AGRICULTURE DEVELOPMENT PLAN SAHIWAL

The Urban Unit
Urban Sector Planning & Management Services Unit (Pvt.) Ltd.

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DISCLAIMER

Urban Sector Planning and Management Sector Unit (Pvt.) Ltd. has meticulously prepared this Agriculture Development Plan report for the Sahiwal Division, ensuring thorough attention to detail throughout the development process.

The opinions expressed in this document are solely those of the authors and do not necessarily represent an endorsement by the Urban Unit.

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AGRICULTURE CHAPTER

EXECUTIVE SUMMARY

Agriculture remains the backbone of Pakistan's economy, despite its declining share in GDP. It continues to play a vital role in the socio-economic structure, particularly in Punjab, where 60% of the population resides in rural areas and depends on agriculture for their livelihood. Punjab produces a variety of crops such as wheat, cotton, rice, sugarcane, citrus, oilseeds, and various fruits and vegetables. However, despite favorable growing conditions, issues like water shortages, declining soil fertility, water quality degradation, and limited agricultural areas have led to reduced yields and livestock productivity. Government interventions have been ineffective in significantly enhancing productivity, largely due to insufficient focus on leveraging each area's comparative advantages and developing value chains.

The global production ranking for major crops from Pakistan has been falling, reflecting a worrying trend. Declining exports, challenges within the value chain, and a lack of value addition have worsened the situation. Policy focus areas have been identified to improve productivity, transition towards high-value crops, enhance water management, and foster integrated rural development.

The Sahiwal division encounters severe agricultural challenges, including a scarcity of certified seeds for potatoes and maize, the widespread sale of uncertified seeds, and frequent pest and disease outbreaks. The region struggles with inadequate seed multiplication infrastructure, issues with genetic purity, and considerable post-harvest losses due to insufficient machinery. There is also a significant knowledge gap among farmers about best practices and technologies, a heavy reliance on groundwater for irrigation threatens long-term sustainability, and the lack of proper processing facilities and export mechanisms stifles economic opportunities.

Addressing these challenges demands targeted interventions. The proposed cropping pattern capitalizes on agro-ecological conditions and logistics analysis to recommend specific crops for the region, focusing on developing the value chain through crop zoning. Steps like increasing yields

to match those of progressive farmers, concentrating on high-value crops, and providing specialized support systems are crucial to improving the agriculture sector's performance.

Efforts to bridge the productivity gap, investing in research and development for crop improvement, and optimizing water resource management are essential. Introducing specialized machinery tailored to the needs of the regional crops and promoting sustainable farming practices are pivotal for long-term growth. Implementing these strategies could substantially enhance agricultural output, value addition, and GDP contribution, transforming the agriculture sector in the Sahiwal division.

1. INTRODUCTION

According to the Economic Survey of 2021-22, Punjab's agricultural sector contributes significantly to the Gross Domestic Product (GDP) at 22.7% and accounts for 37.4% of total employment in the region. This sector includes various activities such as crop cultivation, animal rearing, fishing, and forestry. In fiscal year 2021-22, agriculture in Punjab expanded by 4.40 percent, exceeding both the target growth rate of 3.5 percent and the previous year's growth rate of 3.48 percent. This growth was driven by a favorable mix of high crop productivity, attractive market prices, and government initiatives, along with improved access to certified seeds, pesticides, and agricultural financing. The sector saw an impressive growth rate of 6.58 percent in 2021-22, compared to 5.96 percent the previous year. The production of key crops—cotton, rice, sugarcane, and maize—saw growth rates of 17.9%, 10.7%, 9.4%, and 19.0% respectively. Moreover, other crops accounted for 13.86 percent of the total agricultural value added and contributed 3.14 percent to the GDP, with a growth rate of 5.44 percent, largely due to increases in the production of pulses (29.82 percent), oilseeds (24.75 percent), vegetables (11.52 percent), fruits (1.53 percent), and fodders (0.36 percent).

Despite these achievements, the agriculture sector in Punjab, and Pakistan more broadly, struggles with low productivity due to factors such as substandard and inadequate agricultural inputs, ineffective farm management practices, and limited access to essential inputs for subsistence

farmers. The high costs and limited knowledge often hinder these farmers from adopting modern agricultural technologies. Even large farms, despite using advanced machinery and equipment, struggle to meet international production standards. Consequently, the share of agriculture in the overall GDP has been declining since Pakistan's independence in 1947, dropping from over 50 percent in the 1970s. Moreover, while livestock played a slightly lesser role compared to key crops in the 1970s, it remains a vital component of the agricultural sector.

SALIENT FEATURES OF PAKISTAN AGRICULTURE SECTOR (2022)

Crops	Forestry	Fisheries	Livestock
34.8 % Value Addition in Agri.	1.65 % Value Addition in Agri.	1.65 % Value Addition in Agri.	61.9 % Value Addition in Agri.

Table 1: Crop Wise GDP Share of Pakistan

Crops	Share in GDP (%)	% Value Addition in Agriculture
Major Crops	4.4	19.5
Cotton	0.6	2.4
Sugarcane	0.8	3.7
Rice	0.5	2.4
Wheat	1.8	7.8
Maize	0.7	3.2
Other Crops	3.8	15.3

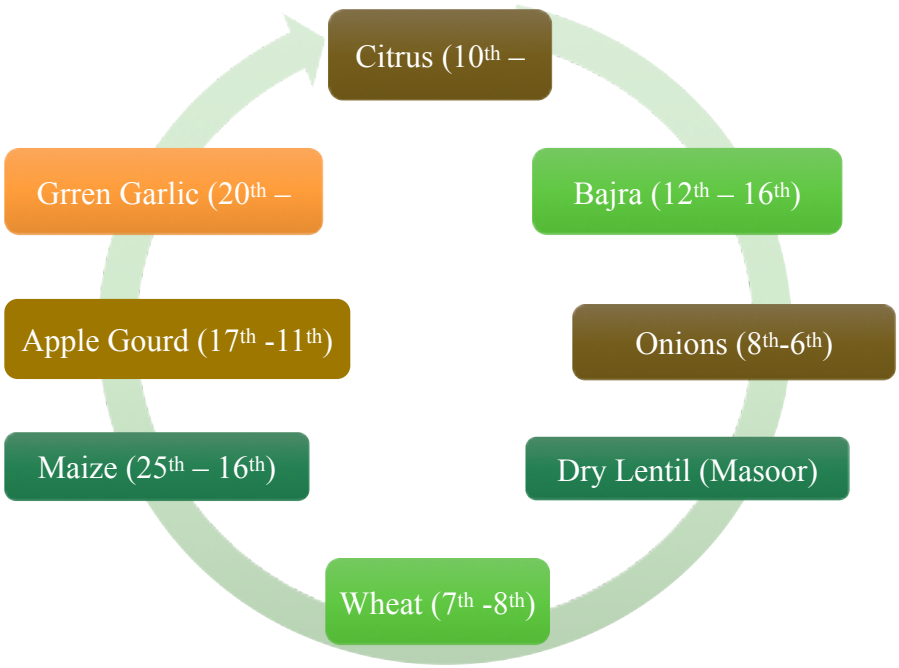
Source: Economic Survey of Pakistan (2021-22)

