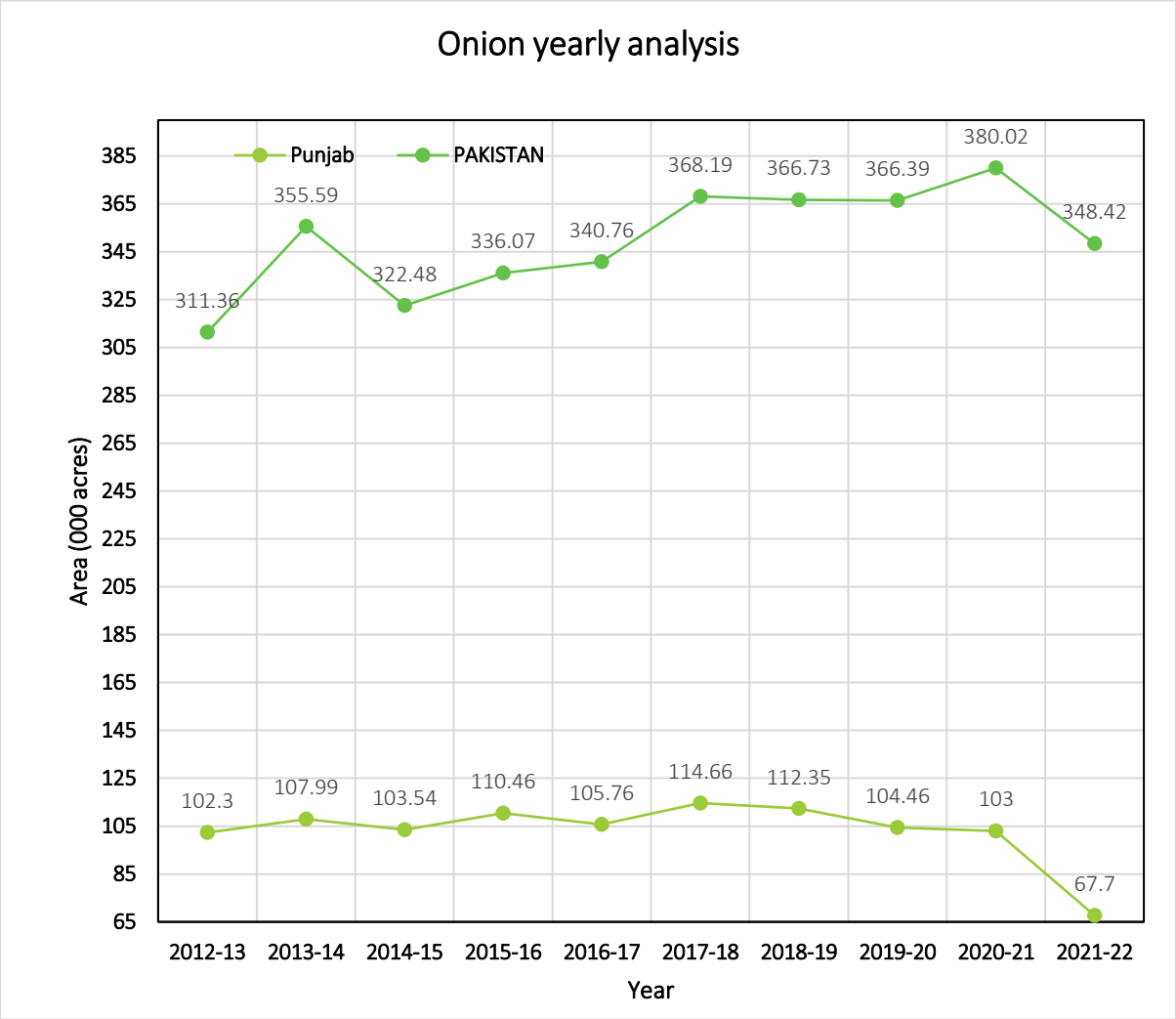


Figure 49: Onion Yearly Area (000 acres) Comparison between Punjab and Pakistan

Source: AMIS

Punjab's production generally follows the same trend as the national production, it often produces a larger quantity.

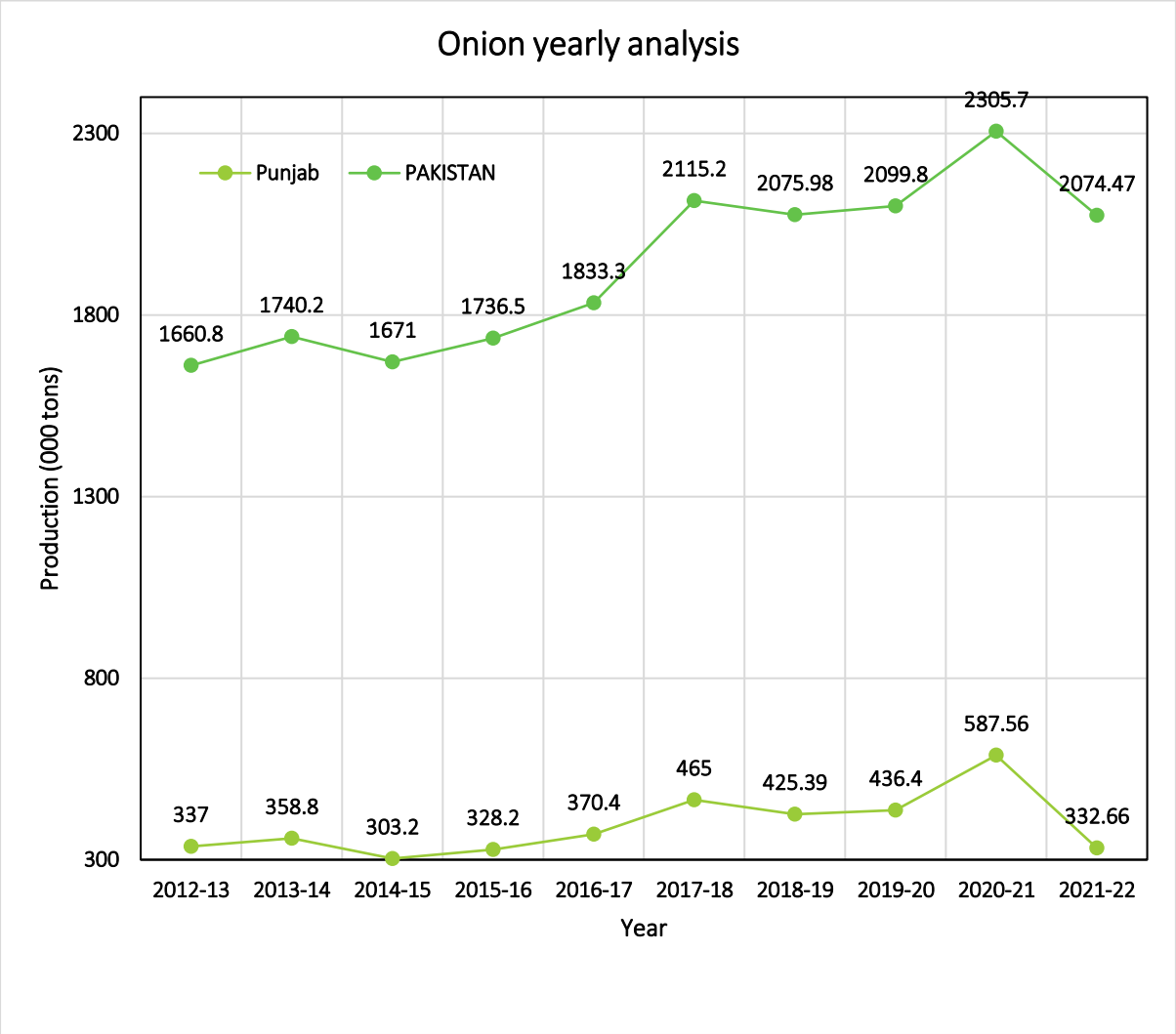


Figure 50: Onion Yearly Production (000 tons) Comparison between Punjab and Pakistan

Source: AMIS

Punjab, has consistently produced higher agricultural yields of onion compared to other provinces in the country. This could be attributed to a number of factors, such as favorable agro-climatic conditions, advanced farming practices, and access to improved technologies and inputs. The combination of these factors might have contributed to the province's sustained success in producing higher yields.

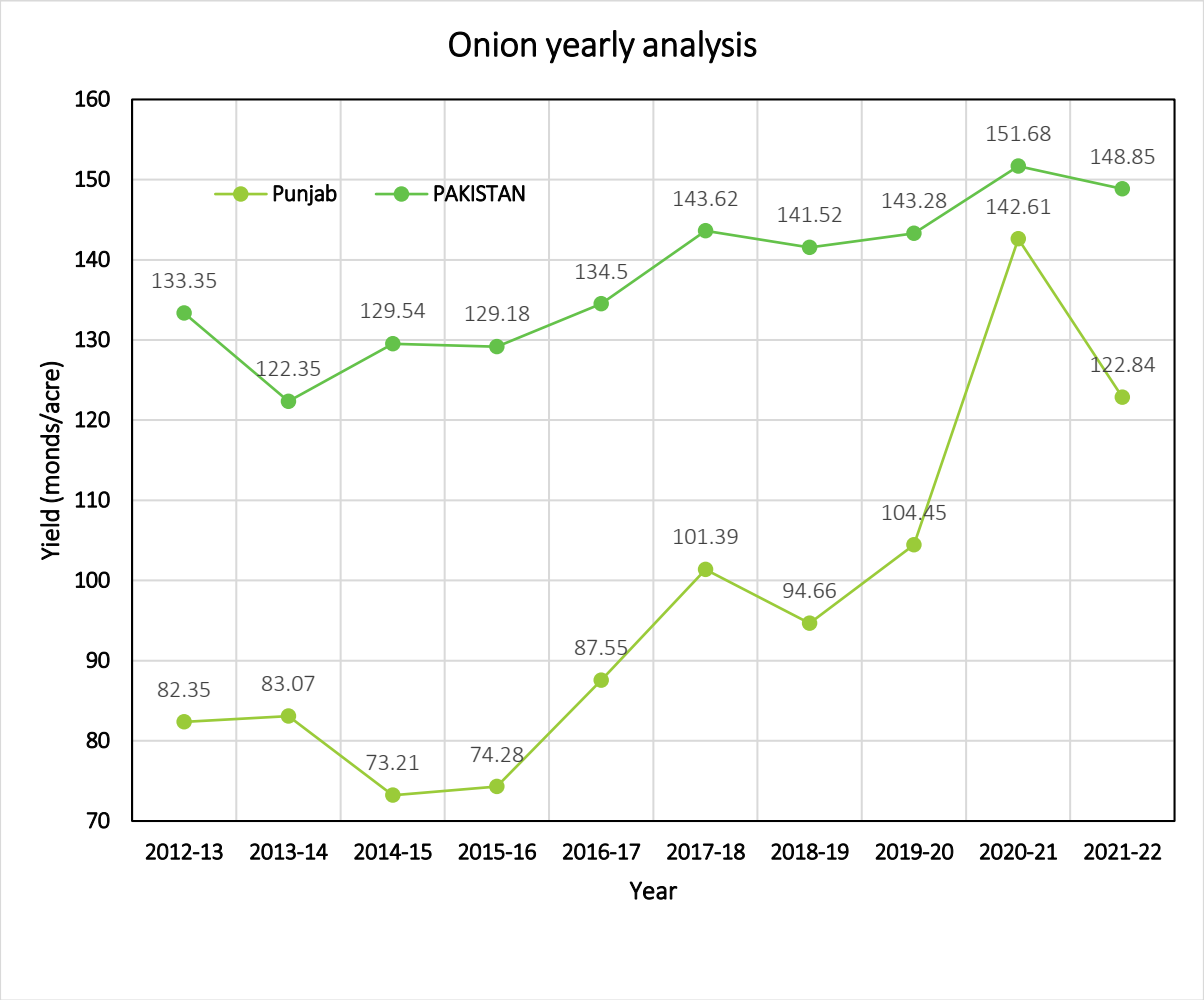


Figure 51: Onion Yearly Yield (monds/acre) Comparison between Punjab and Pakistan

Source: AMIS

BENEFITS TO SMALLHOLDER FARMERS

1. Food and Nutrition Security

- Onions play a significant role in food and nutrition security due to their widespread use, nutritional benefits, and contribution to sustainable agriculture.
- Onions are low in calories but high in essential nutrients, including vitamins C and B6, folate, potassium, and manganese.
- Onions have a relatively long shelf life, contributing to food availability and reducing waste.

2. Livestock Feed and Nutrition

- Onions contain a significant amount of carbohydrates and dietary fiber, which can be useful for energy and digestion in livestock.
- The antimicrobial properties of onions can help in reducing infections and improving gut health in livestock.
- Onions are best used as a supplementary feed rather than a main feed source. Mixing onions with other forages or concentrates can help mitigate potential negative effects.

3. Soil Fertility and Environmental Benefits

- Onion residues can be used as mulch, protecting the soil from erosion, retaining moisture, and slowly decomposing to release nutrients.
- Including onions in crop rotation plans can help manage soil health. Onions can break pest and disease cycles, reducing the need for chemical interventions.

4. Income Generation

- Onions have a long shelf life and can be stored for several months after harvest, allowing farmers to sell them gradually and manage their income flow.
- Onions can be grown on relatively small plots of land, making them suitable for small-scale farmers with limited acreage.

5. Women's Empowerment

- Onion cultivation offers women a reliable source of income, allowing them to contribute to household finances and have greater financial autonomy.
- Women farmers can become entrepreneurs by engaging in onion seedling production, processing, or value-added product development, creating additional income streams and business opportunities.

ONION VALUE ADDED PRODUCTS

Some of the value-added products of onion are paste, dehydrated flakes, powder, rings, puree, vinegar, pickle, juice, and oil. It can be made from either boiled onions or dried onions. Onion pastes are used in curry preparations.

Figure 52: Onion Value Added Products

ISSUES AND CHALLENGES IN ONION VALUE CHAIN

SEED	FARM	HARVEST & LOGISTICS	PROCESS	MARKETS
• High Seed Costs. • Limited availability of onion varieties adapted to changing climatic conditions. • Limited farmer awareness on new seed technologies	• High Cost of Production • Unavailability of Inputs. • Attack of fungal diseases	• Unavailability of modern harvesting machinery. • Limited access to real-time market information.	• Unavailability of processing facilities, • Limited access to modern and efficient processing equipment. • Dependence only on raw onion as a product.	• Price Instability. • No proper exporter setup. • Insufficient access to real-time market information.

INTERVENTIONS

SEED	FARM	HARVEST & LOGISTICS	PROCESS	MARKETS
• Subsidize certified seed production • Incentivize local nursery establishment. • Development of climate resilient varieties.	• Provision of quality fertilizer and pesticide on subsidy. • Introduction of IPM practices. • Ease of financial access.	• Introduction of production technologies and implements keeping in view climate change.	• Establishment of Onion processing unit.	• Establishment of local mandies

14.4. MANGO

Mango (Mangifera indica) holds a prominent position among fruit crops worldwide, including Pakistan. Its cultivation dates back to four centuries ago in South Asia (Yadav and Singh, 2017). Known as "The king of fruits," mango is not only delicious but also highly nutritious and valuable. Mango leaves contain a rich array of minerals (nitrogen, phosphorus, potassium, sodium, iron, calcium, and magnesium), vitamins (A, B, E, C), and proteins. In traditional medicine, mango leaf extracts have been used to treat various ailments such as diarrhea, diabetes, bronchitis, kidney issues, scabies, asthma, and respiratory problems (Kulkarni et al., 2014). The provinces of Punjab and Sindh in Pakistan provide an ideal and favorable environment for mango cultivation, contributing the most to mango production in the country (MNSFR, 2020). Popular mango varieties cultivated in Pakistan are Chaunsa, Langra, Sindhri, Anwer Ratol, and Dussehri, which not only dominate the local market but are also considered as high-demanding fruit crops in the international market. Multan, known as the heart of mango, is the 6th largest mango-producing city in the country (Tahir et al., 2012).

WORLD LEADING MANGO PRODUCING COUNTRIES

The graph shows India as the leading mango producer, producing the highest volume due to favorable climate and extensive cultivation. Indonesia is the second-largest, benefiting from its tropical climate, followed by China, which has a growing agricultural sector and increasing mango popularity.

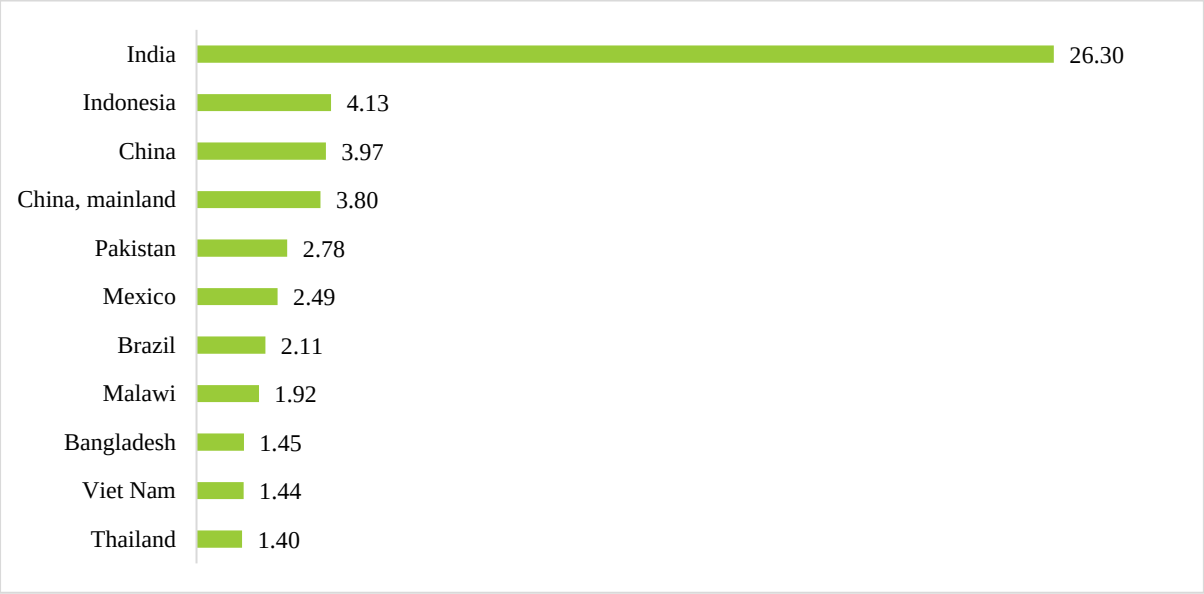


Figure 53: World Leading Mango Producing Countries (Million Tons)

Source: Trade Map, 2022-23

WORLD LEADING MANGO EXPORTING COUNTRIES

The graph shows Mexico as the leading mango exporter, supplying high-quality mangoes mainly to the US and Europe. Thailand follows with its sweet, aromatic varieties, supported by efficient agricultural practices. Peru ranks third, exporting to Europe, driven by its diverse climate and investments in mango production.

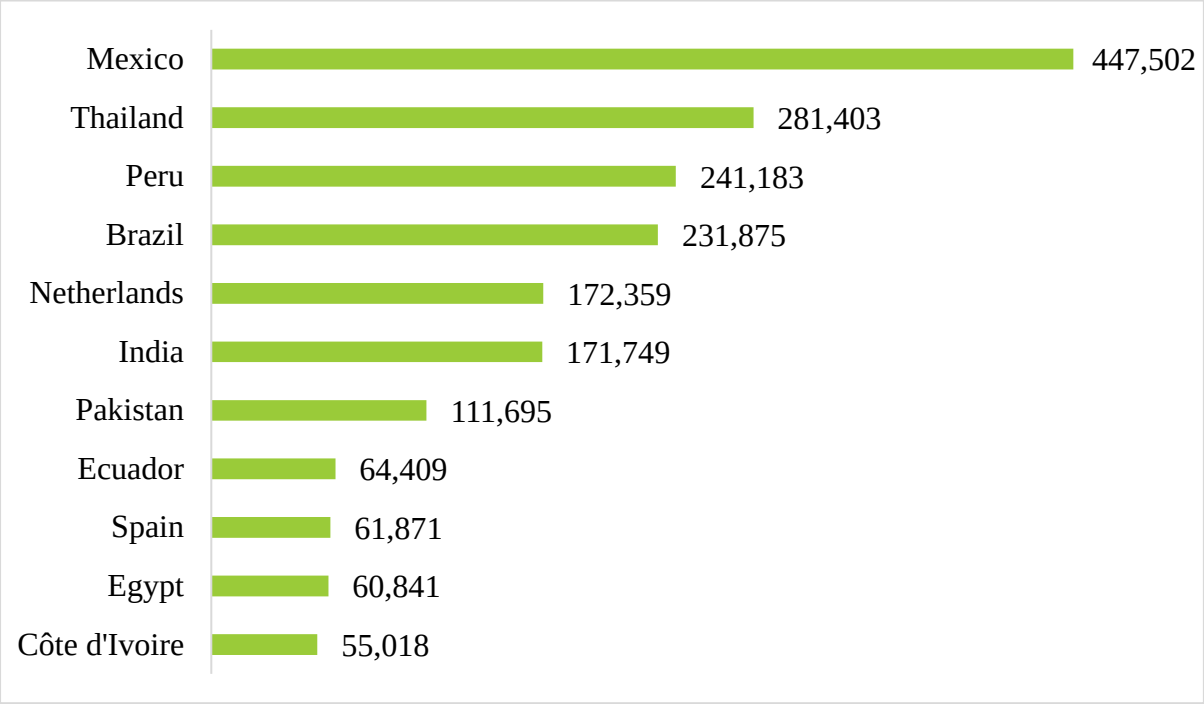


Figure 54: World leading Mango Exporting Countries (Tons)

Source: Trade Map, 2022-23

WORLD LEADING MANGO IMPORTING COUNTRIES

The graph shows the USA as the top mango importer with 607,232 tons due to high consumer demand. China follows with 291,109 tons, driven by growing interest and purchasing power. The Netherlands imports 221,483 tons, acting as a key distribution hub in Europe.