Fruits, Vegetables & Horticulture (4 to 6 % only)

1.1. PAKISTAN RANKING IN THE WORLD (PRODUCTION)

Pakistan's position in global crop production rankings has been steadily declining. Between 2010 and 2021, the ranking for wheat remained relatively stable, slipping slightly from 7th to 8th place. However, other crops experienced more significant drops: citrus fell from 10th to 15th place, bajra (pearl millet) from 12th to 16th place, and lentils from 16th to 20th place. These declines reflect a worrying trend of diminishing production and market share for these major crops on the global stage. The figure below illustrates Pakistan's shifting rankings in various crop productions over this period.

Figure 1: Pakistan Ranking in the World (Production)



Source: FAO Ranking

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

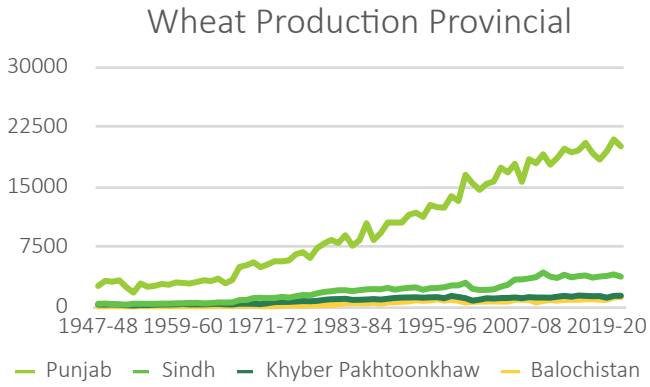
Challenges and concerns within the agriculture sector are influencing its growth and development trajectory. Consequently, the proportion of agriculture's contribution to GDP is witnessing a decline. Additionally, there is a decreasing trend in the share of agricultural employment, while agriculture GDP per worker has remained stagnant at approximately $1400.

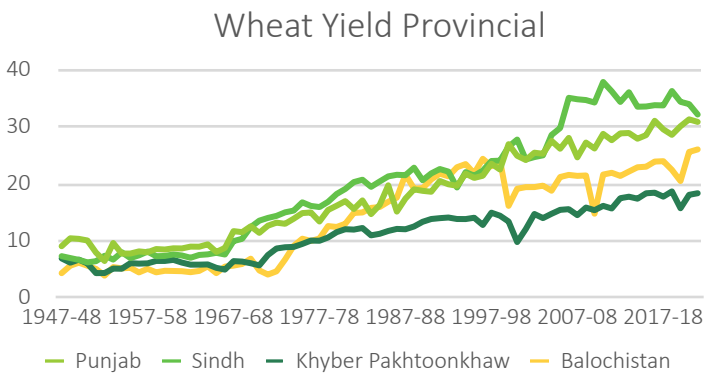
Value chain and value addition issues are evident, as crop production and yields have shown minimal progress, particularly since 2007-2008. The increasing per capita requirement for crops is straining the industry's ability to meet demand, further exacerbating the situation. The region is falling behind in the international market, with a decreasing share of exports.

Specifically, wheat production and yield show a steady increase, while potato production has seen significant growth but with fluctuating yields. Maize production has surged dramatically, although yields have only recently begun to improve. On the other hand, sesame production has experienced volatility, and yields have remained relatively stable with occasional spikes.

These figures illustrate the diverse challenges and concerns impacting the agriculture sector's growth and development.

There is a lack of value addition in the agricultural process.