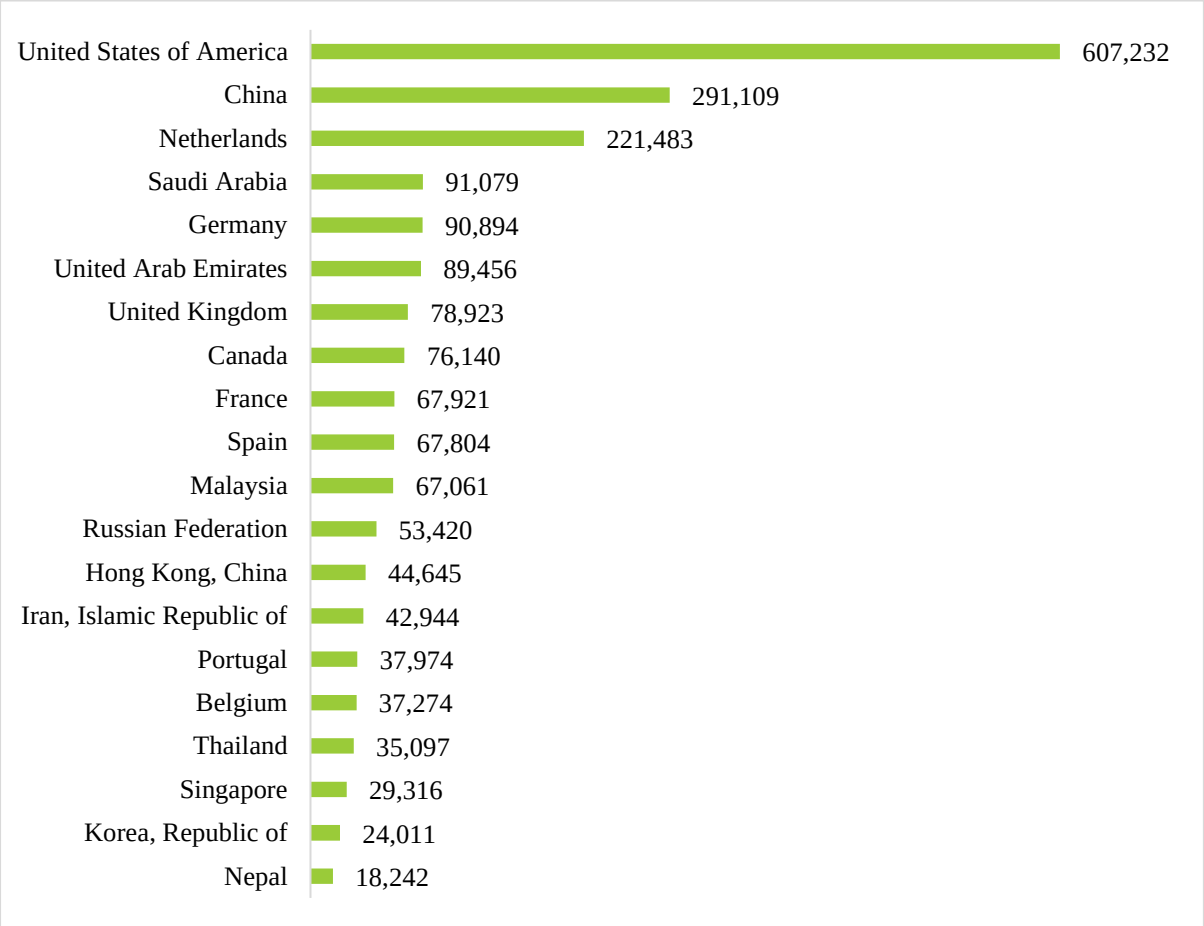


Figure 55: World Leading Mango Importing Countries (Tons)

Source: Trade Map, 2022-23

MANGO EXPORT STATUS IN INTERNATIONAL MARKET

The graph shows mango exports fluctuating with a notable increase starting from 2018, peaking in 2021, and then declining. The rise likely resulted from improved agricultural practices and increased global demand. The peak in 2021 suggests exceptional harvests or heightened market demand, but the subsequent decline could be due to factors such as natural variations in crop yields or changes in market conditions.

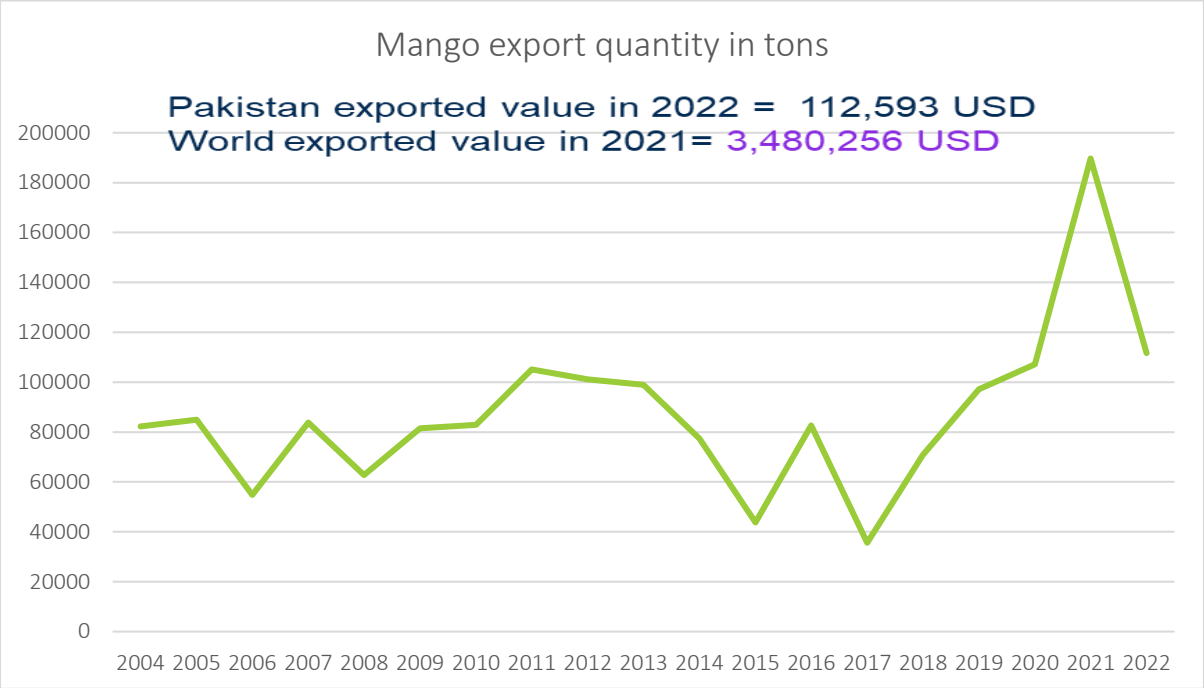


Figure 56: Mango Export Status in International Market

Source: Trade Map, 2022-23

PAKISTAN MANGO EXPORT BY COUNTRIES

Pakistan exported a total of 132,773 tons of mangoes globally. The UAE led imports with 48,364 tons, driven by strong cultural preferences. Afghanistan followed with 30,573 tons, highlighting close trade ties. Kazakhstan imported 17,143 tons, reflecting regional demand for Pakistani mangoes. These figures underscore Pakistan's significant role as a leading exporter of mangoes to regional and international markets.

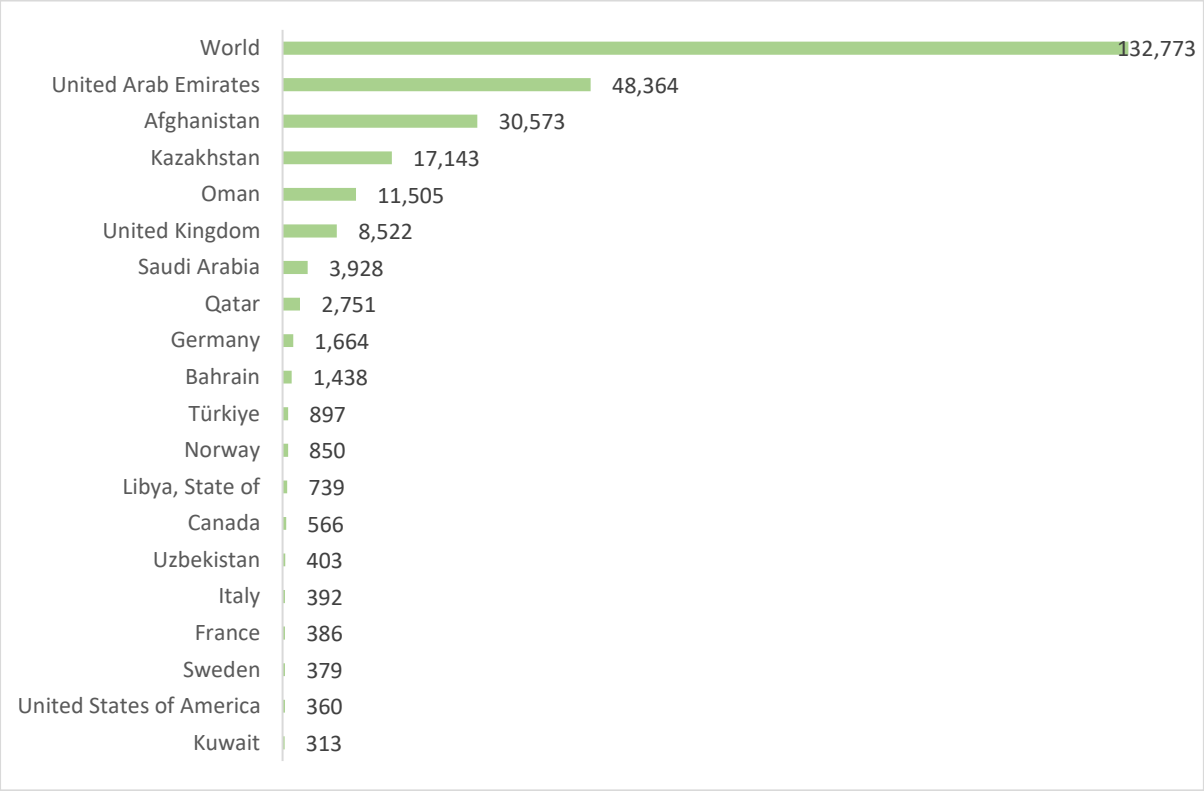


Figure 57: Pakistan Mango Export by Countries (Quantities in Tons)

Source: Trade Map, 2022-23

PAKISTAN MANGO EXPORT BY COUNTRIES VALUE

Ireland leads in importing Pakistani mangoes at 51,500 USD per ton, followed by Japan at 38,571 USD per ton and Serbia at 36,500 USD per ton. These values reflect the premium paid for Pakistani mangoes due to their quality and flavor, underscoring their high demand in these markets.

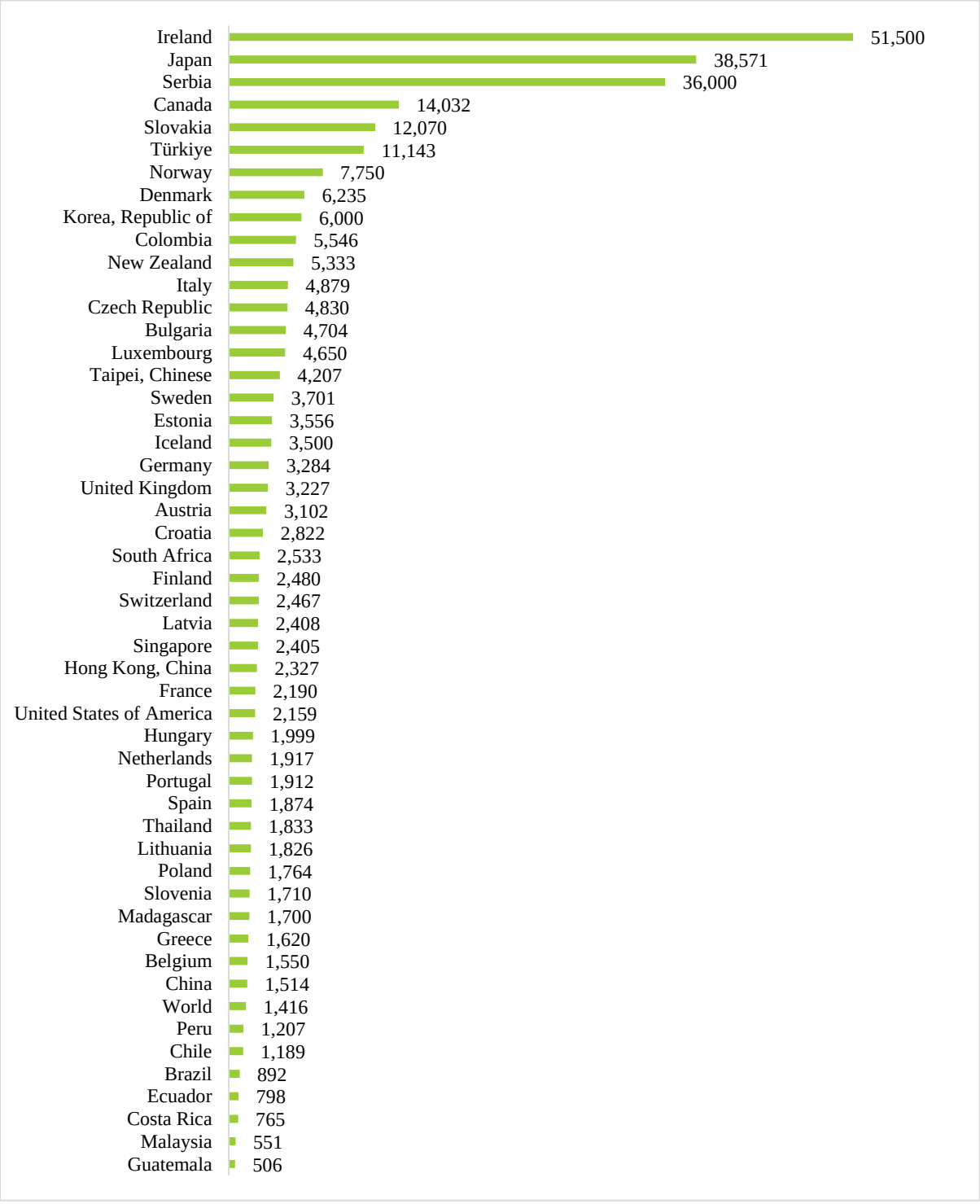


Figure 58: Pakistan Mango Export by Countries Value (USD/Ton)

Source: Trade Map, 2022-23

MANGO YEARLY COMPARISON BETWEEN PUNJAB AND PAKISTAN

From 2012-13 to 2021-22, both Punjab and Pakistan have seen decrease in mango cultivation area. The cultivation area for mango in Punjab was reduced from 269.6 thousand acres in 2012-13 to 244.67 thousand acres in 2021-22. The primary cultivation area is in D.G.Khan Division, which covers 4,507,750 acres. During this period, the cultivation area in Pakistan has reduced from 421.08 to 393.52 thousand acres, with Punjab showing the decrease growth.

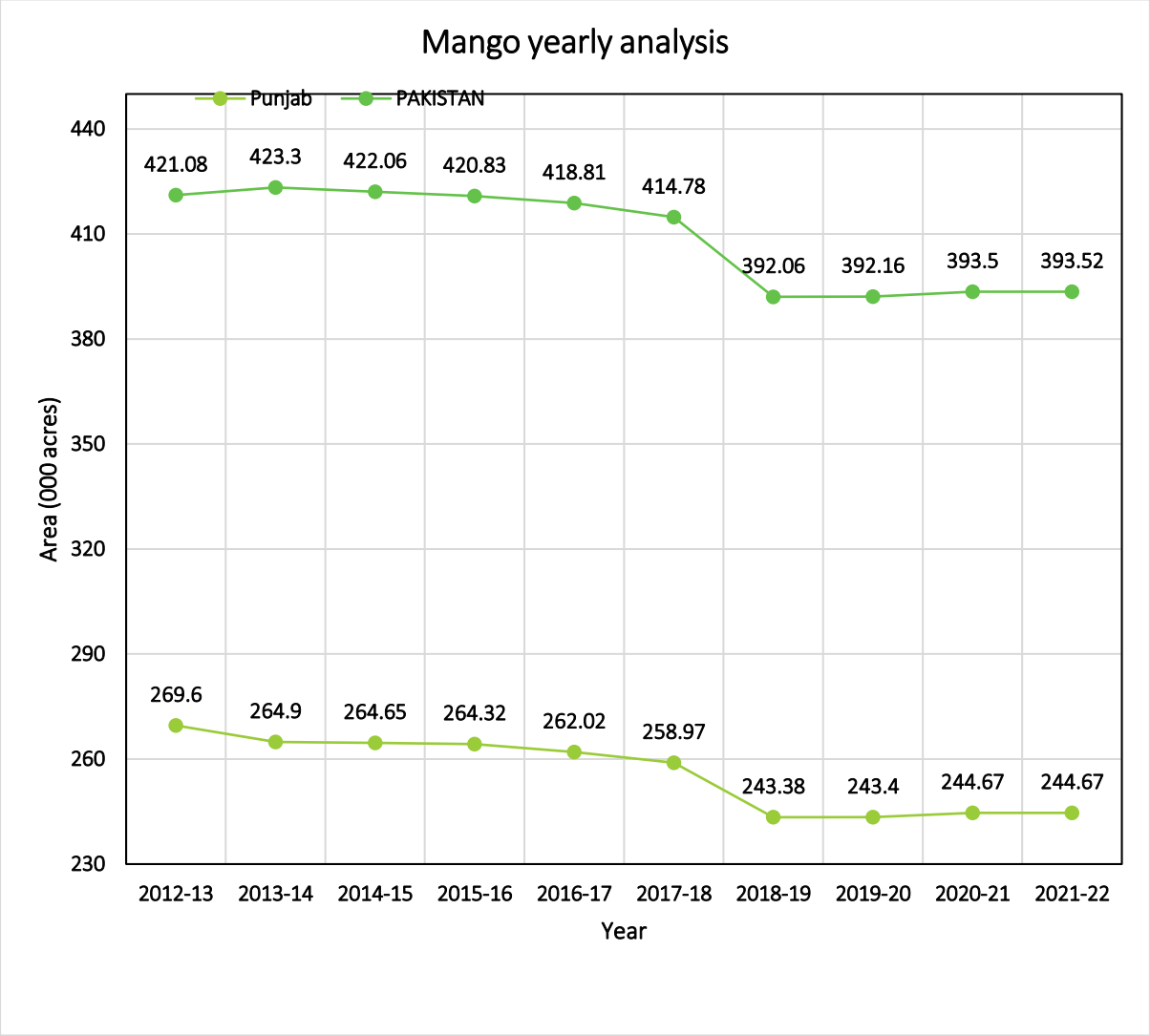


Figure 59: Mango Yearly Area (000 acres) Comparison between Punjab and Pakistan

Source: AMIS

Punjab's production generally follows the same trend as the national production, it often produces a larger quantity. The production gap between Punjab and Pakistan is notable where it shows same trend with respect to production of mango during all years.

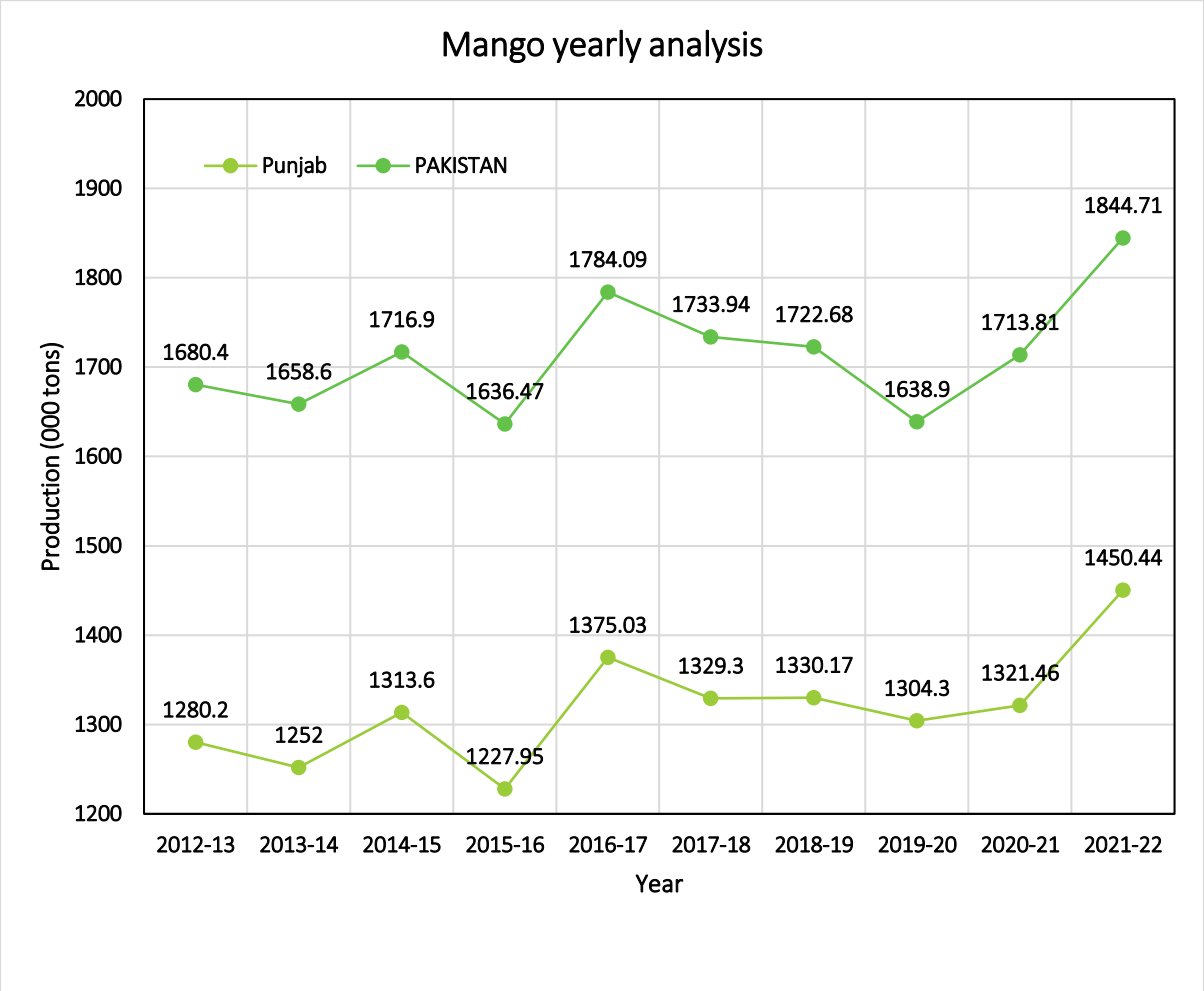


Figure 60: Mango Yearly Area (000 tons) Comparison between Punjab and Pakistan

Source: AMIS

Punjab, has consistently produced higher agricultural yields of mango compared to other provinces in the country. This could be attributed to a number of factors, such as favorable agro-climatic conditions, advanced farming practices, and access to improved technologies and inputs. The combination of these factors might have contributed to the province's sustained success in producing higher yields.