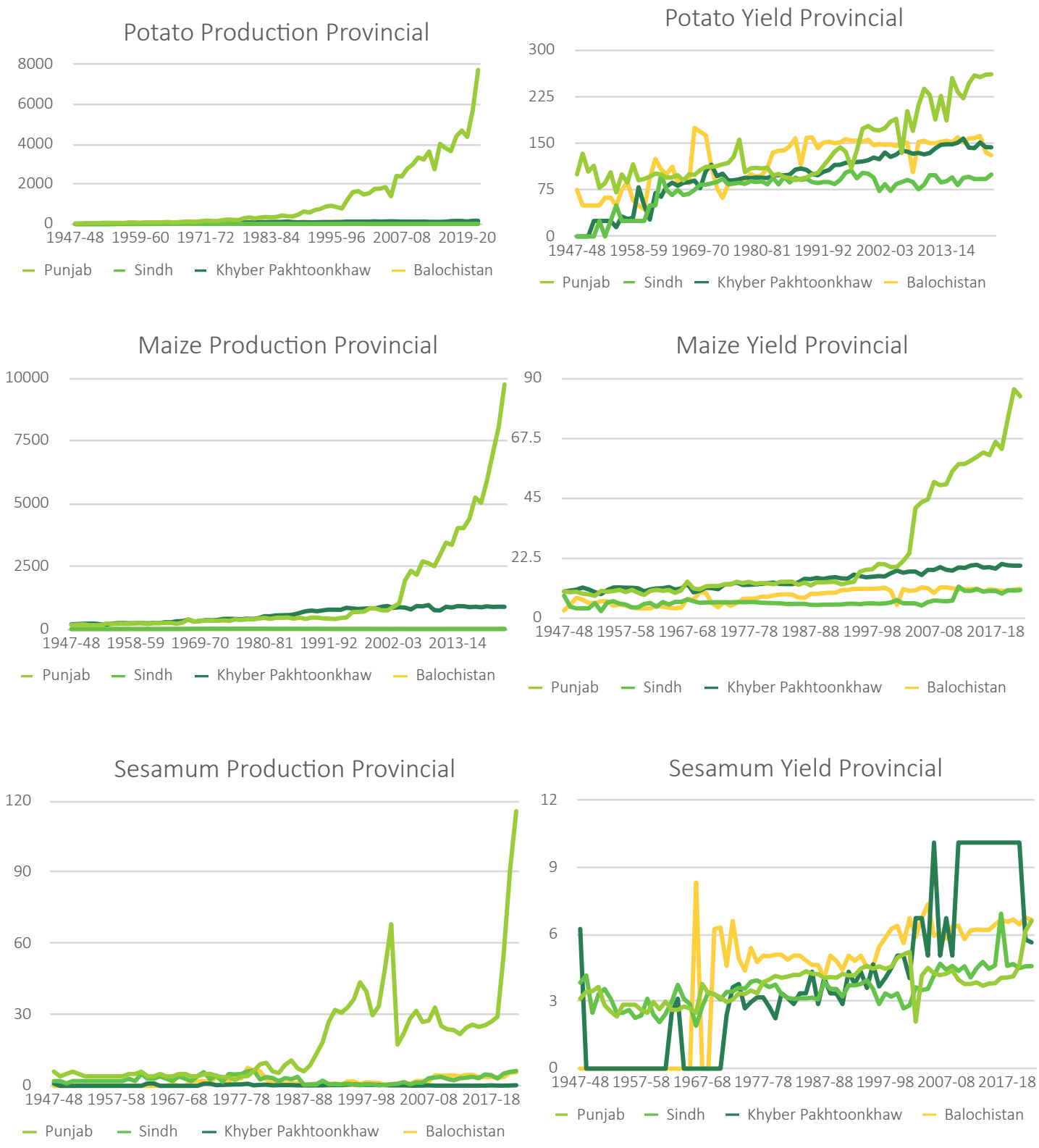


Figure 2: Provincial production and yield potential of crops

Source: AMIS

1.3. AGRICULTURE, FORESTRY, AND FISHING, VALUE-ADDED PER WORKER (CONSTANT 2015 US$)

A measure of agricultural productivity is agriculture value added per worker. In agriculture, value-added is defined as the output of the agricultural sector less the value of intermediate inputs. Agriculture includes the value added by forestry, hunting, and fishing, as also crop cultivation and livestock farming. Argentina ranks first in the world in terms of agricultural value-added per worker. Argentina's agriculture value added per worker in 2019 was 2.76 million US dollars, accounting for 50.19 percent of global agriculture value added per worker.

Source: World Bank

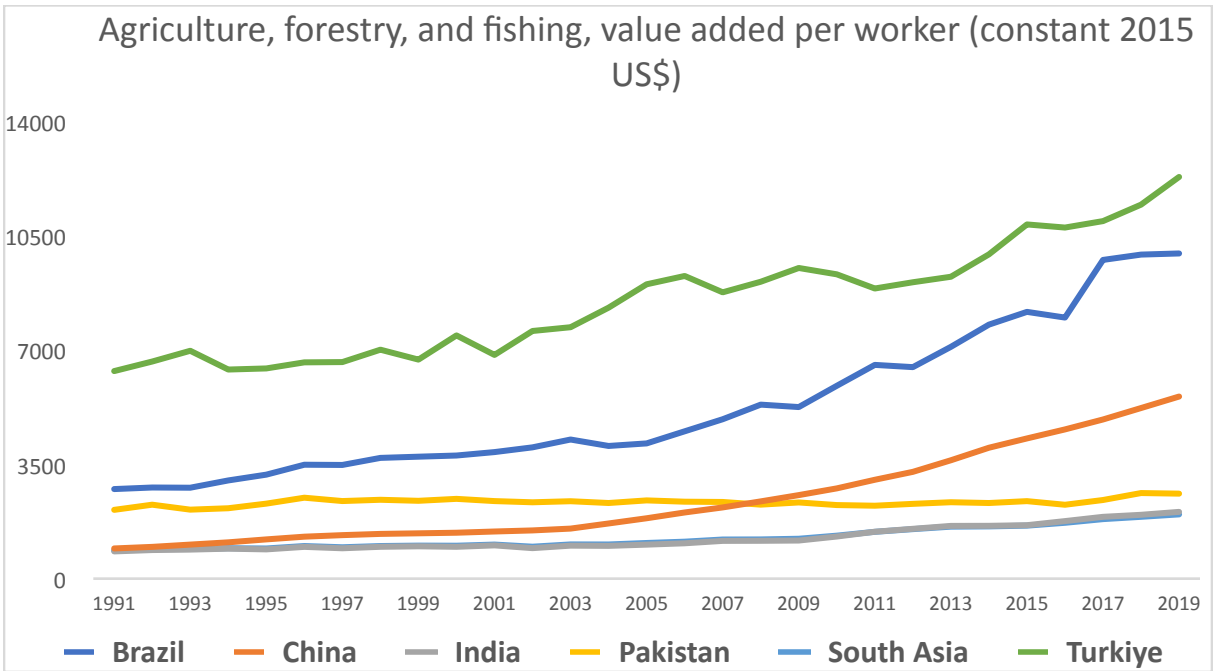


Figure 3: Agriculture, Forestry, And Fishing, Value-Added Per Worker (Constant 2015 US$)

2. COMPREHENSIVE AGRICULTURE TRANSFORMATION PLAN

In response to prevailing challenges, it is imperative for the government to adopt a multifaceted strategy to transform agriculture. This approach should begin with the identification of areas that hold potential for cultivating specific crops, followed by the establishment of specialized clusters

or zones for these crops. These designated zones would be equipped with comprehensive amenities and support systems tailored to meet the unique needs of each crop type. Such a strategic arrangement will enhance resource utilization—land, labor, water, and inputs—thereby increasing efficiency and allowing for effective oversight of the entire value chain, which includes input management, extension services, technological upgrades, research and development, and the management of subsidies.

A key component of the plan involves shifting from low-value to high-value crops. This transition can be facilitated by identifying regions that are best suited for growing high-value crops and prioritizing their cultivation over the next five years. For instance, in the Sahiwal agriculture sector, potatoes, maize, and sesame have been selected for focused cultivation due to their profitability, market demand, value-addition potential, export possibilities, and competitive advantage in global markets. This strategic shift is intended to stimulate growth within the regional agricultural sector by enhancing the productivity of primary as well as other agricultural products like horticulture, food grains, oilseeds, and minor crops. Efficient utilization of limited land resources will also allow for the introduction of high-value crops in the remaining areas.

The Punjab Spatial Strategy (PSS) serves as a long-term framework for spatial development across various sectors including agriculture, livestock, irrigation, food, forestry, industries, environment, urban planning, and social development. This strategy is designed to promote integrated spatial planning by leveraging the comparative advantages of different areas, thus structurally transforming Punjab into a more economically prosperous region.

Additionally, under the PSS, a detailed agriculture transformation plan has been developed which focuses on the comparative advantages of each region or division in Punjab. In this context, the Urban Unit has been tasked with creating a detailed agriculture and livestock development plan for the Sahiwal region, which will address the value chains of each potential or identified crop in the area.

2.1. REGIONAL PLANNING (SCOPE OF WORK)

The agricultural sector is pivotal to Punjab's economy, and enhancing agricultural productivity is crucial for boosting the province's economic growth. Currently, development projects lack a spa-

tial framework for assessment and evaluation aimed at targeted economic growth. The Punjab Spatial Strategy, therefore, prioritizes exploring the agricultural sector's potential for economic expansion within the province. Under the Punjab Spatial Strategy framework, there is a vital need to transform the agricultural sector by increasing crop productivity, expanding cultivation to previously uncultivated areas, and optimizing the crop mix for maximum value addition. This transformation will involve upgrading farmers to progressive farming standards, providing them with advanced support and knowledge, quality inputs in a timely manner, and fostering an enabling environment for growth. The scope of this work includes:

- Developing and Validating Agro-Ecological Conditions: Conducting socio-economic profiling of agriculture and livestock sectors, focusing on assessing the physical environment—land cover, geology, natural resources, climate, hydrology, population dynamics, land use, and community structure—to determine the most beneficial cropping patterns for intensification.
- Cropping Pattern Optimization: Identifying cropping patterns based on yield, pricing, production costs, and profit per acre, and proposing patterns aimed at intensification.
- Value Chain Analysis: Identifying issues within the product-level value chain from seed to market, including resource and financial constraints, and proposing targeted interventions to enhance production and export capabilities.
- Focusing on Export Potential: Analyzing exportable surpluses and developing value propositions for interventions that could lead to significant economic growth in the region.
- Resource Assessments: Evaluating water availability and utilization to ensure the preservation of natural resources.
- Economic and Infrastructure Assessments: Reviewing economic activities related to livestock and agro-based industries, employment, and the labor market, as well as key facilities like agricultural markets, farm mechanization, breeding, and seeding facilities for potential infrastructure and policy interventions.

The regional development strategy for the Sahiwal Division emphasizes transitioning from low-value to high-value crop cultivation within the existing cropping patterns to boost farmer income

and foster agricultural industry growth. This goal is achievable through the strategic formation of clusters of high-value crops in regions where we have a competitive advantage in yield and productivity, supported by favorable ecological conditions. This comprehensive approach aims to reshape Punjab's agricultural landscape, making it more productive, sustainable, and economically viable.

SAHIWAL DIVISION PROFILE

Considering the current agricultural scenario in Punjab, it is imperative to formulate a development plan specifically for the Sahiwal Division. This plan aims to thoroughly assess and address the prevalent challenges within the agriculture and livestock sectors of the region. Its primary goal is to provide a comprehensive analysis of the existing conditions—including production levels, infrastructure quality, market access, and resource management. The development plan will act as a strategic blueprint for launching targeted interventions designed to elevate the agricultural and livestock sectors in Sahiwal. Objectives include fostering sustainable growth, enhancing productivity, improving the quality of agricultural produce, and creating optimal conditions for farmers and other stakeholders. Through the effective implementation of this plan, Sahiwal is poised to become a leading center for agriculture and livestock, making a substantial contribution to the region's economic development.

3. SAHIWAL DIVISON AGRICULTURE PROFILE

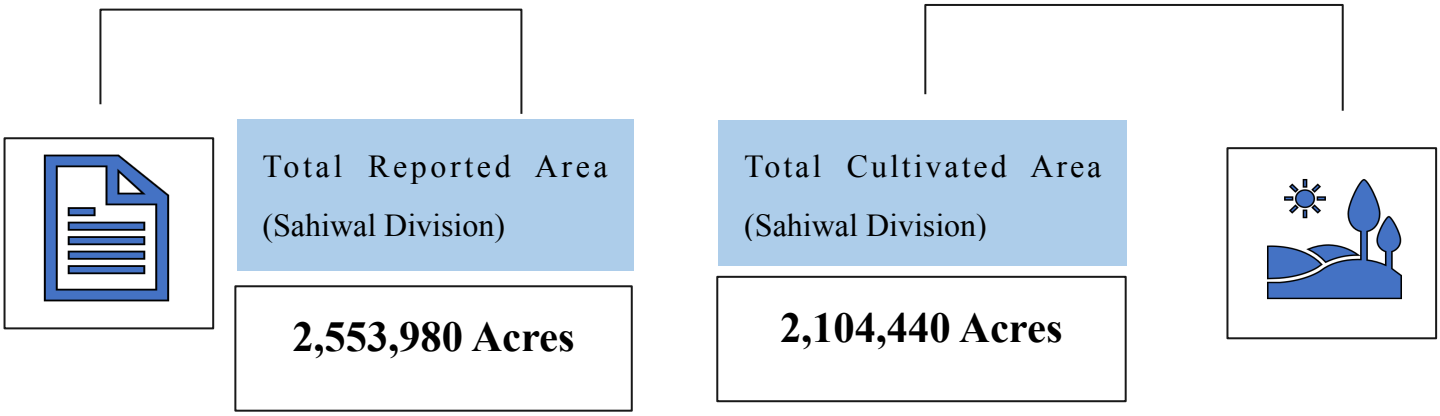


Figure 4: Reported and Cultivated Area

Continuous Urban Development in Sahiwal District	Total
1995-2005	33%
2005-2015	44%

Annual Area Growth Rate in Sahiwal District	Total
1995-2005	2.92%
2005-2015	3.70%
1995-2015	3.31%

Source: Urban Unit

	Employment in Agriculture Sector (%)
Sahiwal	42.8
Okara	51.6
Pakpattan	52.3

Table 2: Urban Development, Annual Area Growth, Employment by Sector
Source: LFS 2021

4. SAHIWAL AGRICULTURE SECTOR PLAN

4.1. VISION

The vision for the Sahiwal division is to enhance agricultural productivity and value addition by efficiently utilizing resources and leveraging natural endowments to improve the region's competitiveness and attractiveness. The Agriculture Development Plan aims to address a spectrum of challenges including limited seed supply, pest and disease control, seed multiplication, genetic purity, post-harvest losses, knowledge gaps, water sustainability, value chain inefficiencies, and export bottlenecks. This comprehensive strategy is designed to boost the economic well-being of the local community, particularly those in rural areas, by outlining clear policy areas, targets, key actions, and stakeholder roles.