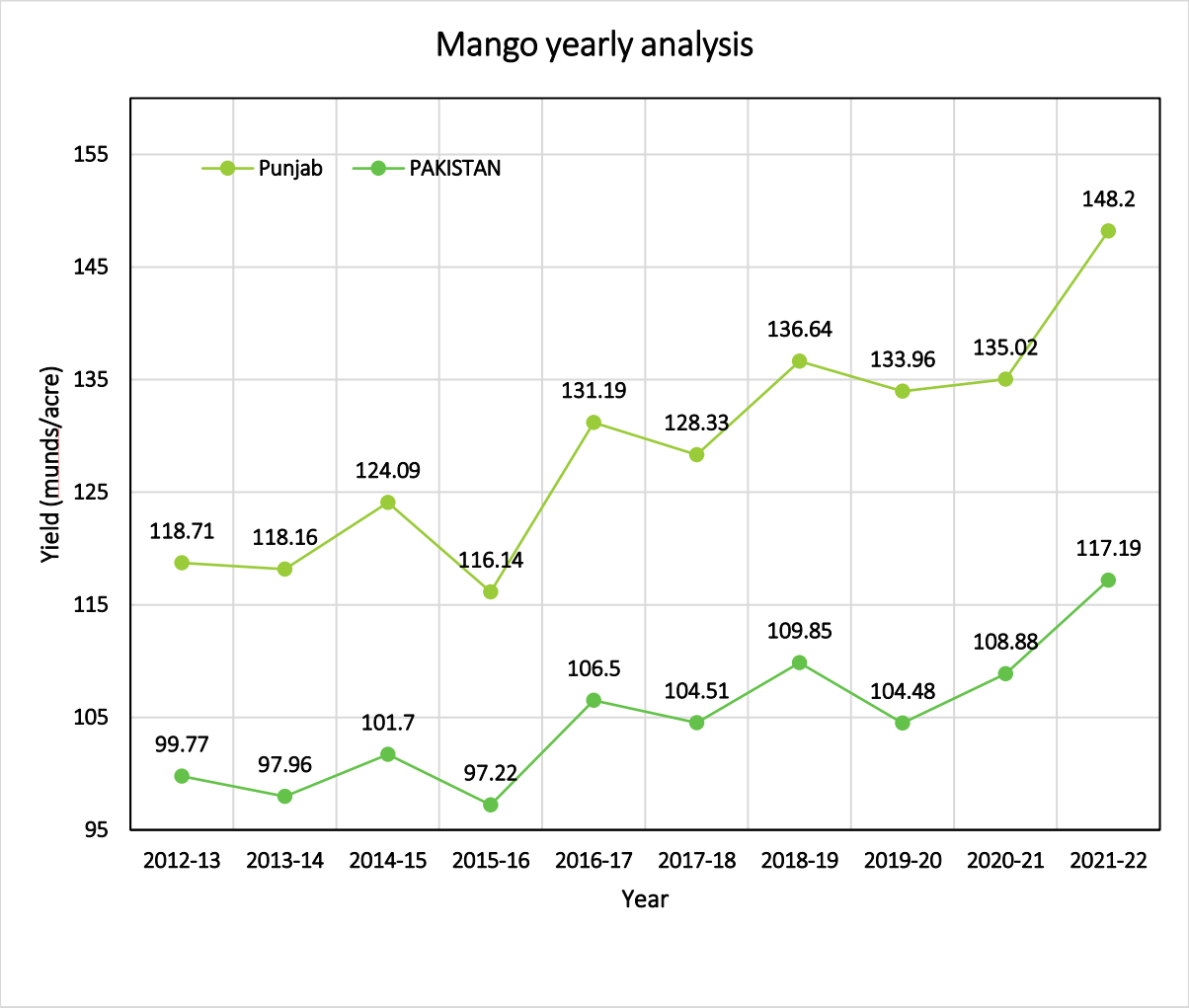


Figure 61: Mango Yearly Yield (monds/acre) Comparison between Punjab and Pakistan

Source: AMIS

ISSUES AND CHALLENGES IN MANGO VALUE CHAIN

SEED	FARM	HARVEST & LOGISTICS	PROCESS	MARKETS
• Majority of the growers raise their own nursery plants in their mango orchards which are not true to variety • Lack of initiatives and continuation in mango research • Lack of availability of certified and disease-free plants	• Poor management practices like intercropping, no pruning, irrigation application methods, imbalanced nutrition, and poor plant protection measures • Outdated production technologies • Climate change and unpredictability of the weather	• Lack of post-harvest technology (i.e., poor harvesting, handling, and packaging) • Improper harvesting practices causing quality issues like handling the injury, fruit latex on the skin of mangoes, and poor grading • Poor value chain infrastructure causes high post-harvest losses, which range from 30% to 40% of Pakistan's mango crop. • Poor handling during loading, unloading, packing, and transportation to mandis causing injuries and damage to the mangoes	• Lack of proper value chain infrastructure and processes for quality compliance in the national and international markets • Lack of well-defined grades and standards making price comparisons difficult for both consumers and value chain actors • Exporters compromising on quality for volume	• Lack of marketing initiatives, poor marketing information, and market risk are the main reasons why growers do not involve in marketing activities. • Low exportability due to risk in the export business and lack of orientation in international markets • Low quality of mangoes in domestic and international markets • Uneven profitability across the value chain stakeholders

INTERVENTIONS

SEED	FARM	HARVEST & LOGISTICS	PROCESS	MARKETS
• Encourage and support farmers to use certified and disease-free seedlings for better yield and quality • Increase investment in mango research to develop better varieties and management practices • Public sector research institutes such as	• Provide training and education to farmers on modern farming practices like good agricultural practices (GAP) and high-density plantation • Encourage the use of modern production technologies and irrigation systems • Farmers need to adopt modern management practices such as high-density	• Provide training and education to farmers and value chain actors on post-harvest management practices to reduce losses and maintain quality • Establish necessary infrastructure and information flow between stakeholders for efficient handling and transportation • Establish grades and standards and proper enforcement to improve market efficiency and ensure quality compliance	• Develop and enforce well-defined grades and standards to improve price comparisons and ensure quality compliance • Develop necessary infrastructure and resources to produce and maintain the quality of mango • Encourage exporters to focus on quality rather than just volume to improve exportability	• The government and other stakeholders can help growers through market information systems and market linkages to increase the profitability of mango production. • Develop strategies to reduce risk in the export business and improve orientation in international markets • Develop and enforce quality compliance measures to improve the quality of mangoes in both domestic and international markets

Multan Research Institute Shujabad in Punjab and Sindh Horticulture Research Institute Mirpur Khas Sindh can provide high-quality seedlings.	plantation, appropriate pruning, flood irrigation, and modern mechanization for better orchard management. • Develop climate-smart agricultural practices to adapt to climate change			• Improve profitability across the value chain stakeholders through fair pricing and support to small farmers.

MANGO VALUE CHAIN

As with many major fruits, the mango global value chain can be divided into five main segments: Production, Packaging & Cold Storage, Processing, Distribution and Marketing and Sales. Following figure illustrates these main stages.

PRODUCTION

Mango trees are perennial; they begin to produce fruits four years after planting, reaching full maturity between 10-15 years. These can be productive for up to 40 years using good management techniques, including fertilizer and irrigation use. However, mango trees are extremely susceptible to pests and diseases such as mango hopper, mealy-bug and powdery mildew among others (Asia Farming, 2017). Hence, they require regular spraying with pesticides, and spraying is generally carried out four to six times a year. As a result, pest management is one of the highest costs in the mango cultivation and can make mango production a risky activity for producers without access to resources to undertake spraying. Unlike many other commercial fruits, production of mango for exports has not yet consolidated and continues to be undertaken by a range of small, medium and large farms. Small farmers are usually grouped in cooperatives to achieve economies of scale or they are linked to a contractor that usually provides technical assistance and financial support.

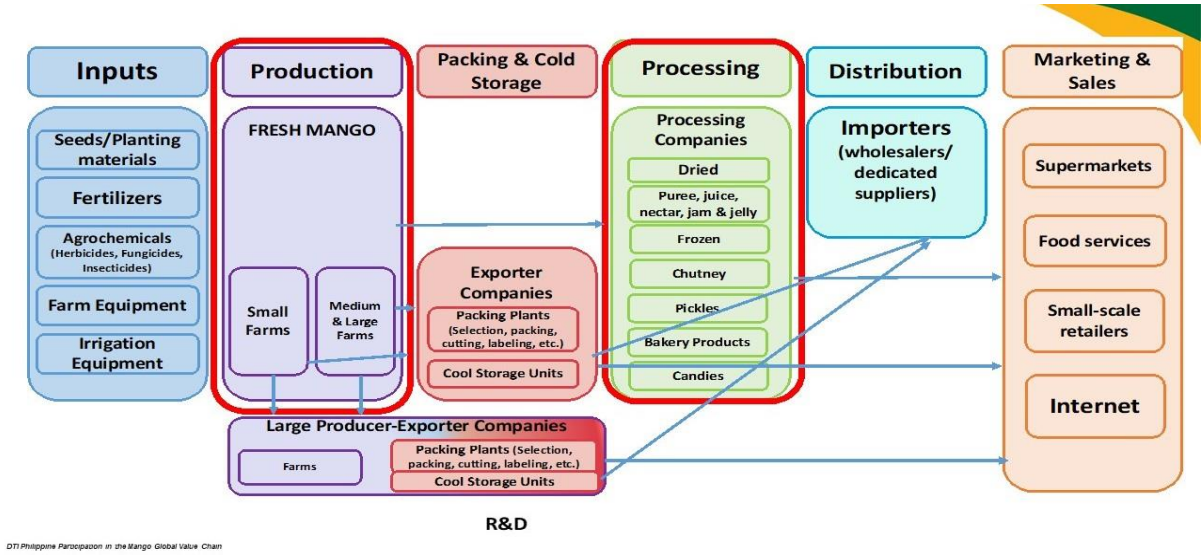


Figure 62: Mango Value Chain

PACKING AND COLD STORAGE FOR FRESH MANGOS

This segment of the chain involves the preparation of fresh mango for shipping and sale. A perishable product, the shelf life of harvested mangos is short (2-3 weeks) compared to other products such as apples (2 to 7 months), grapes (1 to 5 months) or plums (2 to 5 weeks) (CCNI, 2016). In addition, temperature controlled systems must be employed immediately after harvest until the product reaches its final destination. During this stage, fresh mangos are washed, sized and undergo a Hot Water Treatment to control fruit flies. Mangos are then graded and packed in boxes. Exporters may sell mangos to regional distributors or can sell directly to large retail stores.

PROCESSING

This stage of the chain consists primarily of manufacturing activities, converting fresh mango into a range of processed products. The most popular processed mango products are:

Dried: Fresh mangos are peeled, sliced and mixed with sugar. Then, the mango slides are laid in a tray and dehydrated. Dehydration is typically done by osmotic concentration in which the water is removed from the mango.

Purée: Mangos are processed into purée for re-manufacturing into products such as nectar, juice, concentrate, jam and jelly. Mango puree may be made from the whole mango by specialized processors, but also by factories producing dried mango that use the mango leftover on the pit to produce the purée.

IQF: Individual Quick Frozen (IQF) is a technology that allows each piece of fruit to be frozen separately avoiding large chunks of frozen product. The shelf life of IQF mango is up to 24 months. This form of mango is later used in smoothies, salads and confectionaries (Octo Frost, 2016).

Activities in this stage of the chain undertaken by a different set of firms than those involved in production and, while inherently linked to on-farm cycles due to the need for raw materials to maximize installed capacity, this is characterized by lower risk than agricultural production. In addition, this stage further differs in terms of factor intensity compared to cultivation; in the cultivation of mangos, labor is a key component, while in the processing stage of the chain, capital is the main component needed to acquire the necessary equipment and infrastructure.

DISTRIBUTION

The distribution segment of the value chain incorporates all activities corresponding to the reception of the mangos in the end market and delivery to sales outlets. Many exporters sell directly to end clients, but in other cases, brokers or intermediaries may be used in destination country. There is a growing tendency today to focus on direct buying and eliminating intermediaries. However, this requires production and shipping of consistent quality fruit, as there are usually limited mechanisms – particularly for fresh mango exports - for redirecting the shipments rejected by the client to less demanding markets. Brokers tend to be used more often by smaller producers or those that are new to the GVC, serving to aggregate supply and minimize transaction costs for final buyers. In the case of processed mango this is similar in which the exporter sells directly to large food retailers or food manufacturers. Exporters may also sell their products through distributors.

MARKETING AND SALES

This stage involves the point of sale to the final consumer. Marketing and sales activities are performed by several different actors depending on the geographic end-market. These include supermarkets, food services and small-scale retail outlets. Supermarkets increasingly represent the most important market channel, accounting for the largest share of the fruits and vegetable sales in key markets.

MANGO VALUE ADDED PRODUCTS

Mangoes have been transformed into a variety of value-added products that highlight their delicious flavor and versatility. These include beverages made from mango pulp, such as juices and smoothies, as well as delectable mango jams, pickles, and chutneys. Additionally, mangoes are used to create sweet treats like mango toffees and ice cream. They are also utilized in producing mango vinegar and wines, showcasing their potential in both culinary and beverage industries.

Figure 63: Mango value added products

14.5. COTTON

Cotton is the most important natural textile crop in the world, providing 81% of global natural fiber and accounting for 27% of the world's textile production (FAO, 2021). Two allopolyploid species, *Gossypium hirsutum* L. and *G. barbadense* L., were independently domesticated in the American subtropics (Yuan *et al.*, 2021) and now are grown on all continents except Antarctica, producing the majority of the global cotton harvest. In addition, its oleoproteaginous seeds make cotton a major global crop for oil production and livestock feed (Bellaloui *et al.*, 2015). Because of the importance of cotton in clothing, in world industrial and economic development (Wendel and Grover, 2015), and in the history of civilizations, the genus *Gossypium* has attracted much scientific interest from taxonomists, geneticists, archaeologists, ethnologists, and historians. It commonly known as "white gold" is an important cash crop for Pakistan and normally grow in agriculture plains of Punjab and Sindh.

WORLD LEADING COTTON PRODUCING COUNTRIES

The graph shows China as the top cotton producer, benefiting from advanced farming and a large textile industry. India follows with vast arable land and significant economic reliance on cotton farming. The USA ranks third, known for mechanized farming and high-quality yields.

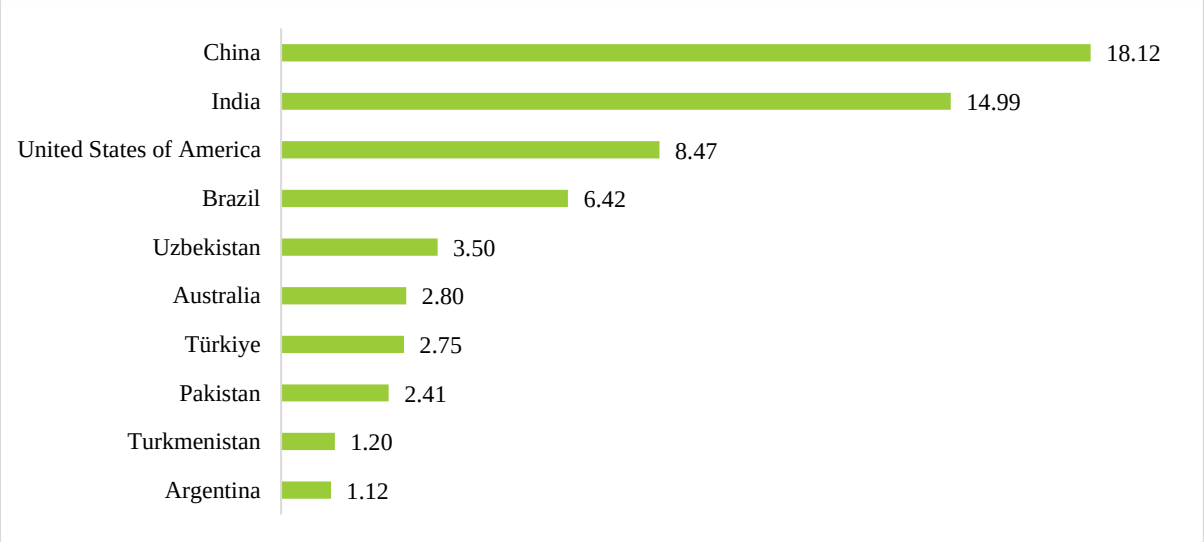


Figure 64: World Leading Cotton Producing Countries (Million Tons)

Source: Trade Map, 2022-23

WORLD LEADING COTTON EXPORTING COUNTRIES

The graph shows the USA as the top cotton exporter, benefiting from high-quality production and efficient supply chains. Brazil follows, with favorable conditions and modern farming techniques. Australia ranks third, known for high efficiency and quality.

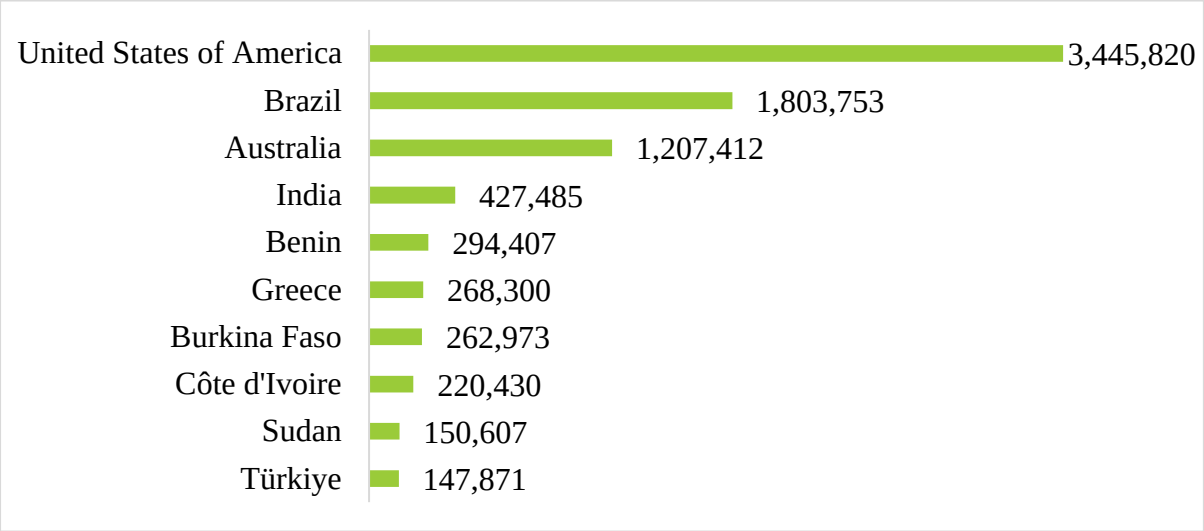


Figure 65: World leading Cotton Exporting Countries (Tons)

Source: Trade Map, 2022-23

WORLD LEADING COTTON IMPORTING COUNTRIES

The graph shows China as the top cotton importer, driven by its large textile industry. Vietnam follows due to its rapidly growing garment sector. Bangladesh ranks third, reflecting its robust apparel industry. These countries import the most cotton to support their significant textile manufacturing and export needs.

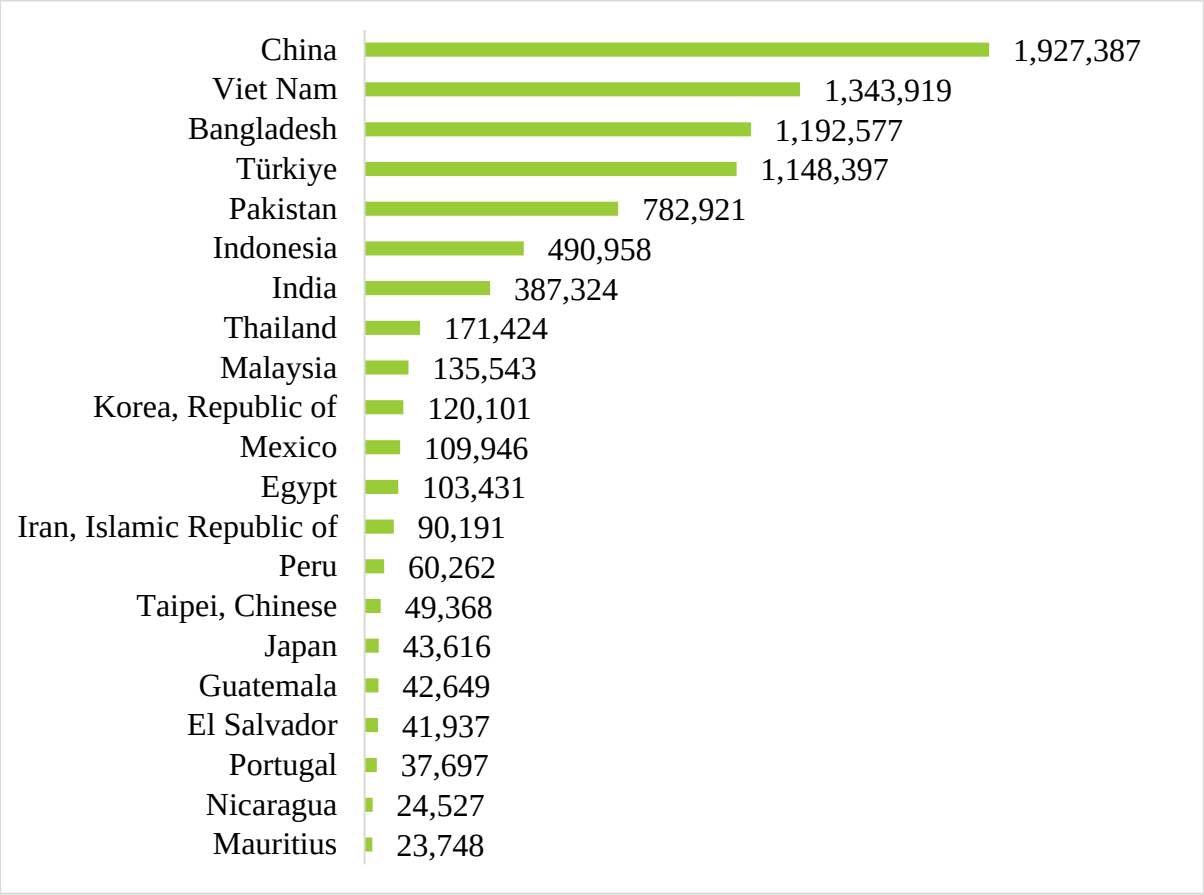


Figure 66: World Leading Cotton Importing Countries (Tonnes)

Source: Trade Map, 2022-23

COTTON EXPORT STATUS IN INTERNATIONAL MARKET

The line graph shows cotton exports rising from 2008-09, peaking during 2012-13, and then declining. The peak in 2012-13 was due to record production and strong market prices. In 2022, Pakistan's cotton export value was 16,498 USD, reflecting continued but reduced export activity.

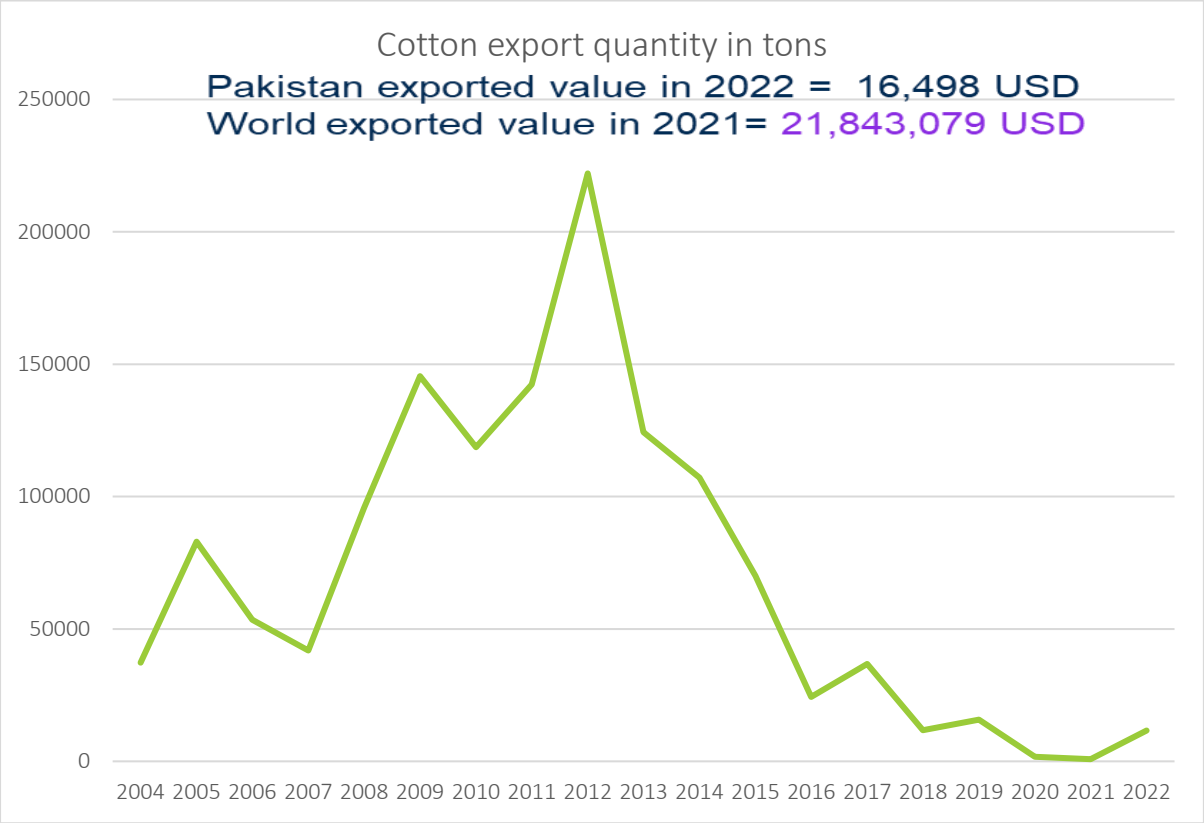


Figure 67: Cotton Export Status in International Market

Source: Trade Map, 2022-23

PAKISTAN COTTON EXPORT BY COUNTRIES

The graph shows Pakistan's cotton export quantities, with a global total of 11,643 tons. Bangladesh is the largest importer, receiving 8,984 tons, while Vietnam follows with 1,409 tons. Indonesia imported 1,249 tons, supporting its textile sector.

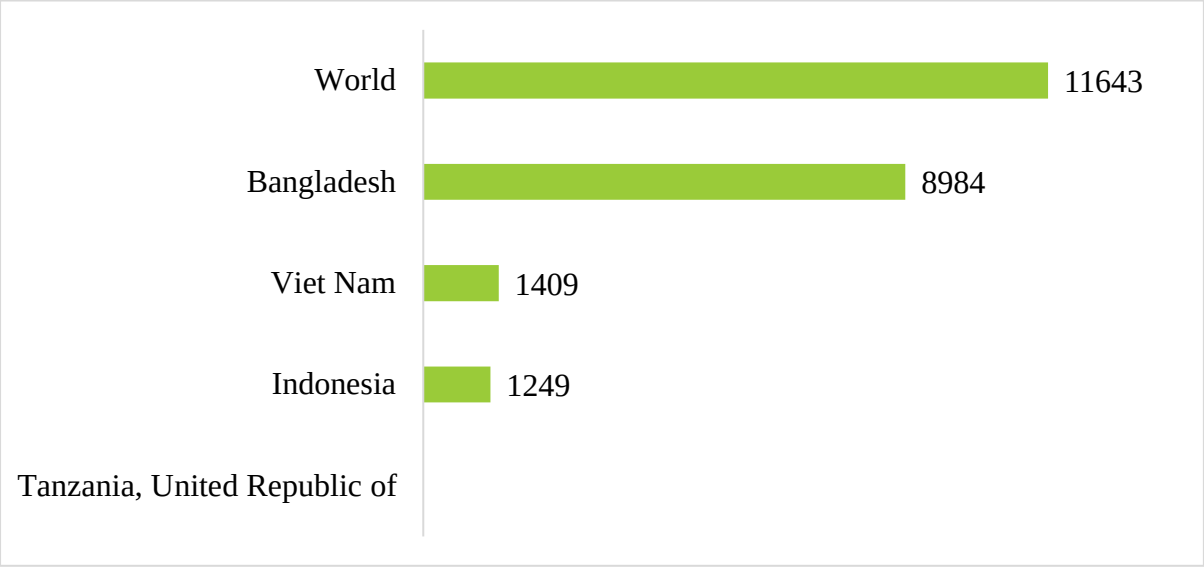


Figure 68: Pakistan Cotton Export by Countries (Quantities in Tons)

Source: Trade Map, 2022-23

PAKISTAN COTTON EXPORT BY COUNTRIES VALUE

The graph illustrates Pakistan's cotton export values per ton to different countries, with Bangladesh leading at 1,460 USD per ton. The global average follows closely at 1,417 USD per ton, indicating the overall pricing trend for Pakistani cotton exports. Indonesia imports at 1,288 USD per ton, underscoring its reliance on Pakistani cotton for its textile sector whereas Vietnam follows at 1,259 USD per ton.

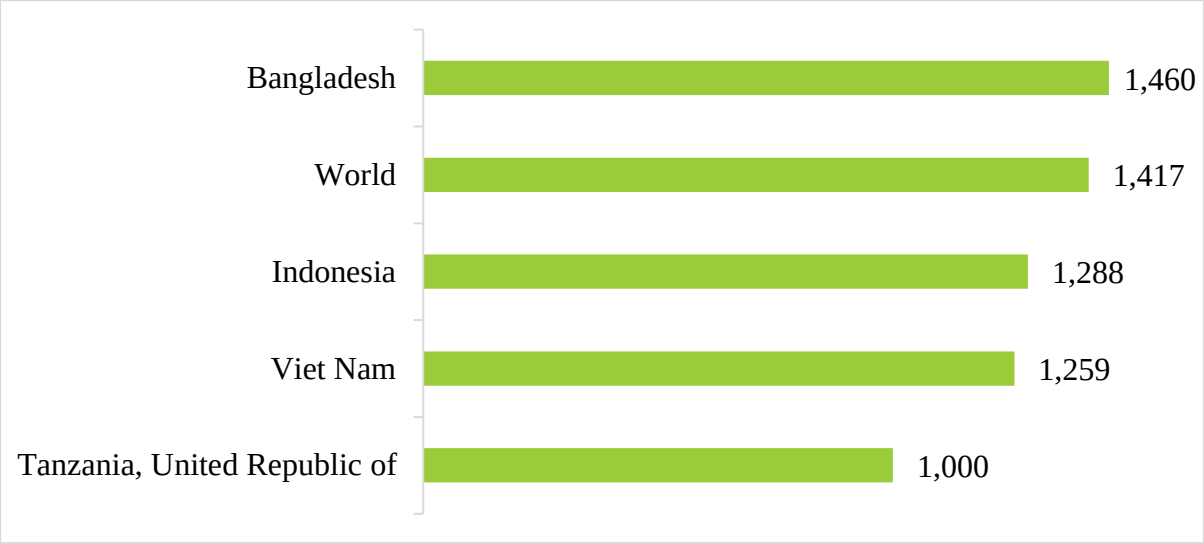


Figure 69: Pakistan Cotton Export by Countries Value (USD/Ton)

Source: Trade Map, 2022-23

COTTON YEARLY COMPARISON BETWEEN PUNJAB AND PAKISTAN

From 2012-13 to 2021-22, the cultivation area of cotton continuously reduced in both Punjab and Pakistan. The cultivation area for cotton in Punjab was reduced from 5705.03 thousand acres in 2012-13 to 3161.01 thousand acres in 2021-22. The primary cultivation area is in D.G. Khan Division, which covers 4,507,750 acres. During this period, the cultivation area in Pakistan has reduced from 7113.8 to 4786.44 thousand acres, with Punjab showing the most reduced growth.

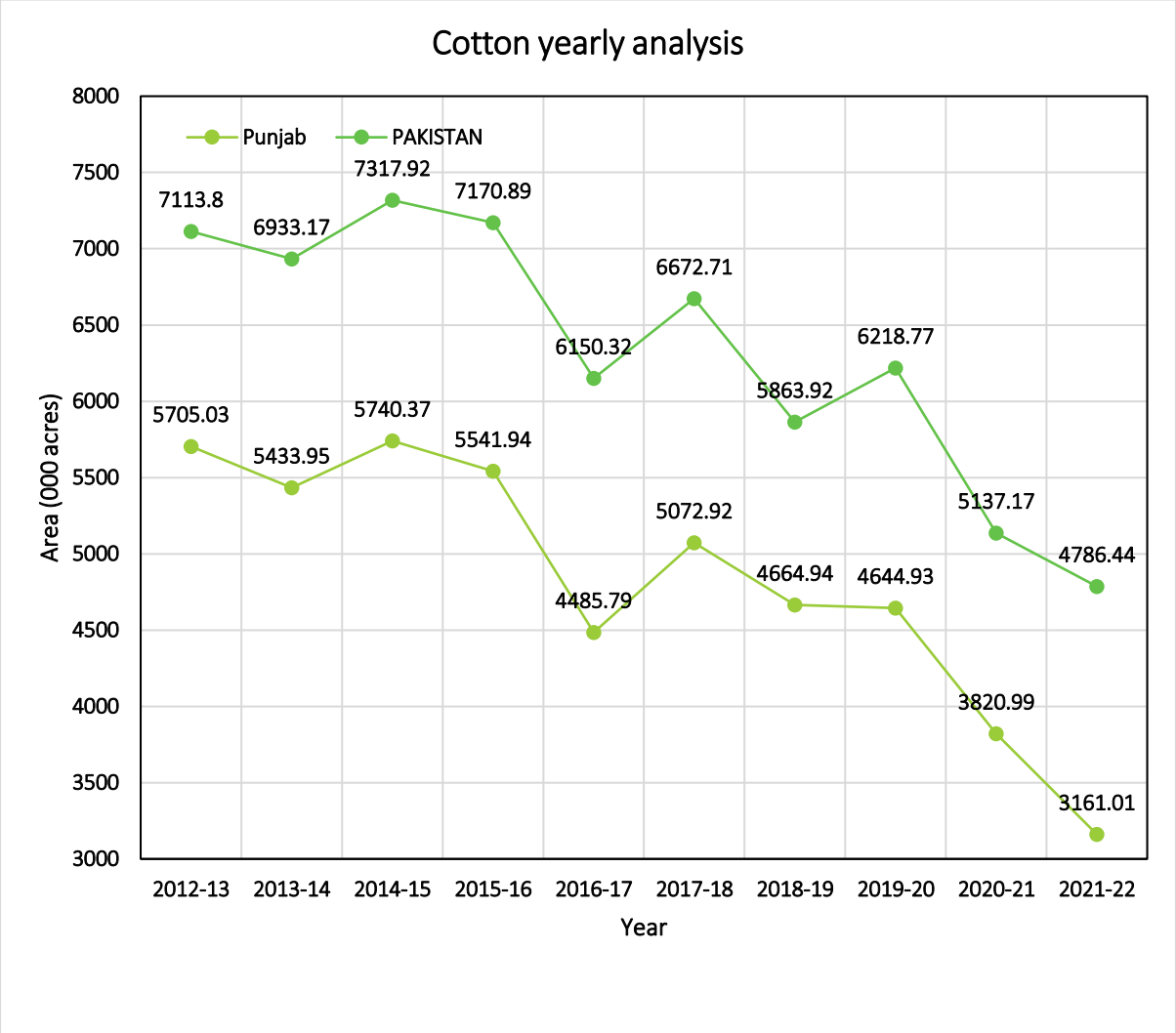


Figure 70: Cotton Yearly Area (000 acres) Comparison between Punjab and Pakistan

Source: AMIS

Punjab's production generally follows the same trend as the national production, it often produces a larger quantity. The production gap between Punjab and Pakistan is particularly notable in 2020-21 and 2021-22, indicating Punjab's increasing dominance in cotton production.

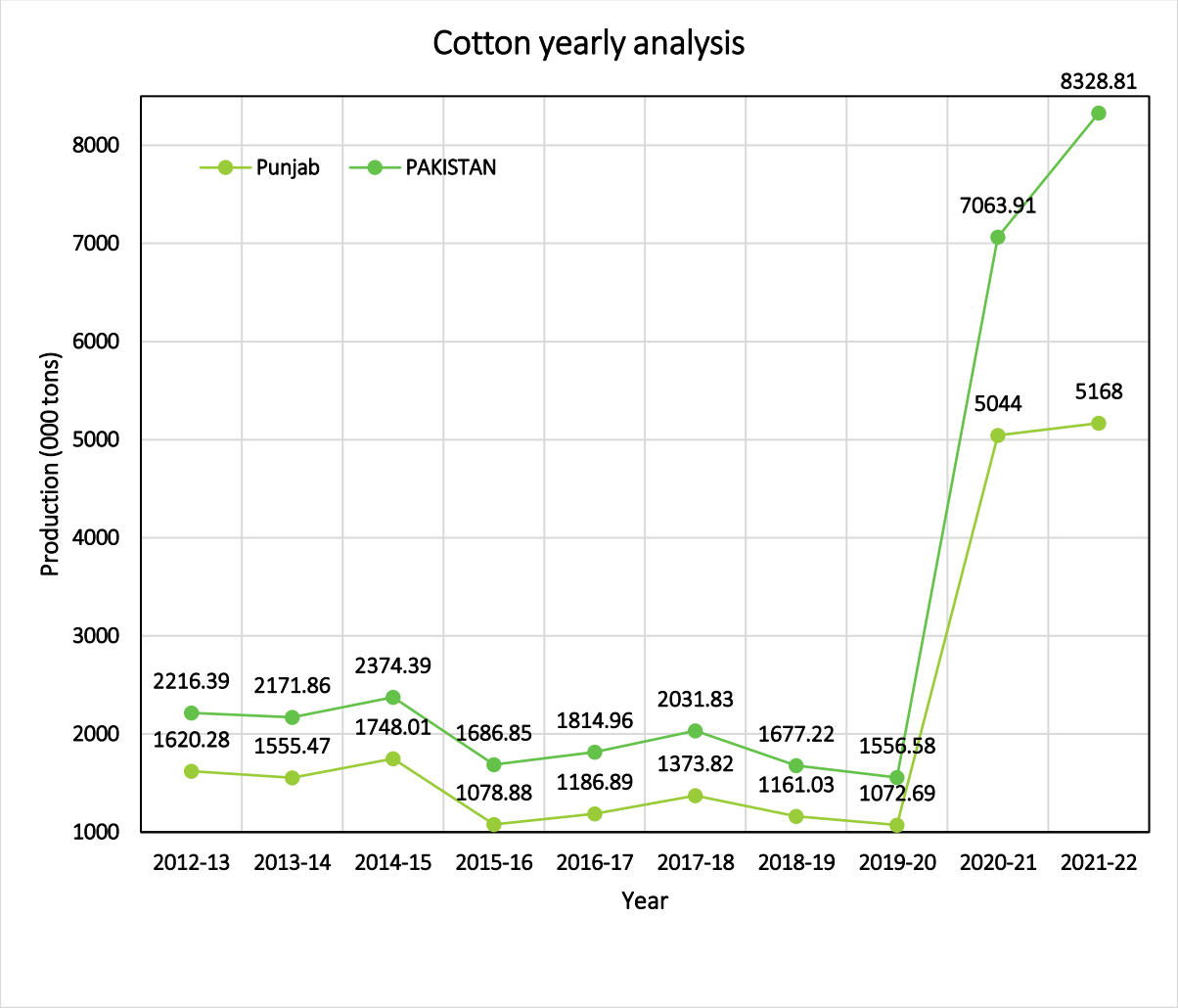


Figure 71: Cotton Yearly Production (000 tons) Comparison between Punjab and Pakistan

Source: AMIS

Punjab, has consistently produced higher agricultural yields of cotton compared to other provinces in the country. This could be attributed to a number of factors, such as favorable agro-climatic conditions, advanced farming practices, and access to improved technologies and

inputs. The combination of these factors might have contributed to the province's sustained success in producing higher yields.

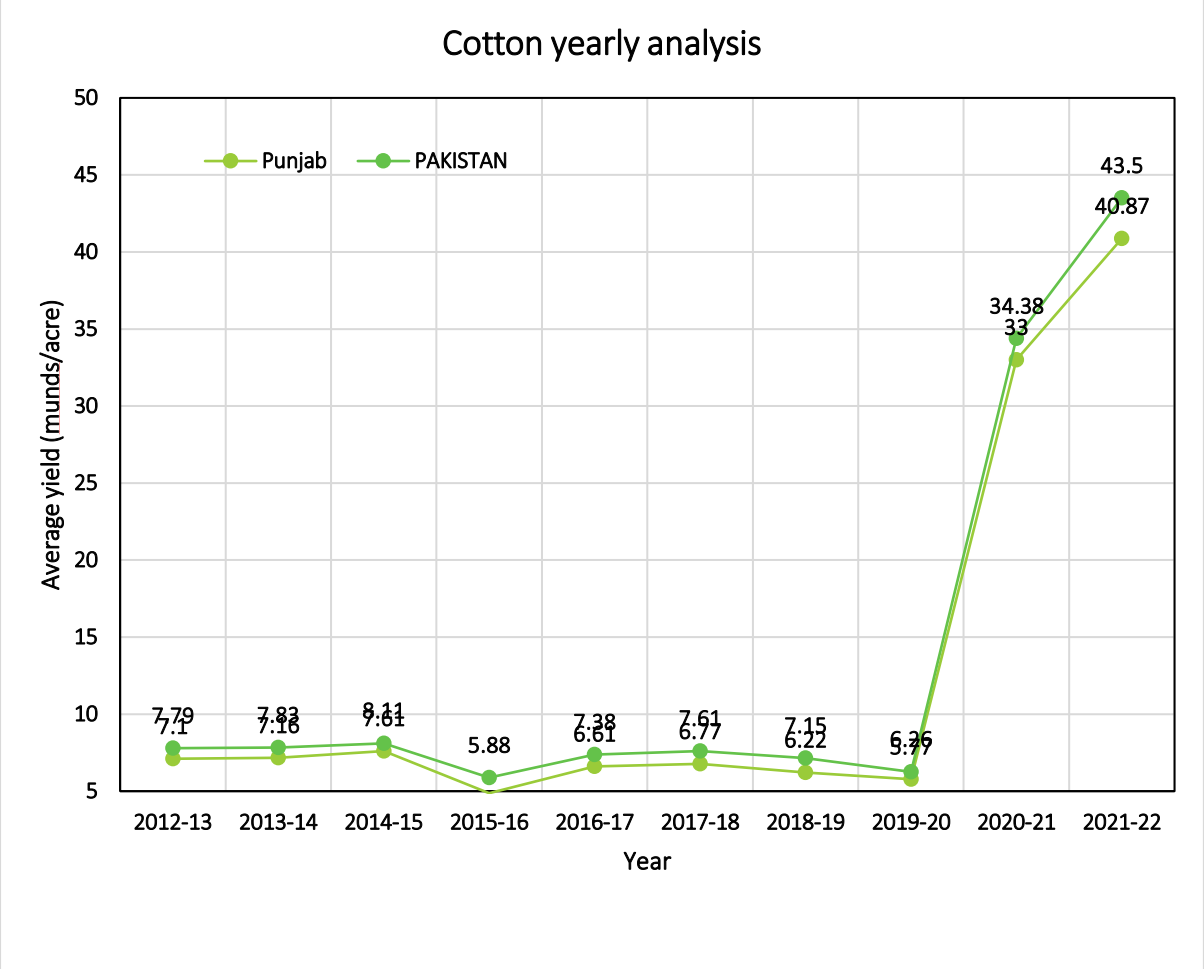


Figure 72: Cotton Yearly Yield (monds/acre) Comparison between Punjab and Pakistan

Source: AMIS

COTTON VALUE CHAIN

The supply chain involves the picking of cotton bolls, separating the lint, spinning the lint into yarn, cutting and weaving the yarn into fabric, and converting the fabric into final products, then distributing these final products to wholesalers who on-sell to retailers who sell to the final consumer, Figure 2. At various stages storage and transport facilities are required which add to the environmental impacts of the cotton supply chain.