4.2. AGRICULTURE OBJECTIVES

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

01 Enhance the competitive position of the agriculture sector to capture global demand and cater to domestic demand through the modernization of traditional agriculture practices.

02 Ensure food security by improving food quantity, quality, and nutrition diversity through higher yields, better crop mix, and farmer profitability.

03 Enhance sustainability and resilience in the wake of climate changes by conserving agricultural resources through efficient use of land & water.

04 Strengthen and promote private sector participation in agriculture value chains with increased investment, technology infusion, and resource man-

05 Improving breed development, on-farm mechanisms, medical facilities, and providing high-quality nutritional feed for enhanced productivity.

06 Contribute towards poverty alleviation and economic development of the province through the provision of an enabling environment and farmer support services.

07 Strengthen local markets and price mechanisms and increase accessibility to the international market by adopting international standards and certifica-

4.3. 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.

- Increase Productivity: Bridge the productivity gap across all crops and livestock, transitioning from low to high productivity.
- Crop Zoning: Identify potential areas for each crop and establish specialized clusters or zones.
- Comprehensive Support: Provide all necessary ancillary facilities and specialized support systems within each crop cluster or zone.
- Optimize Crop Mix: Gradually shift from low-value to high-value crops by prioritizing the cultivation of identified high-value crops over the next five years.
- Efficient Water Use: Transition from wasteful to efficient water use, developing 24 agriculture corridors along the main canals to focus on integrated rural development.
- Departmental Coordination: Ensure all departments coordinate and implement integrated action plans to maximize agricultural 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 collected by our team, it undergoes a thorough analysis and discussion. This includes cleaning, integrating, and verifying the data to ensure accuracy and address any discrepancies. Additional data is sourced via electronic communication and phone calls with the Departments of Agriculture and Livestock to supplement the initial findings. We then create descriptive maps for the upcoming Rabi and Kharif crop seasons, utilizing field data in conjunction with an understanding of the agro-ecological conditions. Following this, the Agriculture and Livestock team conducts a detailed examination to further refine our insights and strategies.

5.2. IDENTIFIED POTENTIAL CROPS IN THE SAHIWAL DIVISION

The significance of Value Chain Development through Crop Zoning and Specialized Support Systems as major initiatives for enhancing productivity and profitability in the Sahiwal Division is evident from the range of potential crops in the region. The Research Institutes have proposed potatoes and sesamum as high-value crops.

VALUE CHAIN DE-

01

CROP ZONING

02

SPECIALIZED SUP-PORT SYS-

03

Stakeholders

- Director Agriculture Extension
- Director Agriculture OFWM
- Deputy Director Agriculture Extension
- Assistant Director Agriculture of all Tehsils
- EADA, Agriculture E & M
- Director Potato research institute

Field Visits

- Farmers of Every Tehsil
- Progressive Farmer of potato, maize and garlic
- Progressive Farmers of peas

RAPID ASSESSMENTS – FIELD VISITS

The Urban Unit Agriculture sector teams visited various sites in the Sahiwal division during December of 2023.

6. SAHIWAL AGRICULTURE SNAPSHOT

6.1. PRODUCTION OVERVIEW

Based on the data, the Sahiwal Division makes a substantial contribution to Punjab's overall crop production. Notably, potato production accounts for 60% of Punjab's total, followed by peas at 42%, and maize at 40%. While the region also has a significant output of various vegetable and fruit crops, pumpkins account for 19% of Punjab's total production. To further boost agricultural productivity in Sahiwal, it is crucial for the government to introduce specialized support systems and modern technologies for high-value crop cultivation. This approach will help maximize efficiency by reducing the reliance on traditional input factors such as land, water, and labor. Given the existing crop patterns, it is evident that the Sahiwal region is vital and has the potential to substantially increase the production of key crops like maize and potatoes.