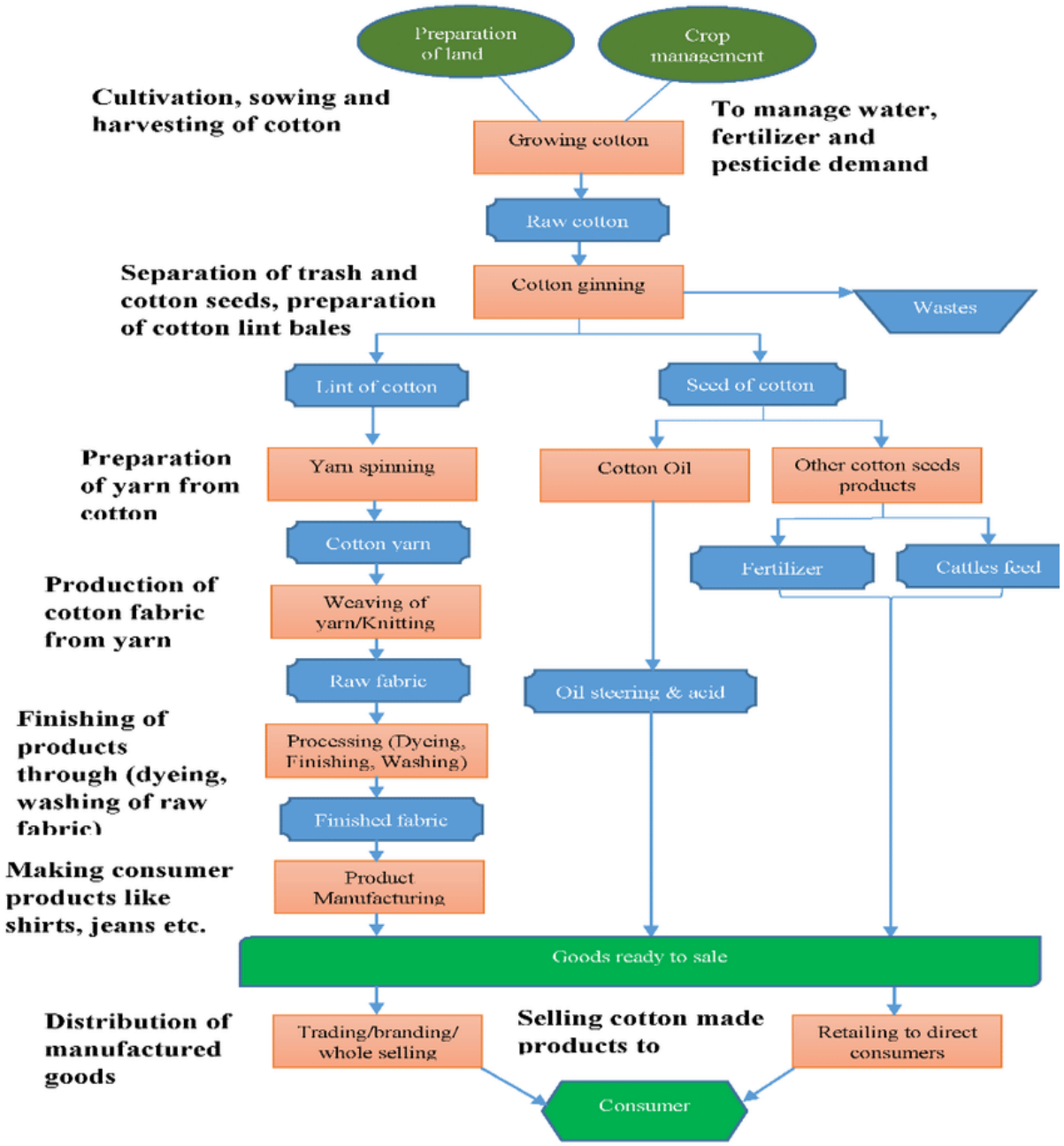


Figure 73: Cotton Value Chain

COTTON VALUE ADDED PRODUCTS

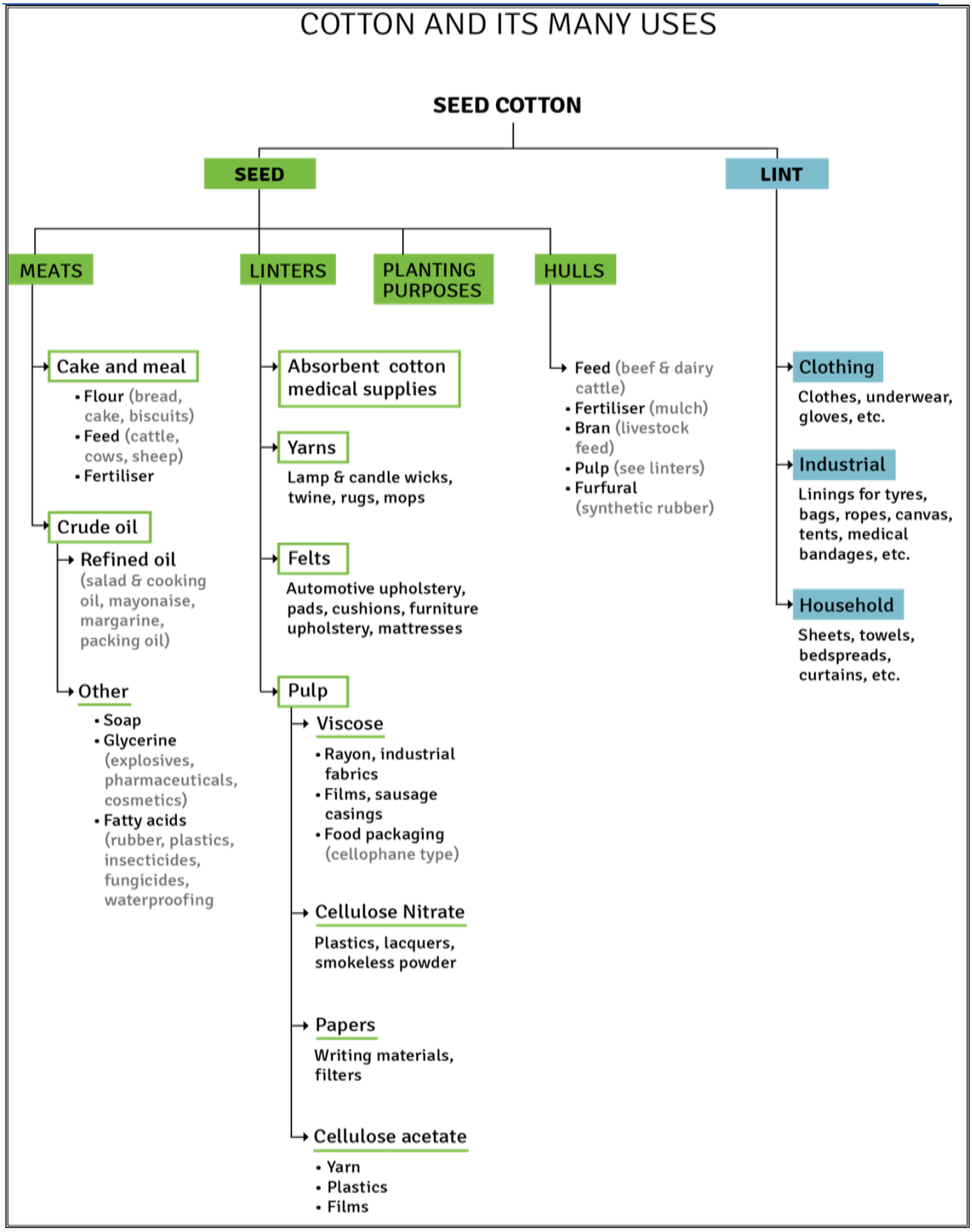


Figure 74: Cotton Value Added Product

ISSUES AND CHALLENGES

SEED	FARM	HARVEST & LOGISTICS	PROCESS	MARKETS
• Most cotton seeds in Punjab are genetically modified Bt cotton (Bollgard-I), which has lost effectiveness against cotton bollworms. • Seed quality is low, with only 60-65% certified seed availability for cotton cultivation, leading to low germination rates. • The informal seed sector, such as farmer-to-farmer sales, is a limiting factor in providing quality seeds. • For the upcoming season, over 35,000 MT of quality seed is required, including unapproved seed varieties.	• Climate change, pests, diseases, water deficiency, and soil degradation are major challenges faced by farmers. • Inefficient water usage, outdated GMO technology, and weeds infestation are limiting factors for yield. • Low literacy rate and economic constraints restrict farmers' access to advanced production technologies. • Water scarcity during cotton growth affects physiological and quantitative traits.	• Labour shortage in the agricultural sector is a major problem, with the migration of labour forces from rural to urban areas causing a lack of pickers. • Cotton picking is done manually in Pakistan, and the unavailability of pickers results in seed cotton loss and a decrease in lint and seed quality.	• Inefficiencies at the ginning stage result in low-quality lint. • Contamination during processing leads to lower price levels for cotton.	• Marketing reforms are needed to reduce contamination and increase price levels. • Farmers require proper financial incentives to eliminate contamination and increase cotton value.

INTERVENTIONS

SEED	FARM	HARVEST & LOGISTICS	PROCESS	MARKETS
• Acquire germplasm and technology, maintain high-quality inbred lines, and produce sufficient high-quality breeder seed. • Use public-private partnerships (PPPs) to access advanced seed technology with international partners. • Implement seed act and make revisions to discourage the informal sector. • Acquire germplasm and technology, maintain high-quality inbred lines, and produce sufficient high-quality breeder seed.	• Provide well-resourced and staffed public research systems at the provincial level. • Enhance capacity for extension services through PPPs, including agri-graduate field engagement programs and ICT-led extension and advisory services. • Train and support farmers in using quality inputs, preventive management, and	• Develop strategies to address labour shortages, such as training and incentivizing local labour. • Encourage farmers to shift from manual picking to mechanical cotton pickers. These machines can significantly reduce labor costs and increase harvesting speed, thereby improving overall productivity. • Conduct training programs and awareness campaigns	• Upgrade ginning equipment to improve lint quality. • Build capacity of ginners with revised standards to ensure quality assurance at each stage.	• Implement structural reforms by establishing an independent governing authority (Cotton Council) that works across all stakeholders in the value chain. • Announce intervention prices, ensuring a margin for

	mechanization services. • Improve water storage capacity to ensure sufficient supply during the cotton-growing season.	to educate farmers about the benefits of mechanized harvesting and the proper operation and maintenance of machinery.		farmers, and consider adopting a minimum ensured price (MEP) system, as seen in India.

14.6. CITRUS

Citrus is a genus from the Rutaceae family comprised of citrus fruits. Citrus is also used as a common name for different citrus fruits (Russo et al., 2021). Citrus falls under the category of non-climacteric fruits. Thus, once harvested, their eating quality cannot be improved. Therefore, harvesting should be done when the ripeness and quality are at their best. The fruit has been reported to show better shelf-life and retention of quality during storage when it is harvested along with small pedicels. The total world citrus production was over 146 million tons in 2017, which was the most prominent single category in fruit production (Pan et al., 2019). Harvesting methods, post-harvest handling, injuries, packaging, and climatic conditions decide the storage stability and quality retention during storage. Continuous loss of water during storage and transportation adversely affects the quality and nutrition of citrus fruit. Methods of scavenging, packaging, and cold storage have detrimental effects on moisture stability, thus, affecting the quality of fruit post-harvest. The rate of moisture loss is highly controlled by meteorological factors such as temperature, relative humidity, and air speed (aeration) (Richa et al., 2016).

CITRUS PRODUCTION BY TYPES IN THE WORLD

The pie graph illustrates global citrus production by types, with oranges leading at 49% of the total. Pakistan's contribution to global orange production is minimal, standing at just 0.02%. Mandarins account for 31%, with Pakistan contributing 4%, indicating a more substantial role in mandarin production. Lemon and lime production collectively make up 12%, with Pakistan's share at 0.04%. Grapefruits represent 8%, with Pakistan's contribution minimal at 0.01%.

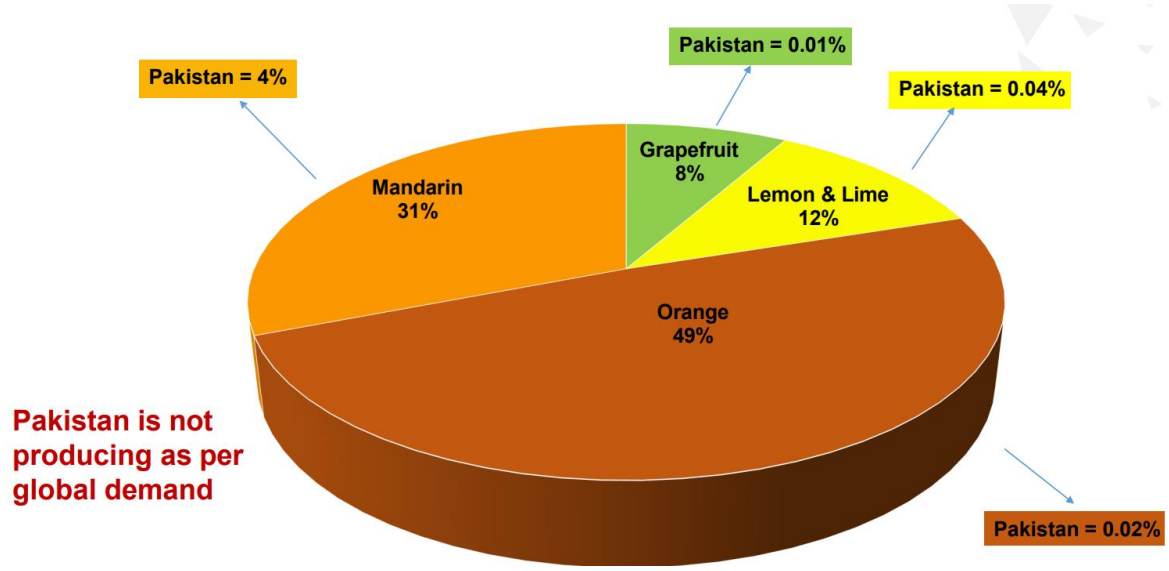


Figure 75: Citrus Production by Types in the World (%)

Source: Trade Map, 2022-23

WORLD PRODUCTION SHARE OF ORANGES

The graph shows the global production (49%) shares of oranges, with Brazil and China each contributing 21%, and India accounting for 9%. Brazil's and China's equal shares highlight their significant roles as leading producers, supported by favorable agricultural conditions and extensive cultivation areas. India follows, contributing significantly to the global orange supply with its diverse agro-climatic zones supporting year-round production.

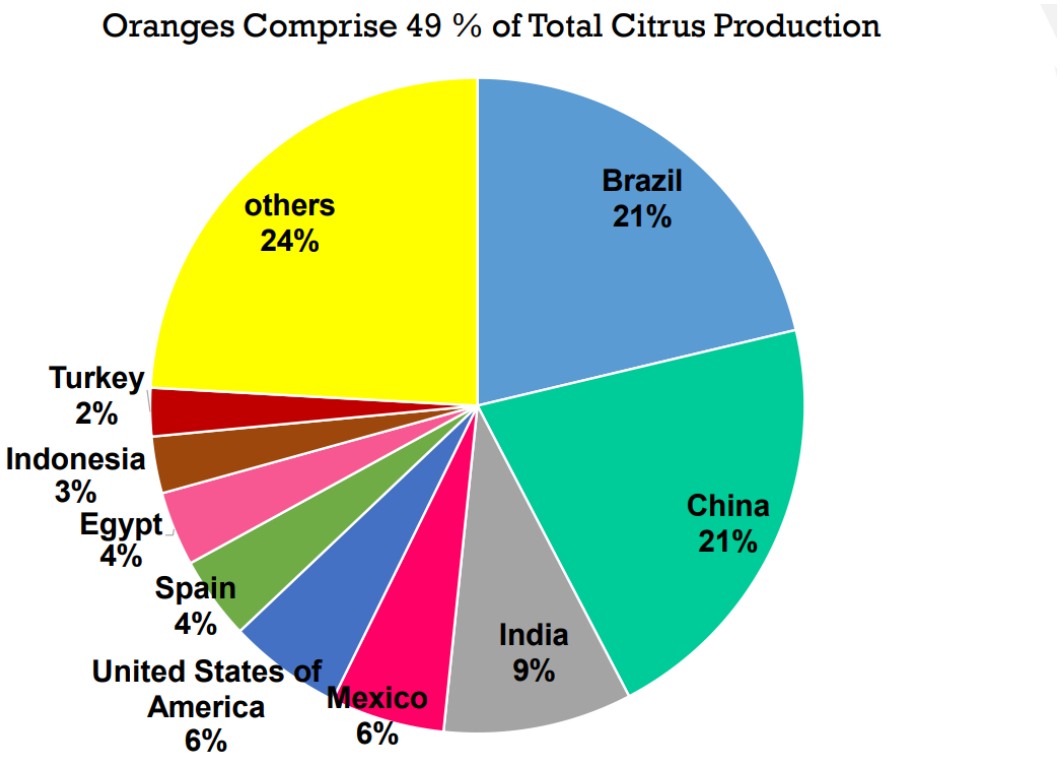


Figure 76: World Production Share (%) of Oranges

Source: Trade Map, 2022-23

WORLD PRODUCTION SHARE OF TANGERINES, MANDARINS, CLEMENTINES, SATSUMAS

The graph shows China as the dominant producer of tangerines, mandarins, clementines, and satsumas, with a 68% global share. Spain and Pakistan each contribute 4%, highlighting their roles in the global citrus market.

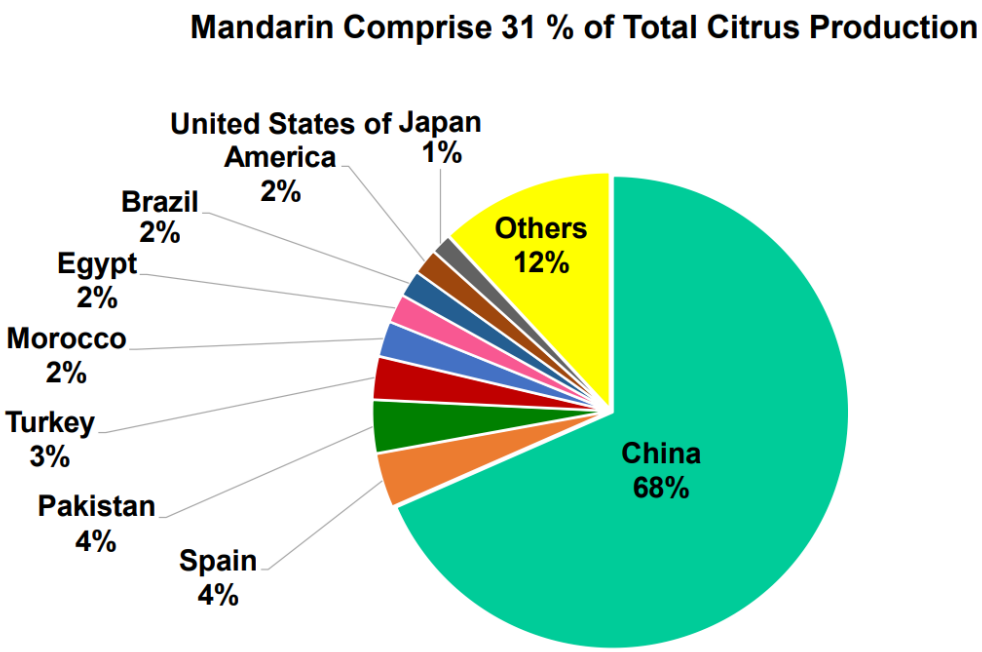


Figure 77: World Production Share (%) of Tangerines, Mandarins, Clementines, Satsumas

Source: Trade Map, 2022-23

WORLD PRODUCTION SHARE OF LEMONS & LIMES PRODUCTION

The graph depicts global production shares of lemons and limes, with China leading at 24%, followed by Mexico at 13%, and India at 12%. China's dominance reflects its extensive citrus cultivation and favorable growing conditions.

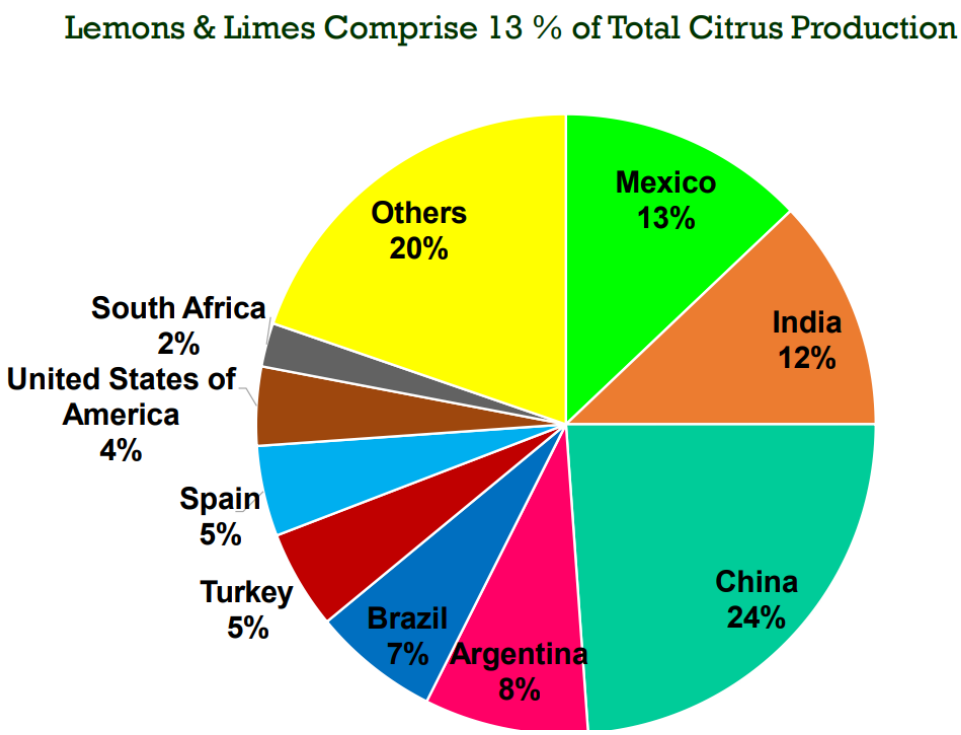


Figure 78: World Production Share (%) of Lemons & Limes Production

Source: Trade Map, 2022-23

WORLD PRODUCTION SHARE OF GRAPEFRUIT

The graph represents the global production share of grapefruit, which comprises 8% of total citrus production worldwide. China dominates this category with a substantial 68% share, United States follows with a 5% share, known for its high-quality grapefruit varieties. Vietnam holds a 4% share, indicating its growing presence in the global citrus market with increasing

cultivation and export capabilities.

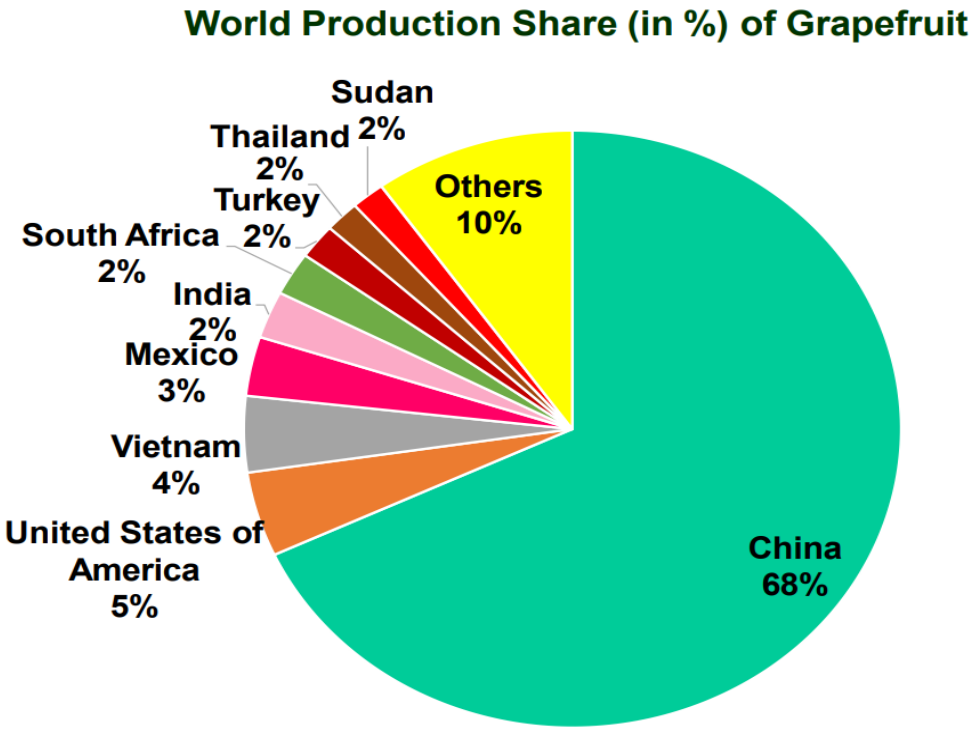


Figure 79: World production share (%) of grapefruit

Source: Trade Map, 2022-23

CITRUS PRODUCTION BY TYPES IN PUNJAB (%)

The graph shows citrus production in Punjab, where mandarins dominate at 94.98%, followed by oranges at 3.56%, lemons at 1.32%, and grapefruits at 0.14%. Mandarins clearly lead, indicating their widespread cultivation and popularity in Punjab's citrus industry, while other citrus types make up smaller but significant portions of the overall production.

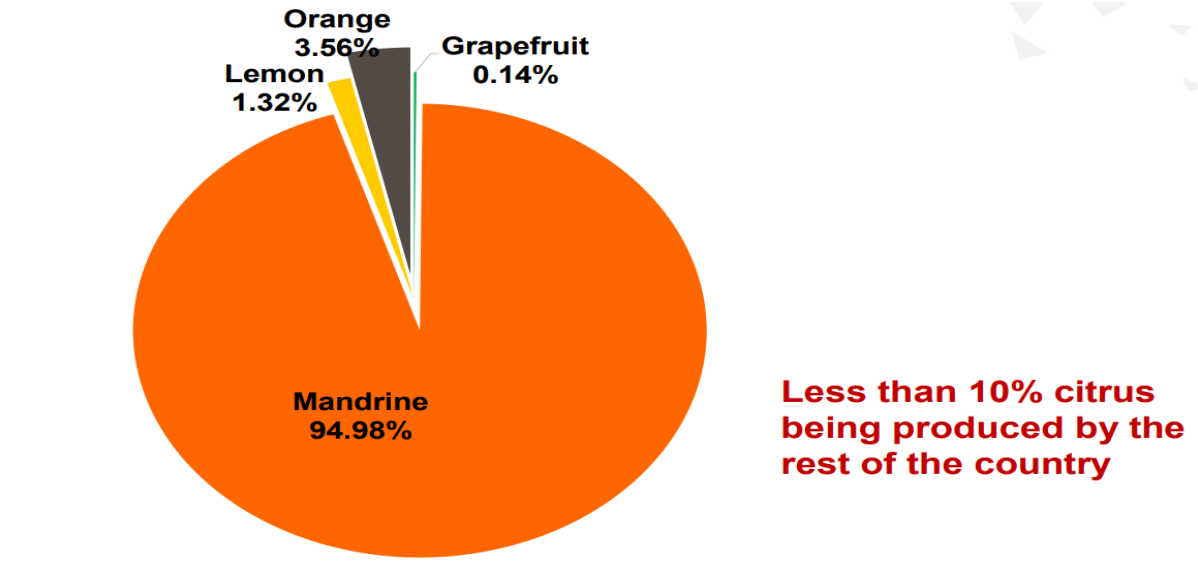


Figure 80: Citrus Production by Types in Punjab (%)

Source: Trade Map, 2022-23

WORLD LEADING CITRUS PRODUCING COUNTRIES

The graph shows China as the top citrus producer, leveraging its vast agricultural resources. Brazil follows closely with its tropical climate and extensive orchards. The USA ranks third, known for its diverse citrus production

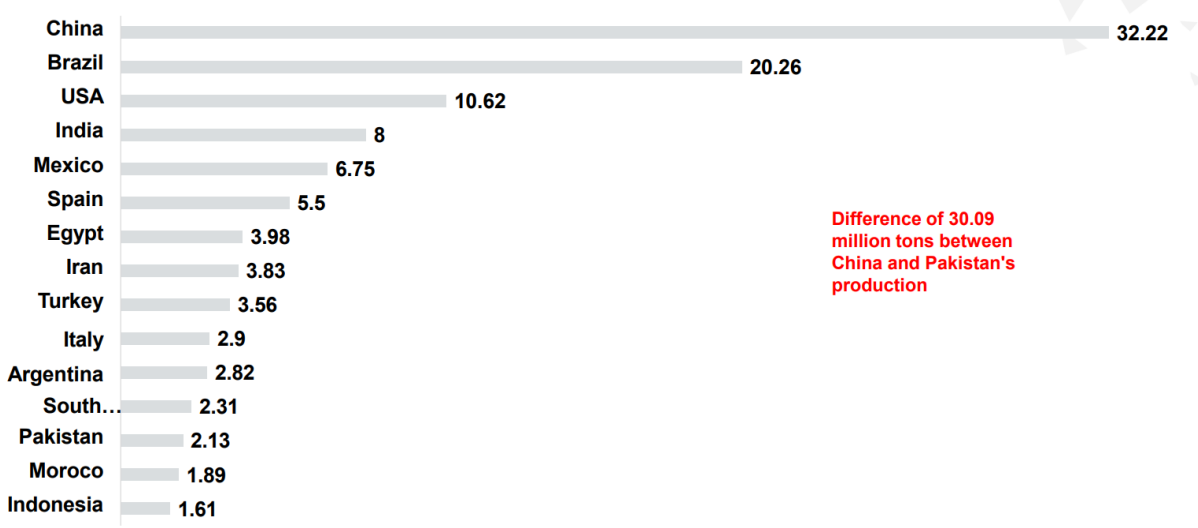


Figure 81: World Leading Citrus Producing Countries (Million Tons)

Source: Trade Map, 2022-23

WORLD LEADING FRESH CITRUS EXPORTING COUNTRIES

Spain holds the distinction of being the largest exporter of fresh citrus fruits globally. South Africa excels in producing high-quality citrus fruits for export markets worldwide. Turkey also plays a significant role, leveraging its strategic location between Europe and Asia to export a variety of citrus fruits, including oranges, lemons, and mandarins

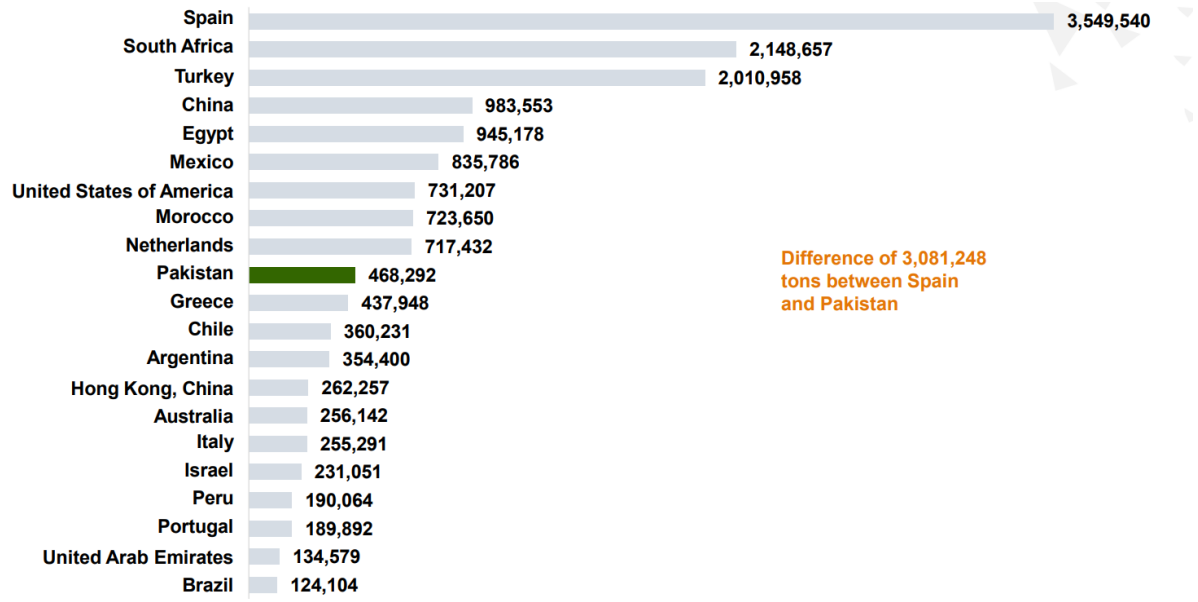


Figure 82: World Leading Fresh Citrus Exporting Countries (Tons)

Source: Trade Map, 2022-23

WORLD LEADING FRESH CITRUS EXPORTING COUNTRIES

Spain leads global fresh citrus exports with 3,653,086 USD thousand, leveraging its favorable climate and advanced infrastructure. South Africa follows at 1,486,097 USD thousand, known for premium citrus varieties. China ranks third with 1,261,170 USD thousand, reflecting its expanding production. Pakistan contributes 177,848 USD thousand, highlighting its role in the global citrus market.

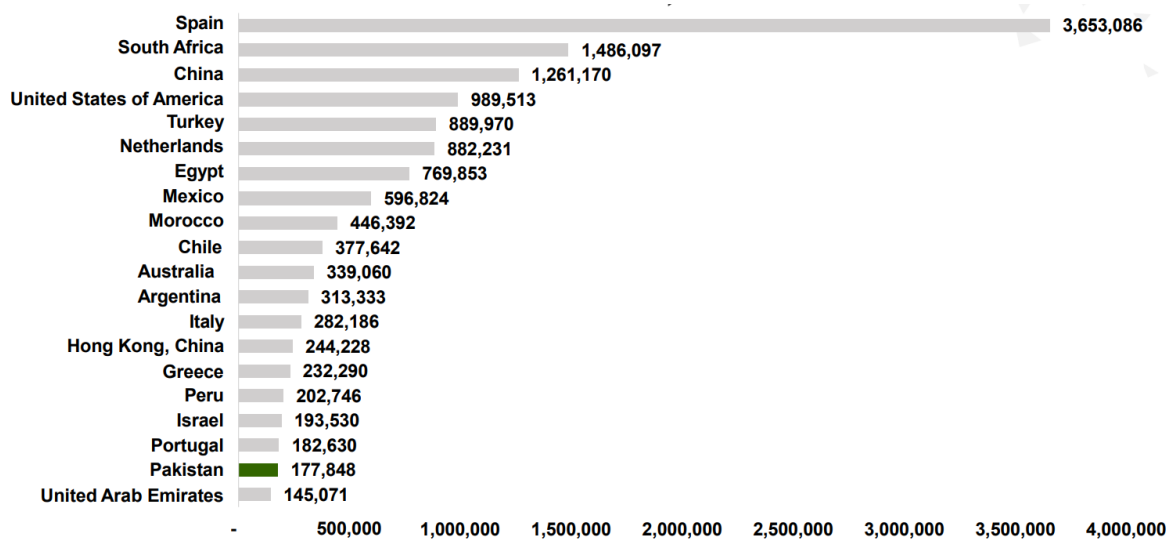


Figure 83: World Leading Fresh Citrus Exporting Countries (USD thousand)

Source: Trade Map, 2022-23

WORLD LEADING FRESH CITRUS EXPORTING COUNTRIES

The graph shows export values per ton of fresh citrus from leading countries. USA leads at 1,353 USD/ton, followed closely by Australia at 1,324 USD/ton and China at 1,282 USD/ton. Pakistan follows with 380 USD/ton, indicating varying market positions and export values among these countries in the global citrus trade.

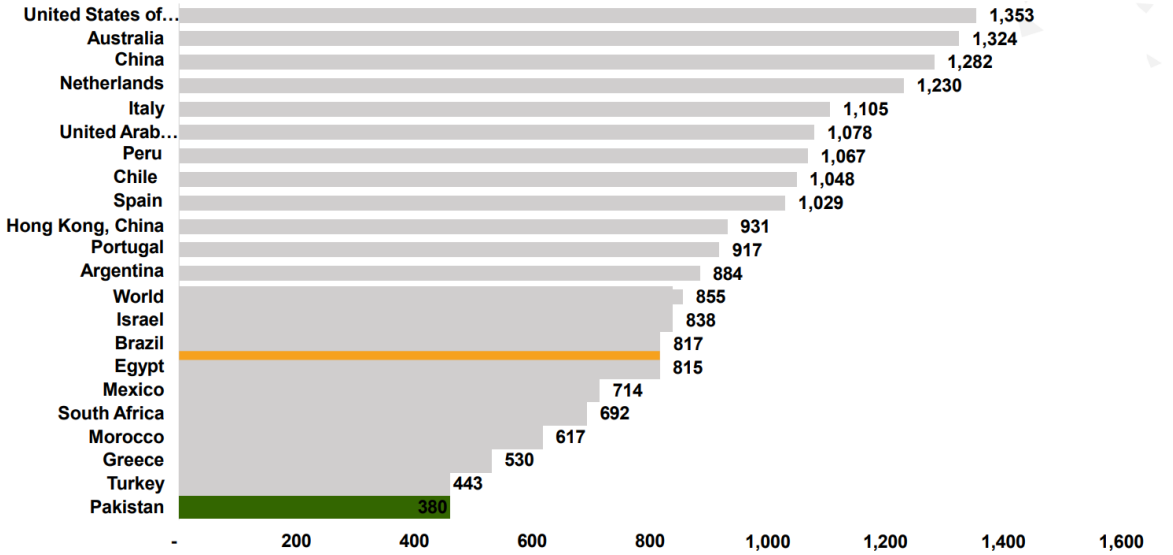


Figure 84: World Leading Fresh Citrus Exporting Countries (USD/Ton)

Source: Trade Map, 2022-23

WORLD LEADING FRESH CITRUS IMPORTING COUNTRIES

The graph depicts leading fresh citrus-importing countries by tonnage: Russia, USA, and Netherlands. These countries import significant quantities of oranges, lemons, and other citrus fruits to meet domestic demand and supplement local production

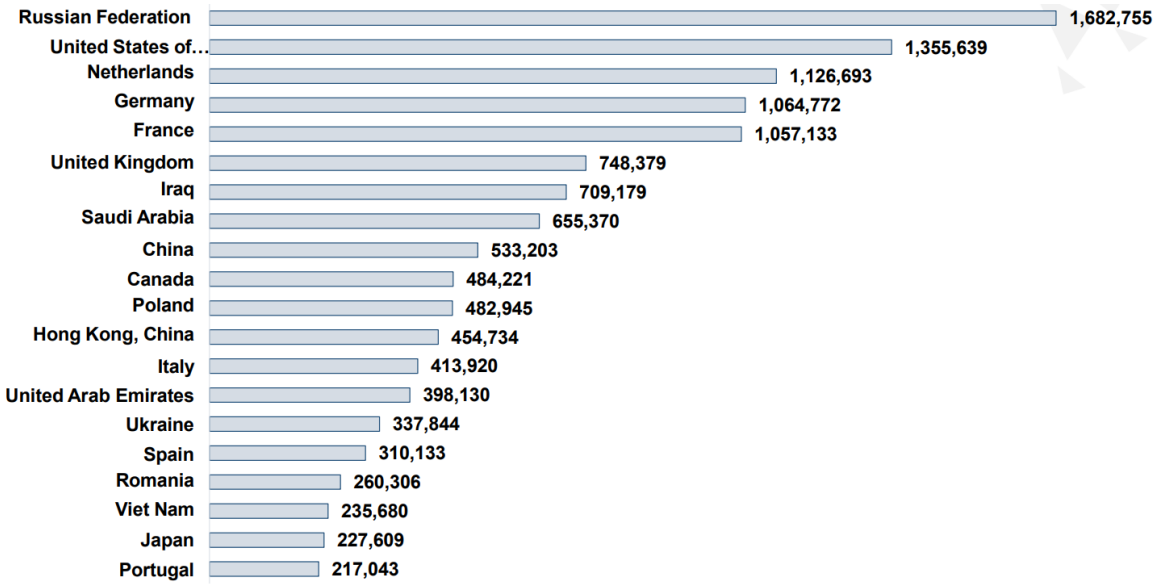


Figure 85: World Leading Fresh Citrus Importing Countries

Source: Trade Map, 2022-23

WORLD LEADING FRESH CITRUS IMPORTING COUNTRIES

The graph shows leading fresh citrus importers by value in USD thousand: USA leads, followed closely by Germany and France. These countries import significant quantities of oranges, lemons, and other citrus fruits to satisfy consumer demand and support their respective markets and industries.

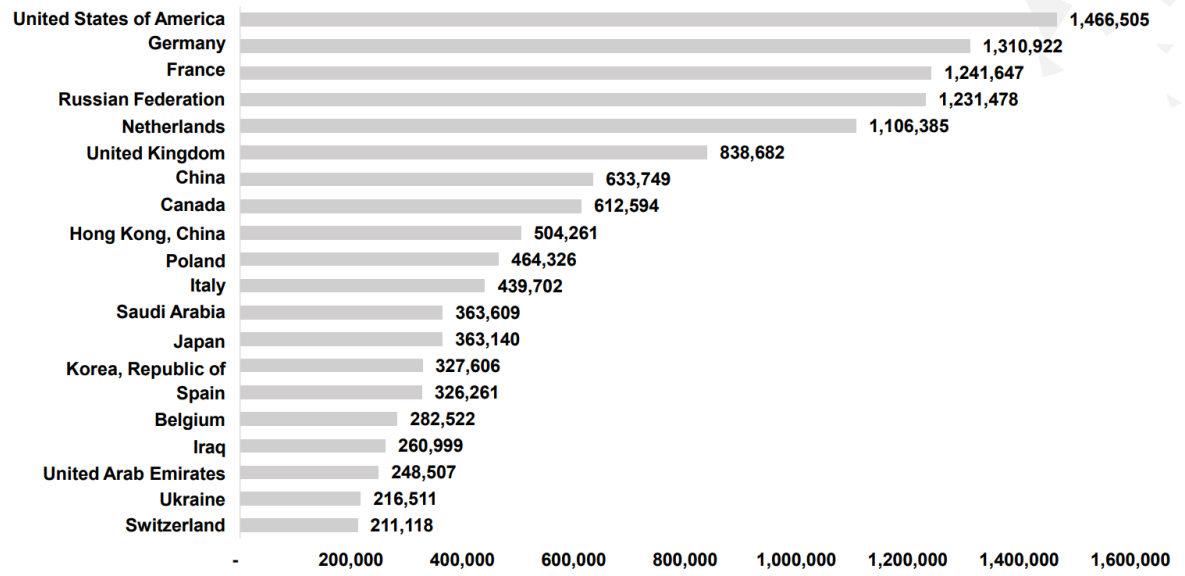


Figure 86: World Leading Fresh Citrus Importing Countries (USD thousand)

Source: Trade Map, 2022-23

WORLD LEADING FRESH CITRUS IMPORTING COUNTRIES

The graph shows import values per ton of fresh citrus: Japan leads at 1,595 USD/ton, followed by Belgium at 1,312 USD/ton, and Canada at 1,265 USD/ton. These figures indicate the premium prices these countries pay for imported citrus.

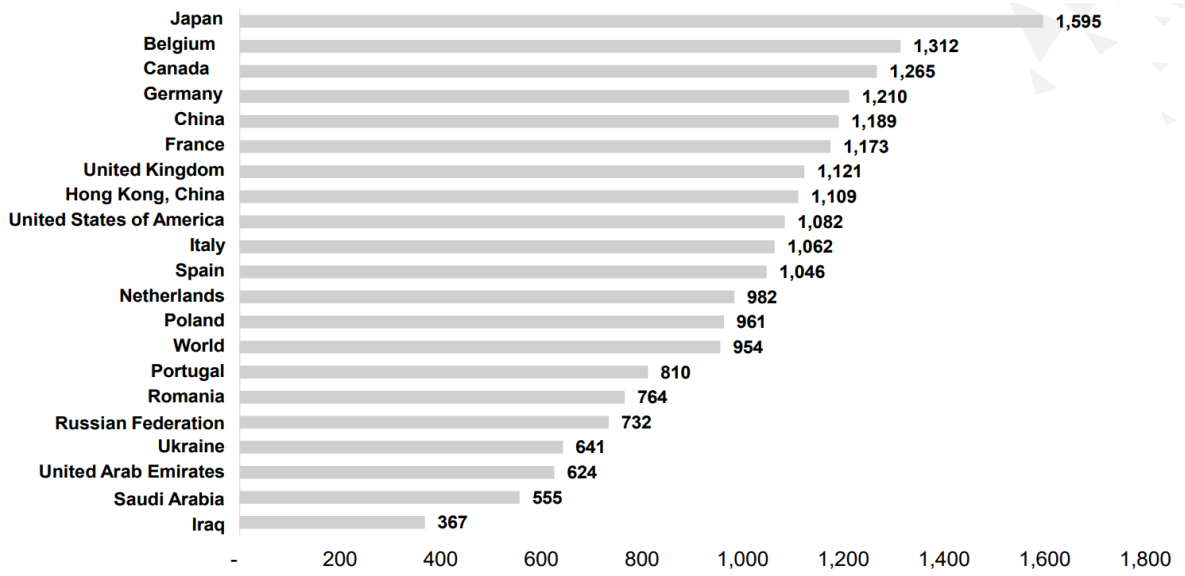


Figure 87: World Leading Fresh Citrus Importing Countries (USD/tons)

Source: Trade Map, 2022-23

PAKISTAN CITRUS EXPORT BY COUNTRIES

Pakistan exported 468,292 tons of citrus globally at an average value of 380 USD per ton. Specifically, it shipped 171,108 tons to Afghanistan at 333 USD per ton and 94,832 tons to Russia at 467 USD per ton.

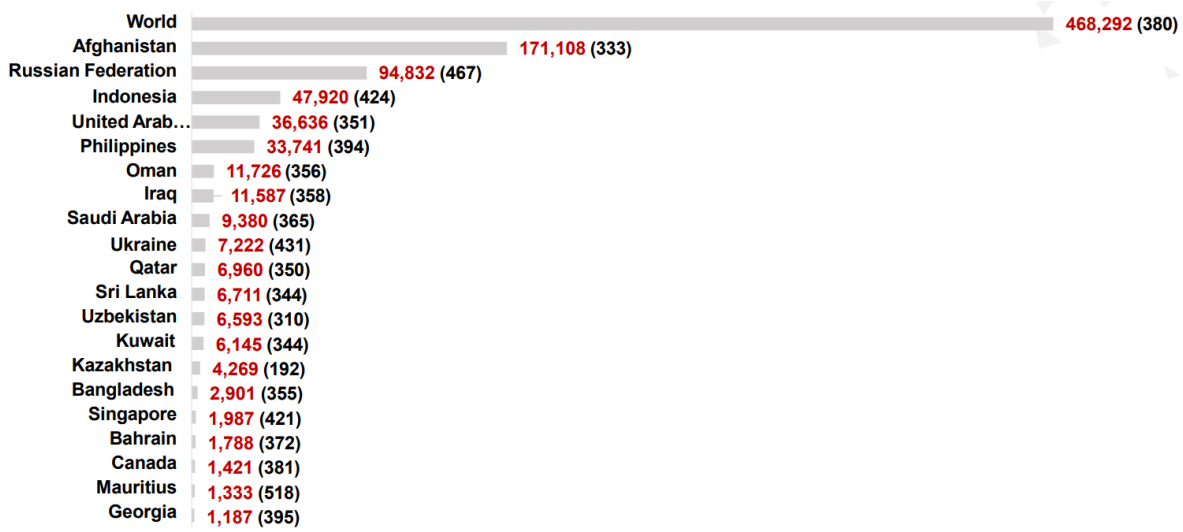


Figure 88: Pakistan Citrus Export by Countries (Quantities in Tons) & Value (USD/Ton)

Source: Trade Map, 2022-23

CITRUS YEARLY COMPARISON BETWEEN PUNJAB AND PAKISTAN

From 2010-11 to 2018-19, both Punjab and Pakistan have seen an increase in Citrus cultivation area but it significantly decreased in 2019-20. The cultivation area for citrus in Punjab was reduced from 455.18 thousand acres in 2010-11 to 358.8 thousand acres in 2020-21. The primary cultivation area is in D.G.Khan Division, which covers 4,507,750 acres. During this period, the cultivation area in Pakistan has decreased from 480.63 to 386.23 thousand acres, with Punjab showing the most reduced growth.

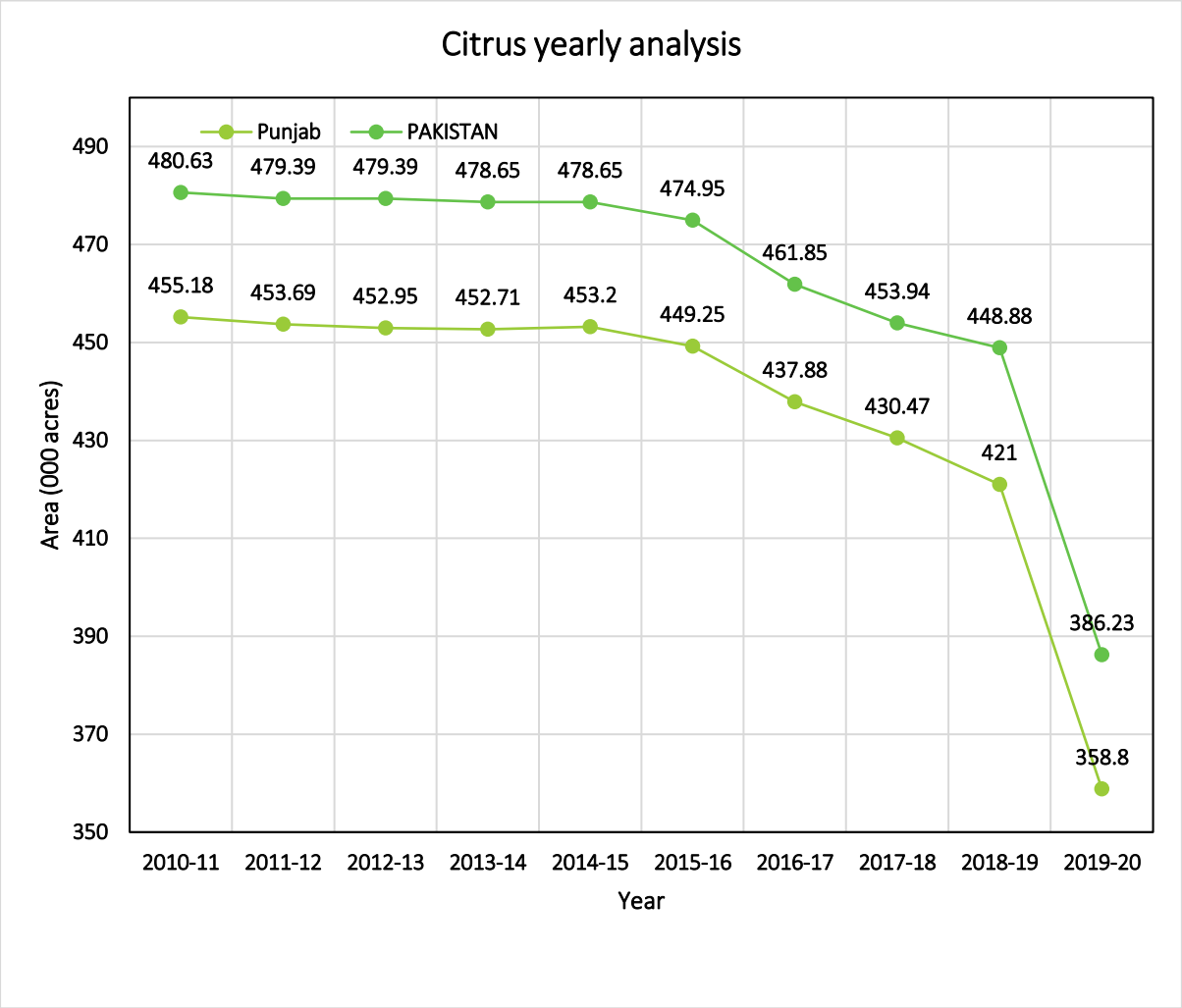


Figure 89: Citrus Yearly Area (000 acres) Comparison between Punjab and Pakistan

Source: AMIS

Punjab's production generally follows the same trend as the national production, it often produces a larger quantity. The production gap between Punjab and Pakistan is notable in all years, indicating same trend in citrus production.