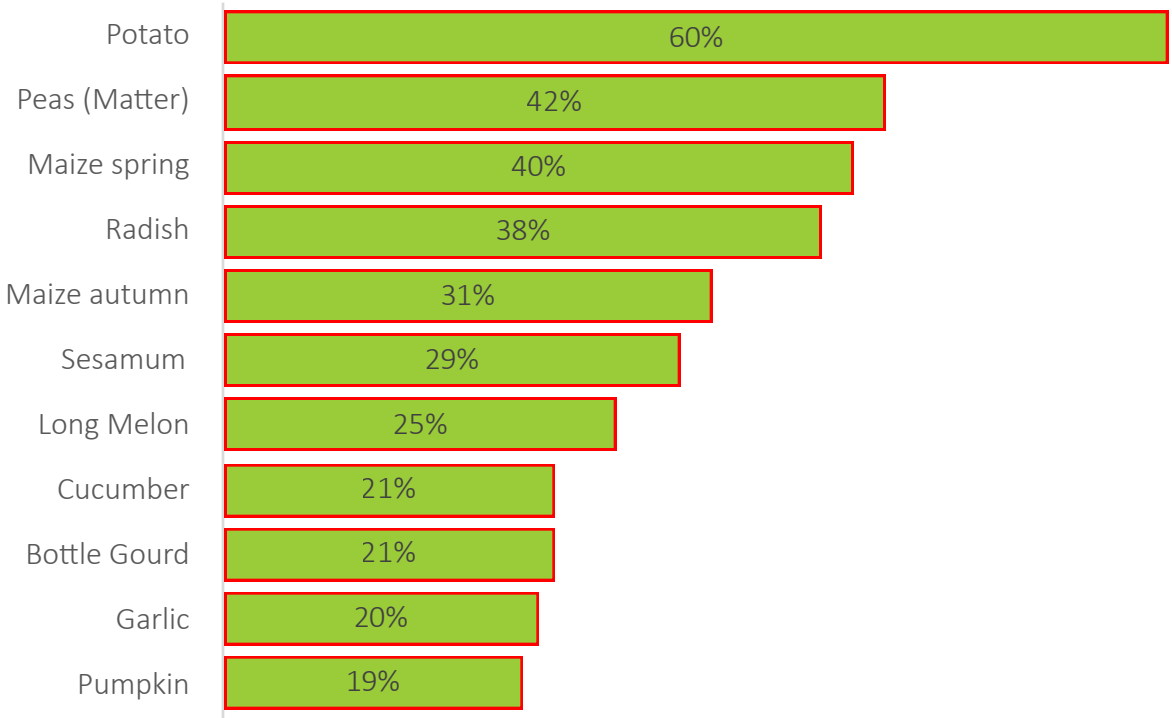


Figure 5: Production contribution as a percentage of Punjab's total

Source: Crop Reporting Service

6.2. CURRENT CROPPING PATTERN

The Rabi cropping pattern in the Sahiwal Division of Pakistan reflects the seasonal cultivation practices where crops are planted in the winter and harvested in the spring. The total area dedicated to Rabi crops in this region is substantial. However, it is evident from the data that a significant portion of the land is dedicated to low-value crops. For instance, wheat, with an output of 805,000 Rs./acre, occupies the largest area, followed by barley and carrots. In contrast, high-value crops such as vegetables and fruits occupy minimal acreage. Consequently, despite the extensive cultivation area, the division only achieves an output of Rs. 80,000 per acre in the Rabi season. This highlights the need for strategic interventions to shift towards high-value crop cultivation, enhance resource utilization, and increase overall agricultural productivity in Sahiwal Division.

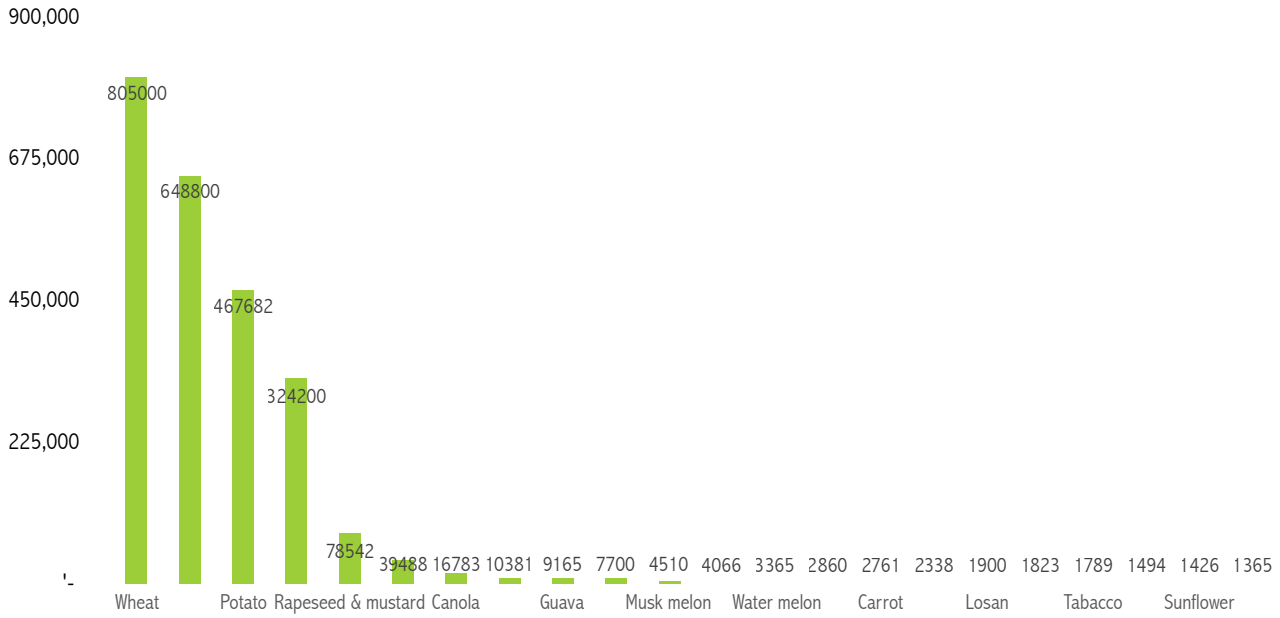


Figure 6: Current Cropping Pattern in Rabi

Source: Crop Reporting Service

Figure 7 illustrates the current Kharif cropping pattern in the Sahiwal Division. During this season, rice, maize, and sesamum make significant contributions to the area's agricultural output. However, despite this, the Sahiwal Division is only achieving an output of Rs. 135,000 per acre in the Kharif season. Out of the total Kharif area of 2,561,390 acres, 296,400 acres remain unused.

To shift the cropping pattern towards higher-value crops, it is essential to consider the region's agro-ecological conditions, identify suitable crops, and develop the value chain effectively. Although the region holds substantial agricultural potential, it has not been fully realized. Addressing gaps in the existing supply chain with a specialized support system will help bridge this deficiency. Diversifying agriculture and tackling barriers to production enhancement and increased profitability are crucial steps to achieving these goals. By taking into account the agro-ecological conditions, specific crops have been proposed to effectively meet the set targets, thereby maximizing the agricultural productivity and economic output of the Sahiwal Division.