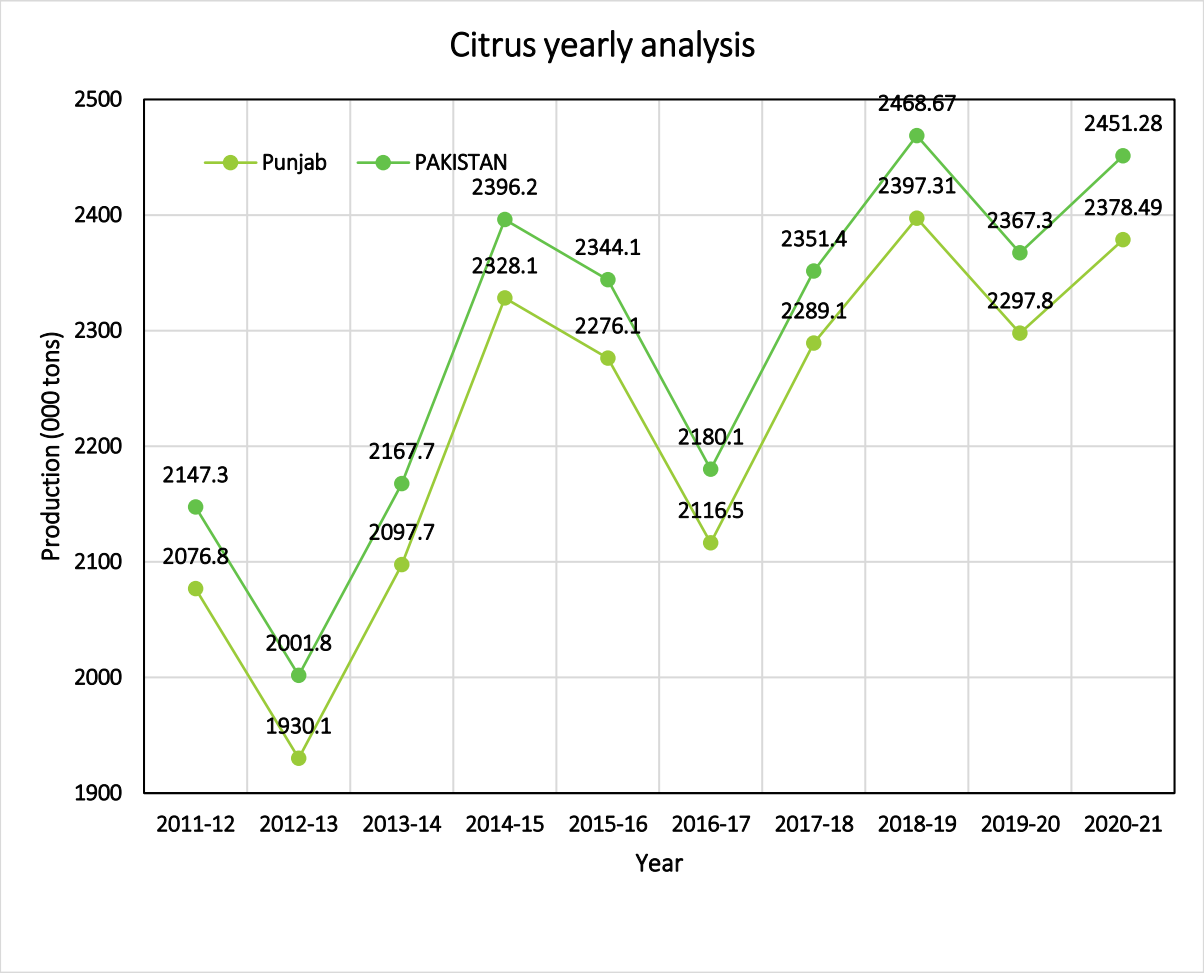


Figure 90: Citrus Yearly Production (000 tons) Comparison between Punjab and Pakistan

Source: AMIS

Punjab, has consistently produced higher agricultural yields of citrus compared to other provinces in the country. This could be attributed to a number of factors, such as favorable agro-climatic conditions, advanced farming practices, and access to improved technologies and inputs. The combination of these factors might have contributed to the province's sustained success in producing higher yields.

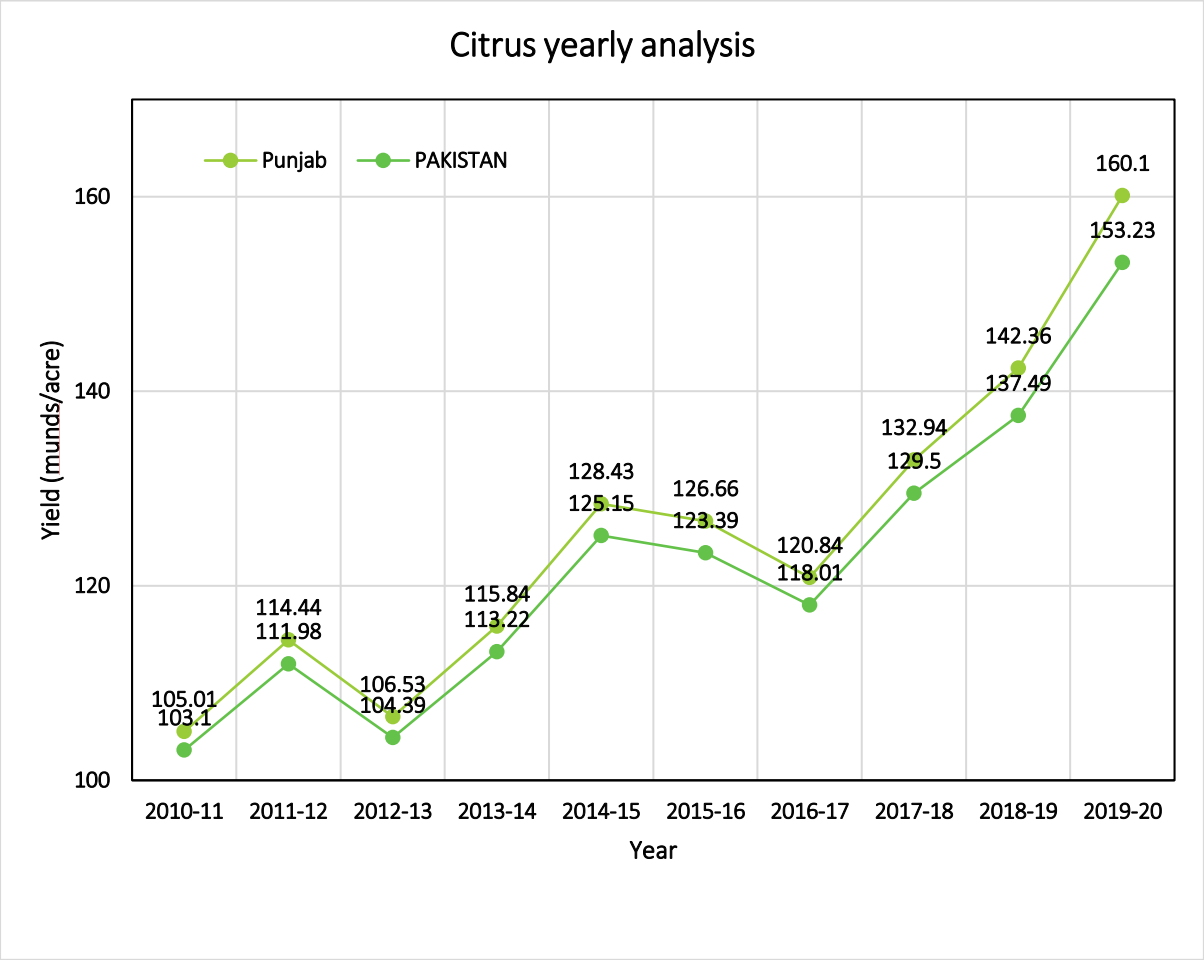


Figure 91: Citrus Yearly Production (000 tons) Comparison between Punjab and Pakistan

Source: AMIS

CITRUS VALUE CHAIN

Citrus value chain is completely depicted in the Figure which indicated that majority of the farmers sold their orchard to contractors who have harvesting rights at least for one year. There are several factors which are considered while contract is being negotiated between contractor and the farmer, which include age and health of the orchard, flowering intensity, citrus variety, distance from metal road, quality of road, availability of transport facilities and transportation cost. These factors are not the only factors which influence the negotiation process, as these factors are of prime interest for the contractors only. Considerations for the farmers are

different. . Contractors made the contract on behalf of commission agents therefore in most of the cases are bound to transfer to them.

Marketing of citrus fruits not only needs substantial resources but also requires considerable time. Activities like marketing research, picking, grading, packing, and transportation involve more time and resources implications. Farmers generally have an attitude of risk aversion. Another important factor of declining quality of Kinnow was that around 70 percent of the labor employed at the farm for harvesting is migratory mainly moved from southern Punjab. Generally, they are not concerned with quality of the fruit when they pick it because labor is paid based on number of baskets of the fruits picked, therefore, consideration for the labor is quantity and not quality.

Kinnow is generally transported in plastic buckets, each weighing 20 kg to 40 kg, to the processing factories. However, at every transfer point there is substantial potential for improvement. Domestic market prices are greatly influenced under the export of Kinnow. When the exports start declining, the prices come down rapidly. Sometimes big players of the market pool resources together and push prices downward.

Middlemen sell their produce mainly to wholesalers through open auction while processing industry (exporters and juice making companies) also buy from the commission agents. Some growers also act exporter.

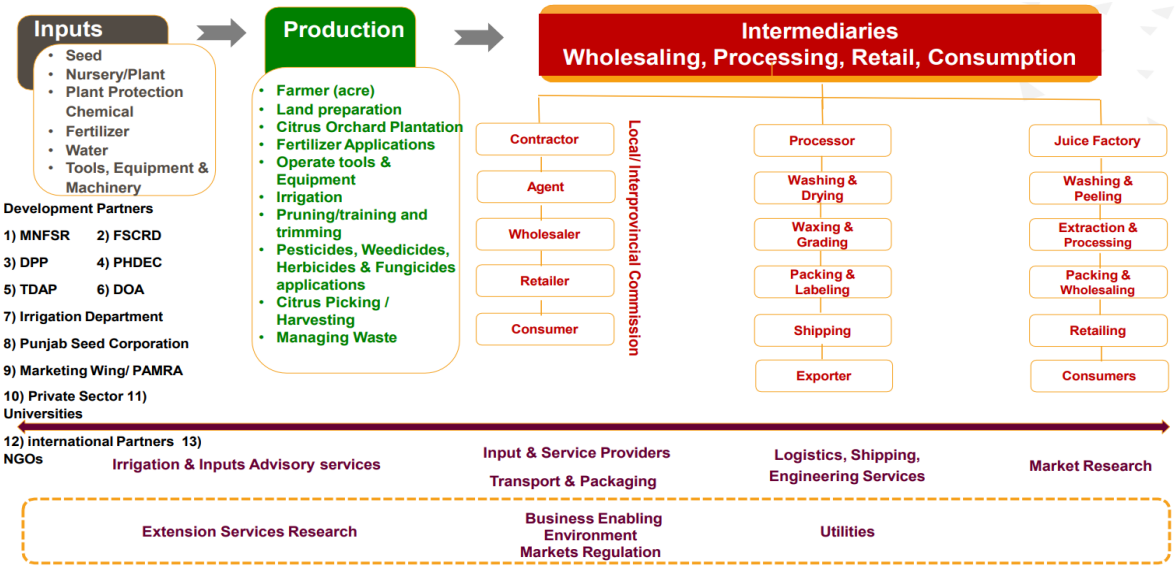


Figure 92: Citrus Value Chain

ISSUES AND CHALLENGES IN VALUE CHAIN

SEED	FARM	LOGISTICS & PROCESS	MARKETS
• Unapproved /uncertified varieties • Lack of institutional support to provide database and inventorying of certified, disease free seed plants. • Unreliable supply of certified plants. • Lack of registered nurseries • Poor nursery management practices	• Fail to meet Demand annually because of limited capacity. • Inadequate supply of plants required for new zones. • Old outdated orchard management practices • Inefficient Irrigation systems • No disease free zones identified for new plantation • No standardized curriculum for orchard management • Reduced shelf life of fresh fruits • Food safety issues • Spread of diseases • Low Price • Post-Harvest Losses up to 20%	• Inadequate and scarcity of existing facilities for Grading, Polishing and sizing for local market demands.. • Quality assurance mechanisms and standardized certifications for export is missing. • Limited value addition opportunities • Existing capacity of frozen juice is low • Increase life of product to improve exportability • Lack of modern technology • Access to finance problem • Low and inadequate quality of existing storage facilities	• Lack of regulation • Poor marketing infrastructure • Lack of marketing campaign for local consumption • Marketing/trading Citrus under one brand from Pakistan as a premium product • Lack of integrated citrus marketing plan • Lack of market research/ market identification • Poor access to high end market • Lack of presence at international exhibitions/ trade shows

	• Lack of extension Services and technical assistant • Poor pest / disease management • Imbalance use of Nutrition • Intercropping	• Transportation supply chain needs to be made efficient • Low automation	• Lack of support from trade counsellors posted abroad in opening new markets/relationship management in existing markets

INTERVENTIONS

SEED	FARM	HARVEST & LOGISTICS	PROCESS	MARKETS
• Up gradation of CRI to develop 1 million certified plants / annum of existing & new varieties. • DNA & all other required testing for mother plant and scion varieties (annual indexing, monitoring mechanism, track report) for citrus.	• Provision of subsidy on weedicide and pesticide. • Database of new plants/ plantation according to zoning and identification of new disease-free areas for new varieties of citrus. • Installation of High Efficiency Irrigation Systems (HEISs) on new Plantations	• Standardized harvest handling practices manual to be developed and disseminated. • Product sizing standards to be developed according to international practices and disseminated	• Establish ment of Cold storage • Training of labor on Grading, Sorting, Packaging , usage of processing equipment .	• Conduct market survey. • Develop packaging manufacturing industry for citrus and mango. • Develop local manufacturing industry to manufacture Grading/Sorting/Packing lines for citrus.

CITRUS VALUE ADDED PRODUCTS

Citrus fruits can be transformed into various products like juices, essential oils, and marmalades. These products include candied peels, sauces, dried slices, and citrus powder, enhancing both culinary and baking applications. Citrus extracts are used in health supplements, cosmetics, and cleaning products for their natural benefits. These value-added products highlight the versatility of citrus, creating new market opportunities.

Figure 93: Citrus Value Added Products

15. VEGETABLE INTERVENTIONS

Proposed Interventions to Improve Early Vegetable Production and Markets in D.G. Khan Division

- Increase access to fresh produce by expanding Fruit & Vegetable markets.
- Provide technical and financial assistance to individuals interested in starting a vegetable business to expand the variety of produce grown and sold in the region.
- Encourage farmers to create value-added products like jams, pickles, and sauces to tap into new market opportunities.
- Improve storage and transport of perishable goods to reduce losses.
- Promoting sustainable farming practices, such as conservation tillage and integrated pest management, can increase productivity while minimizing environmental impact.

- Train farmers on best practices in agriculture, including pest management, soil fertility, and new technologies.
- Improve market information systems and strengthen market linkages to ensure farmers can access better prices and market opportunities for their produce.
- Invest in agricultural R&D to create crops adapted to local conditions.

SHORT TERM

- Establish a packing house or the vegetable cartel.
- Grade vegetables to have an export-oriented approach.
- Explore value-added opportunities
- Grow exotic vegetables like cherry tomatoes, asparagus, iceberg, and broccoli.
- Establish cold stores to support the export of fruit and vegetables.
- Improve the road infrastructure (Farm to Market)
- Encourage the development of small and medium-sized food processing businesses that can create jobs and add value to locally grown products.

MEDIUM-TERM

- Build cold stores for vegetable growers to store their crops.
- Provide financial assistance to farmers to maintain the supply chain.
- Develop seed varieties with universities and research institutes.
- Train farmers on grape pruning techniques and how to increase its shelf life.
- Certify nurseries to ensure plant sustainability.
- Encourage farmers to adopt climate-smart practices like rainwater harvesting and efficient irrigation to reduce greenhouse gas emissions.

LONG TERM

- Encourage tunnel farming in the region.
- Establish a farm-to-market linkage.
- Develop a drip irrigation system in the region.
- Develop a comprehensive survey analysis on the vegetable growers in the region.
- Establish more units to process and sell frozen vegetables.

- Conduct research to produce hybrid seeds of vegetables locally.

16. TEHSIL KOH-E-SULEMAN

"Koh-e-Suleman" is situated in D.G. Khan District of Punjab province. The climate of the project area is dry both in summer and winter, and an average rainfall of 203.92 mm (based on D.G Khan meteorological station's data 2001-2015) is recorded here. Promoting agriculture in the hill torrents of the Koh-e-Suleman area can help mitigate the impacts of climate change and sustain farming. Current Cultivated area of Koh-e-Suleman in DG Khan is 62,833 acres while potential cultivated area is 280,563 acres.

Map XIV: Koh-e-Suleman map

16.1. AGRICULTURAL LAND UTILIZATION IN KOH-E-SULEMAN

In Koh-e-Suleman, covering areas of DG Khan and Rajanpur, agricultural land utilization covers a total of 1,710,198 acres. DG Khan encompasses 721,777 acres of agricultural land, while Rajanpur contributes 988,421 acres. However, actual total area is 2,714,164 which is calculated using RS/GIS.

Table 10: Land Utilization in Koh-e-Suleman

District	Current Total Area (Acres)	Actual Total Area (Calculated using RS/GIS)
Koh-e-Suleman area of DG Khan	721,777	1,268,481
Koh-e-Suleman area of Rajanpur	988,421	1,445,683
Total	1,710,198	2,714,164

16.2. CURRENT CROPPING PATTERN IN KOH-E-SULEMAN

In Koh-e-Suleman, the current cropping pattern varies in both DG Khan and Rajanpur districts. In DG Khan during the Kharif season, crops like bajra (pearl millet) cover 31,772 acres, sorghum spans 11,072 acres, and cotton and millet each occupy small areas of 67 and 64 acres respectively. In the Rabi season, DG Khan allocates the largest area, totaling 11,605 acres, for wheat crop. Meanwhile, in Rajanpur, 2,896 acres dedicated to onions and 1,390 acres to wheat. Additional cultivation includes sorghum, rice, and millet across smaller areas.

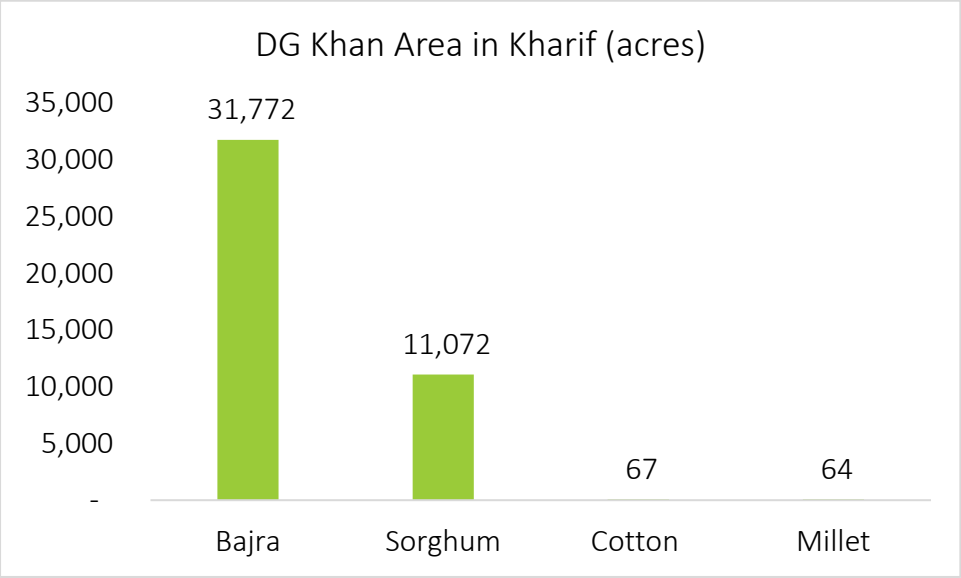


Figure 94: Kharif Cropping pattern (acres) in DG Khan area of Koh-e-Suleman

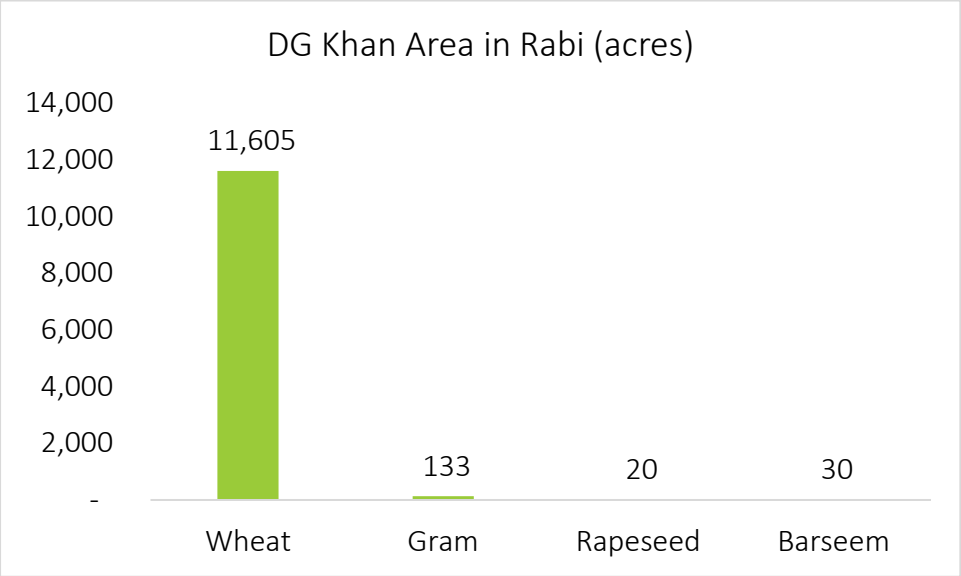


Figure 95: Cropping pattern (acres) in DG Khan area of Koh-e-Suleman

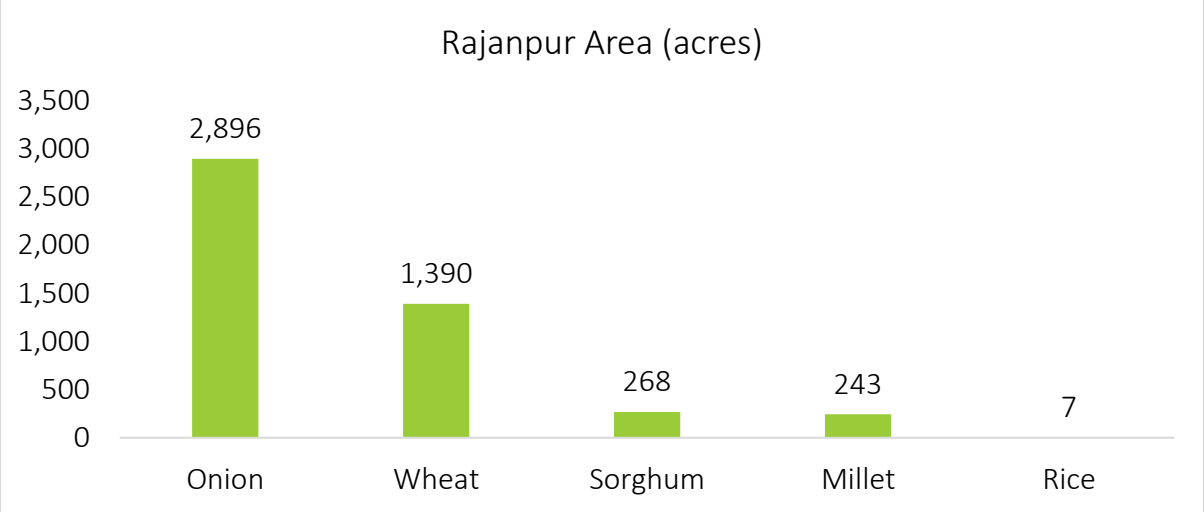


Figure 96: Cropping pattern (acres) in Rajanpur area of Koh-e-Suleman

16.3. POTENTIAL CROPS OF KOH-E-SULEMAN

Koh-e-Suleman in Punjab, Pakistan, is suitable for cultivating several high-potential crops including citrus fruits like oranges and kinnows, olives, dates, peaches, pistachios, and almonds. These crops thrive in the region's favorable climate and contribute significantly to agricultural diversity and economic growth.

16.4. PROBLEMS FACED BY AGRICULTURE SECTOR

- Open grazing is a threat to Kharif & some Rabi crops
- No/incomplete land record (difficulty for target subsidy)
- Very poor accessibility to markets
- Traditional and small scale farming

16.5. PROPOSED INTERVENTIONS FOR AGRICULTURE SECTOR

SHORT TERM

- Fencing of agri. fields
- Land record surrey
- Provision of vegetable seed kits

MEDIUM TERM

- Provision of infrastructure (especially farm to market roads)
- Orchards development on drip irrigation system

LONG TERM

- Development of Seed Varieties according to local agro-ecological conditions
- Development of dedicated offices by agriculture and livestock department

16.6. IRRIGATION METHODS IN KOH-E-SULEMAN

POTENTIAL IRRIGATION METHODS

Irrigation Scheme/Water Channel

Lift Irrigation Scheme

Storage Tank &Drip System (HEIS)

Mini Dam

PROBLEMS OF IRRIGATION SYSTEM

- Inadequate irrigation system and supplies (water storage, water channel & rainwater harvesting system)
- High construction cost of irrigation facilities

- Loss of irrigation water in peak discharge of hill torrents
- High pumping cost
- Constraints due to geographic and topographic situations
- Water scarcity

PROPOSED INTERVENTIONS FOR IRRIGATION SECTOR

SHORT TERM

- Construction of water channels and storage ponds
- Provision of drip irrigation system with solar system

MEDIUM TERM

- Construction of mini dams

LONG TERM

- Construction of new water reservoir

16.7. COMMON PROBLEMS OF AGRICULTURE SECTOR IN KOH-E-SULEMAN

- Unavailability of certified seed & plants
- Climate change (temperature extremes, erratic rains, lack of weather forecast system)
- Obsolete agriculture technologies
- Soil erosion
- Water shortage and declining quality
- High pest, disease & weed infestation
- High input cost (seed, fertilizer, irrigation, plant protection)
- Imbalance fertilizer application, no micronutrients application
- Lack of crop zoning & diversification
- Inadequate value chain (processing & value addition)
- Lack of mechanization
- Small farmers and land fragmentation
- Exhaustive cropping pattern
- Inadequate research facilities

DEVELOPMENT INTERVENTIONS

SHORT TERM

- Provision of certified seed
- Provision of certified plants
- Establishment of model farms
- Provision of extension services and capacity building & training of farmers

MEDIUM TERM

- Civil Veterinary Center (CVC)
- Land leveling and de-stoning
- Provision of farm machinery

LONG TERM

- Development of local state of the art markets especially for high value crops

17. RECOMMENDED INTERVENTIONS

Crops	SEED	FARM	HARVEST & LOGISTICS	PROCESS	MARKETS
GARLIC	Implement a local seed varieties replacement program; through multiplication of pre-basic and basic quality seeds developed by research institutes by partnering with private seed companies to reduce import bill	Organize labour training programs with the help of VRI to ensure availability of skilled labour within the Crop Cluster	Incentivize and subsidize farmers for Mechanization (e.g. rotavator, planter, dryer etc) of Garlic production activities	Incentivize private sector by offering credit through banks for establishment of garlic powder and paste production unit.	Establish a garlic market in garlic cluster with storage, packing and grading facilities to maintain high quality.
OILSEEDS	Provide high-quality seeds; through multiplication of pre-basic and basic quality seed developed by Oilseed Research Institute by introducing private seed companies to reduce import bill	Provide farmer training workshops on climate resilience practices through research and extension wing	Promote mechanization and machine use training for oilseed crops in order to minimize post-harvest losses and get good yields.	Provide subsidized oil extraction units to local farmers with the help of the private sector on matching grants	Enhance oilseed value chains with storage, packing, grading and export facilities to ensure high quality products.

MOONG	Fund research and creation of climate and pest resilient varieties	Enhance soil fertility and crop management for Moong through improved knowledge of crop management technologies and fertility requirements.	Moong harvesting, post-harvest management, improve markets and community based storage facilities to reduce post-harvest loses	Work with the private sector for the establishment of state of the art Daal preparation unit	Create a lentils market for export by having stronger quality control
GRAM	Provide adequate subsidy on certified seeds through Kisan card	Provide subsidized installation of Sprinkle/drip Irrigation to improve water efficiency	Capacity building of farmers and labor on gram production and harvesting techniques by research and extension wing	Develop infrastructure and treatment processes for value addition in gram production	Establish a gram market and connect growers directly with industries in gram cluster
TOMATO	• Development of Certified Seed varieties (Pre basic, basic and multiplication). • Local tomato seed varieties replacement program.	• Provision of inputs (Fertilizer, Pesticides and Implements) on subsidy. • Promote the use of tunnel farming techniques to extend growing seasons and increase crop yields	• Capacity building and specialized labour for Tomato harvesting. • Establishment of CA (Control Atmosphere) storage by incentivizing its import.	• Establishment of CA (Control Atmosphere) storage by incentivizing its import.	• Establishment of tomato market in tomato cluster. • Implement grading systems to meet export standards.

OLIVES	Provide technical assistance to farmers for the establishment of olive orchards	Expand subsidy on the installation of drip irrigation system	Minimize post-harvest losses by enhancing the efficiency of olive collection and transportation	Establish a table olive processing unit, and specialized olive tree nurseries	Introduce olive value addition products and provide its export market
DATES	Develop climate-resilient Certified Seed Varieties (Pre basic, basic and multiplication) and CSA production technologies	Establish workshops on management practices for raising productivity Upgrade conventional orchards with high density plantation Introduce solar tunnel drying method to growers	Provide training program on modern techniques, plant protection, harvesting, packing, and processing of dates	Improve value addition by introducing packhouses for export market	Establishment of dates market in dates cluster

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RECOMMENDED INTERVENTIONS FOR AGRICULTURE (57,892 MN)

Certified/ Quality Seed Development	New Seed Varieties | Seed Replacement Program | Certification & Provision
	27 projects for Rs. 7,813 mn
On Farm Management	IPM Practices | Availability of high quality inputs | Production Technologies
	45 projects for Rs. 8,641 mn
Mechanization	Subsidy on Implements | Smart Tool Mechanization| Capacity Building
	9 projects for Rs. 3,605 mn
Logistics & Markets	Model Markets | Storages and Warehouse | Grain silos
	28 projects for Rs. 6,715 mn
Value Addition Process	Processing Units | Juice and Peeling Units | Ginning and Spinning Mills
	23 projects for Rs. 4,310 mn
Improve Water Efficiency	Water Channel Improvement| HEIS | On Farm Water Storages
	12 projects for Rs. 19,988 mn
Structural Reforms	Extension Services | Ease of Financial Access | Support Systems
	18 projects for Rs. 6,820 mn

19. PROPOSED PROJECTS

Crops	Phase	Interventions	Cost (Tentative) in Million Pkr
Onion	Short-term	Local onion seed varieties development and replacement program by VRI Faisalabad and VRS Karor	314
	Short-term	Provision of inputs (Fertilizer, Pesticides and Implements) on subsidy to develop onion cluster through Kisan card by extension wing	171
	Medium-term	Capacity building of farmers and labor on onion production and harvesting techniques by research and extension wing	150
	Medium-term	Establishment of specialized onion market in onion cluster	200
	Medium-term	Incentivize onion processing by development of onion by-products such as paste, dehydrated flakes, powder, rings, puree, vinegar, pickle, juice, and oil in onion cluster	200
	Medium-term	Strengthen regulatory enforcement and implement quality control measures and provision of quality inputs by extension wing	50

	Long-term	Development of climate-resilient Certified Seed Varieties (Pre basic, basic and multiplication) and CSA production technologies	150
Total			1,235
Garlic	Short-term	Local seed varieties replacement program; through multiplication of pre-basic and basic quality seed developed by Research Institute by introducing private seed companies to reduce import bill	100
	Short-term	Provision of inputs (Fertilizer, Pesticides and Implements) on subsidy to develop garlic cluster through Kisan card by extension wing	130
	Medium-term	Organizing labor training programs with the help of VRI to ensure skill labor availability in the Crop Cluster	50
	Medium-term	Establishment of garlic market in garlic cluster with storage, packing and grading facilities to ensure quality.	125
	Medium-term	Incentivizing private sector by credit through banks for Establishment of Garlic powder and paste production unit	50
	Medium-term	Strengthen and capacity building programs for the provision of specialized extension services.	80

	Long-term	Development of climate-resilient Certified Seed Varieties (Pre basic, basic and multiplication) to the Farmers of Garlic.	200
	Long-term	Incentivize and subsidize farmers for Mechanization (e.g. rotavator, planter, dryer etc) of Garlic production activities	220
Total			955
Oilseeds (Sunflower/Rapseed/Canola/Sesamum)	Short-term	Provision of High-Quality seed; through multiplication of pre-basic and basic quality seed developed by Oilseed Research Institute by introducing private seed companies to reduce import bill	319
	Short-term	Provide farmer training on climate resilience practices through research and extension wing	70
	Short-term	Introducing policy for the provision of support price till market development through Kisan card	150
	Short-term	Arrange seminars and capacity-building sessions to create awareness about best management practices/CSA production technology for selected crops during Rabi and Kharif season.	120
	Short-term	Provision of inputs (Fertilizer, Pesticides and Implements) on subsidy to develop crop clusters.	533

	Medium-term	Promote mechanization for oilseed crops in order to minimize post-harvest losses and get good yields.	300
	Medium-term	Provision of subsidized oil extraction units to local farmers with the help of the private sector on matching grants	550
	Medium-term	Ensure Hybrid Seed Availability through National and Multinational Seed Companies.	300
	Long-term	Establishment of state-of-the-art oilseed market with storage, packing, grading and export facilities to ensure quality.	200
Total			2,542
Early vegetables including chilies, onion, garlic, tomatoes and others in Rojhan	Short-term	Conduct research to locally produce hybrid seeds of vegetables &Train farmers on seed breeding techniques to locally produce hybrid seeds of vegetables.	40
	Short-term	Establish a packing facility in Rojhan for efficient vegetable processing	75
	Short-term	Implement grading systems to meet export standards.	35
	Short-term	Develop value-added products, such as Juice from strawberries and pulp from tomatoes, for product diversification	90
	Short-term	Build cold storage at the nearest airport to support vegetable exports.	110

	Medium-term	Offer financial support to farmers to help maintain and enhance the supply chain of vegetables	25
	Medium-term	Development of climate-resilient Certified Seed Varieties (Pre basic, basic and multiplication) and CSA production technologies	125
	Medium-term	Provide farmer training on climate resilience practices through research and extension wing	10
	Long-term	Promote the adoption of tunnel farming techniques to extend growing seasons and increase crop yields	20
	Long-term	Develop connections between farms and markets to streamline the supply chain and reduce post-harvest losses.	25
	Long-term	Promote and incentivize the drip irrigation system in the region.	25
	Long-term	Develop a comprehensive survey analysis on the vegetable growers in the region.	15
	Long-term	Establish more Opa-like units to process and sell frozen vegetables.	120
Total			715
Chillies	Short-term	Capacity building of farmers and labor on chilies production and harvesting techniques by research and extension wing	150

	Short-term	Provision of inputs (Fertilizer, Pesticides, and Implements) on subsidy to develop chilies cluster.	196
	Medium-term	Establishment of chilies market in its cluster.	200
	Medium-term	Establishment of the chilies processing unit (dry chili, hot sauce & chili powder).	50
		Strengthen regulatory enforcement and implement quality control measures and provision of quality inputs by extension wing	50
		Establish local markets and strengthen market information system	30
	Long-term	Development of hybrid chilies varieties and cultivation under controlled environment.	300
Total			976
Moong	Short-term	Moong soil fertility and crop management through Improved knowledge on crop management technologies and fertility requirements	120
		Capacity building of farmers on pests, diseases and weeds management in Moong and provision of quality inputs	170
	Medium-term	Moong harvesting, post-harvest management, improve markets and community based storage facilities to reduce post-harvest loses	220
		Facilitate private sector for the establishment of state of the art Daal preparation unit	250

	Long-term	Provision of climate and pest resilient varieties	150
Total			910
Gram	Short-term	Provision of inputs (Fertilizer, Pesticides and Implements) on subsidy to develop gram cluster through Kisan card by extension wing	165
	Short-term	Provision of Sprinkle/drip Irrigation to improve water efficiency	700
	Medium-term	Support commercialization of Seed Producers	130
		Developing Infrastructure and Processes for Value Addition in Gram	150
		Capacity building of farmers and labor on gram production and harvesting techniques by research and extension wing	130
		Establishment of gram market in gram cluster	210
	Long-term	Provision of subisidy on certified seed through Kisan card	150
Total			1,635
Cotton	Short-term	Introduce superior germplasm and deploy advanced technology for high-quality inbred lines and breeder seed	700
	Short-term	Introduction of IPM practices for effective insect/pest control in the area.	210

	Short-term	Provide credit and insurance through Kisan card, ensuring financial ease for farmers	300
	Short-term	Provision of fertilizer and pesticide on subsidy through Kissan card	700
	Short-term	Upgrade water storage for ample supply during cotton season.	500
	Short-term	Modernize ginning for better lint quality and competitiveness.	470
	Short-term	Enforce Seed Act, discourage informal sector through quality control.	200
	Short-term	Capacity building of farmers on pests, diseases and weeds management in cotton and provision of quality inputs	200
	Short-term	Conduct market surveys to identify demand in international and local markets.	100
	Medium-term	Introduce and implement the CSA production technologies	310
	Medium-term	Improve seed grading and processing facilities for enhanced efficiency.	320
	Medium-term	Collaborate with international partners through PPPs to access advanced seed technology.	600
	Medium-term	Strengthen extension services capacity via PPPs, incorporating agri-graduate field programs and ICT-led advisory services.	440
	Medium-term	Develop strategies like local labor training and incentives to mitigate labor shortages.	390
	Medium-term	Build capacity of ginners with revised standards to ensure quality assurance at each stage.	310

	Medium-term	Establishment of Foundation seed cell to strengthen the seed production facilities	900
	Long-term	Development of climate-resilient Certified Seed Varieties (Pre basic, basic and multiplication) and CSA production technologies	270
	Long-term	Development of Ginning cotton industry & Spinning cotton industry to meet international standard	1000
	Long-term	Implement structural reforms by establishing an independent governing authority (Cotton Council) that works across all stakeholders in the value chain.	150
	Long-term	Announce intervention prices, ensuring a margin for farmers, and consider adopting a minimum ensured price (MEP) system, as seen in India.	170
Total			8,240
Mango	Short-term	Provide training program on modern techniques, plant protection, harvesting, packing, and processing of mango	300
	Short-term	Strengthen farmer cooperatives, facilitate direct marketing, and provide business training.	250
	Medium-term	Cultivation of Mango on High-density Planting under Drip Irrigation in new areas.	970
	Medium-term	Establish/ update Cold Storage/Controlled atmosphere facilities for local and international market/ mandi to increase shelf life.	600

	Medium-term	Develop new varietal characteristics in terms of shelf life, robustness in handling, and ability to withstand phytosanitary treatments (HWT, VHT, or irradiation) to target high-end markets.	450
	Medium-term	Strengthning of Mango Research Station	1000
	Medium-term	Develop and enforce quality compliance measures to improve the quality of mangoes in both domestic and international markets	40
	Long-term	Improve profitability across the value chain stakeholders through fair pricing and support to small farmers by developing blockchain	45
	Long-term	Develop climate-smart agricultural practices to adapt to climate change	70
	Long-term	Strengthen market linkages and improve market information systems to ensure that farmers and processors can access better prices and market opportunities for their products.	35
	Long-term	Promote the export of the most in-demand mango varieties, such as Chenab Gold, to increase profitability.	110
	Long-term	Develop mango byproducts, such as mango toffee etc, to increase profitability & Increase value addition by building more pulping units to produce pulp according to international standards for export purposes.	225

	Long-term	Upgrade research and development, and build research labs for dried mangoes to develop new mango byproducts.	60
	Long-term	Standardize and establish modern nurseries to improve the quality of mangoes and develop a monitoring and evaluation system to maintain quality.	55
Dried Mango	Short-term	Provide technical assistance and training to farmers on pre-treatment, harvesting and drying techniques	100
	Short-term	Provide technical assistance and training to processors on proper drying, packaging, and labeling techniques	70
	Medium-term	Develop and disseminate quality standards for dried mangoes	45
	Medium-term	Develop and disseminate standards for packaging and labeling of dried mangoes	60
	Medium-term	Establish market linkages with potential buyers and exporters, both domestically and internationally	50
	Long-term	Provide access to finance for farmers and processors to invest in the necessary equipment and infrastructure for drying mangoes	300
	Long-term	Establish a system for quality control and certification of dried mangoes, including testing for food safety and adherence to international standards	80

	Long-term	Invest in the necessary infrastructure for drying mangoes, including solar dryers, storage facilities, and transportation systems	200
	Long-term	Advocate for policies and regulations that support the development of the dried mango value chain	65
Total			5,180
Dates	Short-term	Provision of inputs (Fertilizer, Pesticides and Implements) on subsidy through Kisan card by extension wing	171
		Provision of local and imported plants and nurseries on subsidized rate	210
		Provision of Better Management Practices for raising productivity	150
	Medium-term	Provide training program on modern techniques, plant protection, harvesting, packing, and processing of dates	75
		Establishment of dates market in dates cluster	250
	Long-term	Introducing the Solar Tunnel Dates Drying	150
		Allocate funds for a district date palm research center	400
		Improving Value Addition by Introducing Packhouses for Export Market	170

		Development of climate-resilient Certified Seed Varieties (Pre basic, basic and multiplication)	230
		Establish tissue culture facilities.	400
		Upgradation of Orchards with High Density Plantation	250
Total			2,456
Tomatoes	Short-term	Provision of inputs (Fertilizer, Pesticides and Implements) on subsidy through Kisan card by extension wing	650
		Local tomato seed varieties replacement program.	300
	Medium-term	Establishment of Tomato paste production unit	200
		Establishment of CA (Control Atmosphere) storage	180
		Establishment of tomato market in tomato cluster.	200
	Long-term	Development of climate-resilient Certified Seed Varieties (Pre basic, basic and multiplication)	300
Total			1,830
	Short-term	Conduct market survey to identify demand in international and local market for Kinnow and other varieties and identifying protocol for export of citrus to the various markets &	120

Citrus (Oranges)		conduct survey of registered nurseries. All nurseries to be given targets to produce 20 million plants & monitor them.	
	Short-term	Incentivize and subsidize farmers for Integrated Orchard Management to minimize disease spread and crop damage	150
	Medium-term	Incentivizing private sector by credit through banks for the establishment of Citrus processing and grading unit within the crop clusters	320
	Medium-term	Incentivizing private sector by credit through banks for the establishment of Cold storage within the crop clusters	600
		Diversify product offerings to mitigate market risks	150
	Long-term	Development of Certified Seed Varieties (Pre basic, basic and multiplication) according to the international market demand	350
Total			1,690
Olives	Short-term	Provision of inputs (Fertilizer, Pesticides and Implements) on subsidy through Kisan card by extension wing	250
	Short-term	Provide technical assistance to Farmers for the establishment of olive orchards	200
	Short-term	Provide subsidy on the installation of drip irrigation system	400

	Medium-term	Establishment of a table olive processing unit, and specialized olive tree nurseries	400
	Long-term	Establishment of olive processing facilities	180
	Long-term	Introduce olive value addition products and provide its export market	380
	Long-term	Provision of climate-resilient certified olive nursery and implement its CSA production technology	250
	Long-term	Act as a repository of olive genetic resources and their management.	170
	Long-term	Minimize post-harvest losses and enhancing the efficiency of olive collection and transportation.	130
	Long-term	Undertake socio-economic research in olive crop	100
	Long-term	Expanding market access and ensuring fair prices for olive products.	200
Total			2,660
WATER EFFICIENCY			
WATER EFFICIENCY	Short-term	Climate Smart Water Management and Information Services including development of a Water Accounting System, Evapotranspiration-based Water Management System, Early Warning System and Provision of Information and Data to Facilitate Climate Change Adaptation	304

	Short-term	Building on-Farm Resilience to Climate Change through Development of practices for climate change resilient and Training of extension workers and farmer facilitators	348
	Short-term	Establishment of Technology Transfer Centers (TTCs) in DG Khan Division for the demonstration to enhance water use efficiency through; Farm layout planning/ designing, precision / LASER land leveling and water budgeting & accounting, Provision of rapid soil testing kits to the farmers at TTCs for application of balanced fertilizer, Fixation of pipe nakkas according to soil type and water flow for channelized stream flows,Installation of flow measurement devices for open channels and tubewells for measuring the discharge of water for water accounting,Installation of soil moisture monitoring gadgets,	700
		Introduction of high efficiency irrigation system	1000
	Short-term	Support farmers for installation of tunnels for off-season vegetable production.	210
	Short-term	Provision of 400 LASER land levelers to the farmers/ service providers for strengthening LASER land leveling services in the private sector.	400
	Medium-term	Construction of on-farm water storage ponds in irrigated areas for storing excess canal/ rainwater for supplemental irrigation.	6825
		Remodeling of thal canal to improve capacity	2500
	Medium-term	Install solar systems for operating high efficiency irrigation systems.	630

	Long-term	Improvement of unimproved & additional lining of watercpourse improvement	6000
	Long-term	Promote high efficiency irrigation systems on Drip and Sprinkle Irrigation System on fruit and vegetables farms.	871
	Long-term	Deliver soil moisture to the farmers/ service providers.	200
TOTAL			19,988
Common Structural Projects	Medium-term	Provision of specialized extension services for vegetable crops.	320
	Medium-term	Provision of specialized extension services for fruits.	300
		Establishment of markets for low crops like kalwanji etc	200
	Medium-term	Ease of financial access and insurance services to farmers.	300
	Medium-term	Upgradation and establishment of agriculture markets by rehabilitation or provision of depleted/missing facilities, infrastructure, and utilities.	500
	Medium-term	Establishment of feed mills by incentivizing private sector in ppp mode.	300
		Introduce Projects to reclaim salt affected areas	800
	Medium-term	Integrated Pest diagnosed, warning, and control management for all crops	200

	Medium-term	Set up of support system for the farmers in case of crop failure and price fluctuation for vegetables and fruit crops.	500
	Long-term	Establishment of state of the art warehouse and grain silos in ppp mode.	300
	Long-term	Installation of grading unit for fruits	350
	Long-term	Establish a centralized database for agricultural commodities	150
	Long-term	Establish government-regulated mandis in underserved areas	500
	Long-term	Develop region-specific agricultural planning strategies.	240
	Long-term	Increase recruitment and training of field staff. Recruit local field staff.	800
	Long-term	Incentivize the region specific crops which govt needs	600
	Long-term	Promoting research for enhancement of mash and lentil production to reduce pulse import bill	60
	Long-term	Improving an organizations overall performance and efficiency by improving the members (individuals and groups) performances, commitment, and flexibility. (HR)	400
TOTAL			6,820