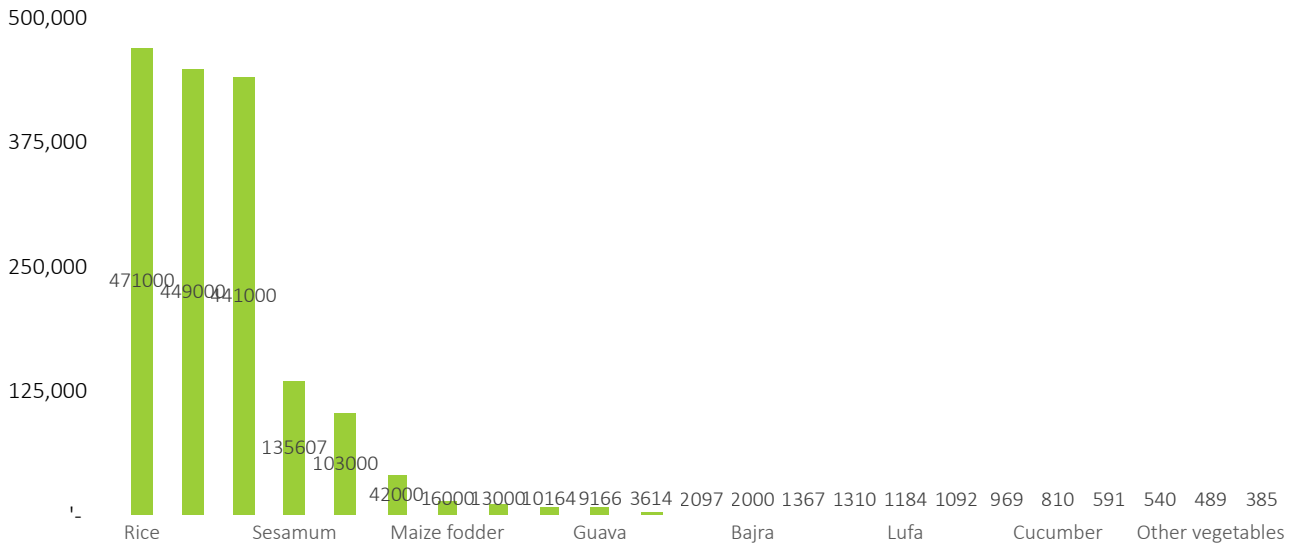


Figure 7: Current Cropping Pattern in Kharif

Source: Crop Reporting Service

7. ISSUES AND CHALLENGES OF AGRICULTURE

The agriculture sector in Pakistan faces a multitude of challenges, including water shortages, land fragmentation, insufficient mechanization, an inefficient supply chain, limited financial accessibility, and the impacts of climate change. These issues have led to a decline in agricultural productivity, increased costs, and restricted the sector's ability to compete effectively in the global market. Addressing these challenges requires the implementation of comprehensive policy reforms, investment in research and development, infrastructure improvements, and the adoption of modern technologies. These actions are crucial for enhancing productivity, efficiency, and competitiveness within the agricultural sector.

Current issues within the agricultural value chain have significant repercussions on the sector, including reduced production, decreased farmer incomes, and a lack of competitiveness in international markets. However, recent ground investigations have identified key concerns and challenges that need to be addressed to improve the situation.

7.1. ISSUES AND CHALLENGES IN SAHIWAL DIVISION

The agriculture sector in the Sahiwal Division of Punjab faces several challenges that hinder productivity and growth. These include a limited supply of high-quality, certified seeds and the prevalence of uncertified, substandard seeds, leading to reduced crop yields. Frequent pest outbreaks and high disease incidence, coupled with inadequate research, further exacerbate these issues. Water management is inefficient, with heavy reliance on groundwater and traditional irrigation practices leading to wasteful use.

Significant post-harvest losses occur due to inadequate storage and processing facilities, and the lack of modern machinery. Farmers face knowledge gaps and have limited access to specialized extension services and financial resources. Value chain inefficiencies and insufficient processing facilities reduce market access and profitability. Land fragmentation and poor land management practices limit economies of scale, while climate change adversely impacts crop yields. Poor infrastructure and limited market access further compound these problems. Addressing these issues requires comprehensive policy reforms, investment in infrastructure, research, and capacity

building to enhance agricultural productivity and sustainability in the Sahiwal Division.

7.2. ISSUES AND CHALLENGES IN SEED QUALITY

1. **Lack of Germ-plasm and Seed Copying:** The region faces a shortage of germ-plasm for seed production, and therefore, seed producers often resort to copying existing seeds. This practice undermines the quality and genetic diversity of the available seeds, negatively impacting crop productivity.
2. **Seed Theft:** The problem of seed theft is prevalent in the region, leading to the unauthorized and uncontrolled distribution of seeds. This illegal practice not only undermines the intellectual property rights of seed producers but also contributes to the availability of uncertified and low-quality seeds in the market, negatively impacting crop productivity.
3. **Inadequate Seed Storage Facilities:** The absence of proper seed storage infrastructure, such as seed banks, hampers the preservation and availability of high-quality seeds. This lack of storage facilities contributes to a diminished supply of reliable seeds, ultimately affecting agricultural productivity.
4. **Heavy Reliance on Imported Seeds:** The Sahiwal Division heavily depends on imported seeds, which introduces challenges related to quality control, adaptability, and cost. The reliance on imported seeds limits the region's self-sufficiency and hampers efforts to develop and promote locally adapted seed varieties.

7.3. ISSUES WITH VALUE CHAINS

1. **Storage Constraints:** Insufficient cold storage facilities in Pakpatan lead to post-harvest losses of perishable produce like potatoes and vegetables.
2. **Pea Cultivation Challenges:** Improper germination and climate change susceptibility hinder pea yields and quality.
3. **Potato Virus Y:** This viral disease poses a significant threat to potato production in the region.
4. **Absence of Quality Inspection and Price Control:** There is a lack of mechanisms for inspecting the quality of inputs and controlling their prices, resulting in uncertainties and potential exploitation in the market.

7.4. SOCIO-ECONOMIC CONSTRAINTS

1. **Limited Tunnel Farming Adoption:** High costs and knowledge gaps among farmers impede the uptake of tunnel vegetable cultivation.
2. **Low-Quality Inputs:** The region faces challenges related to the availability of low-quality inputs, which adversely affect agricultural productivity.
3. **High Prices and Non-availability:** Inputs required for farming, such as seeds and fertilizers, are either unavailable or obtained at exorbitant prices, creating obstacles for farmers.
4. **Lack of Advisory Services:** Farmers lack access to proper guidance and advice regarding the appropriate inputs needed for specific crops and regions, hindering effective decision-making.
5. **Limited Awareness and Poverty of Farmers:** Farmers in the Sahiwal Division lack awareness and access to modern agricultural technology, which hinders their land productivity. The adoption of advanced practices is additionally impeded by small landholdings and poverty.
6. **Inadequate Credit Facilities:** Limited access to loans, high-interest rates, and untimely availability of credit negatively impacts crop productivity. The lack of dependable credit options prevents farmers, especially those with low incomes, from purchasing quality agricultural inputs, leading to lower crop yields.
7. **Insufficient Upscaling of Modern Agricultural Technologies:** Despite the proven benefits, the adoption of modern agricultural technologies remains limited due to various factors, including financial constraints, lack of access, and inadequate guidance. Small farmers face challenges in adopting new technologies and often lack comprehensive knowledge and training. Therefore, there is a need for proper education to encourage the adoption of modern agricultural practices.
8. **Irrigation Water Quality:** Drainage water contamination with salts and toxins adversely affects soil health, vegetable growth, and poses risks to crop yields and human health. Proper drainage systems are crucial to mitigate these negative impacts.

7.5. INSTITUTIONAL CONSTRAINTS

1. **Absence Of Specialized Extension Services:** There is a lack of dedicated extension services specifically tailored for agriculture in the region. Farmers do not have access to specialized guidance and support to enhance their agricultural practices.

2. **Overburdened Extension Workers:** Extension workers often have additional duties that divert their focus from their primary responsibilities. This overburdening prevents them from carrying out their core duties effectively, impacting the delivery of crucial agricultural information and assistance.

3. **Lack Of Promotion And Monitoring:** Extension workers often face limited opportunities for professional growth, with outdated promotion systems in place. Moreover, there is a lack of effective monitoring mechanisms to assess the performance and impact of extension services.

4. **Lack Of Integration Among Departments:** The coordination and integration among different agricultural departments are insufficient. This lack of collaboration hinders the seamless flow of information, resources, and services required for agricultural development in the Sahiwal Division.

5. **Lack Of Policy Integration:** There is a lack of integration between policies and the specific needs of the agriculture sector in the region. This results in a mismatch between policy objectives and their effective implementation.

6. **Non-implementation Of Targets And Goals:** Although agricultural policies often include targets and goals, their implementation is often inadequate, resulting in a failure to address critical issues. For instance, the subsidy requirement for a specific regional crop with a comparative advantage should be based on the needs of the farmer, which is often overlooked.

7. **Insufficient Institutional Seed Production Capacity:** Public sector seed production institutes in the Sahiwal division face limitations in seed production capacity due to financial, human resource, and infrastructural challenges.

8. **Inadequate Agricultural Research And Extension:** The pace of technological advancement in agricultural yields per hectare has been slow in recent decades, compared to the 1960s and 1970s. Research institutes have not effectively contributed to developing new varieties or improving water utilization practices. Lack of coordination between research and extension organizations hinders the dissemination of improved inputs, technologies, and practices to farmers, who continue to rely on inefficient traditional methods.

9. **Ineffectiveness Of Agricultural Education & Training:** Insufficient education and training opportunities for farmers result in low agricultural productivity. Inactive and ineffective agriculture extension services fail to provide guidance on modern and improved agriculture practices, irrigation management, and soil health strategies. Farmers lack training on innovative techniques and strategies for enhancing land productivity, and the transfer of knowledge from progressive farmers to others is limited.

10. **Insufficient Capacity Building:** There is a lack of initiatives for capacity building within agricultural institutions. The absence of training and skill development programs prevents extension workers from gaining the necessary knowledge and expertise to provide up-to-date and internationally relevant guidance.

8. PRODUCTIVITY COMPARISON OF AGRICULTURE SECTOR

Agriculture is the cornerstone of Punjab's economy, yet the sector faces numerous challenges. These include a reduction in available arable land, the impacts of climate change, water scarcity, and a significant migration of population and labor from rural to urban areas. Additionally, rising costs of inputs such as fertilizers, pesticides, and seeds are concerning for crop cultivation. High-quality early generation seeds are both scarce and expensive, and there is a lack of preliminary research focused on developing new crop varieties that are resistant to pests, diseases, and changing climate conditions. Addressing these challenges is essential for sustaining and growing Punjab's agricultural productivity.

8.1. CROP YIELD

In figure 13, a comparison of crop yields reveals significant productivity gaps between the yields of average farmers, progressive farmers, and international benchmarks. For instance, while progressive farmers achieve higher yields in crops like cucumber, radish, and maize, the average yields in Sahiwal fall short of these levels. This disparity underscores the untapped potential within the region. To bridge this gap and enhance agricultural productivity, it is essential to invest substantially in agricultural research and extension systems. By facilitating the dissemination and adoption of the latest agricultural and irrigation technologies, and improving the utilization of inputs, irrigation water management, reclamation, and drainage, Sahiwal can achieve higher yields and close the productivity gap in targeted crops. This focused approach will lead to enhanced productivity and sustainability in the agricultural sector of the Sahiwal Division.

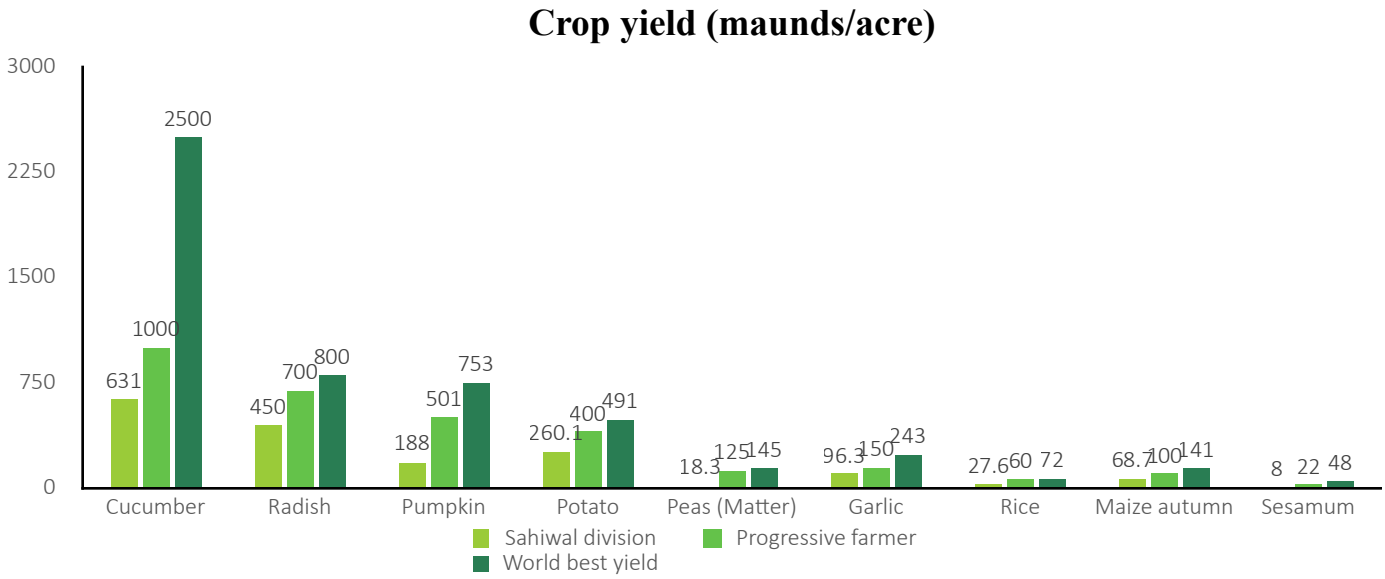
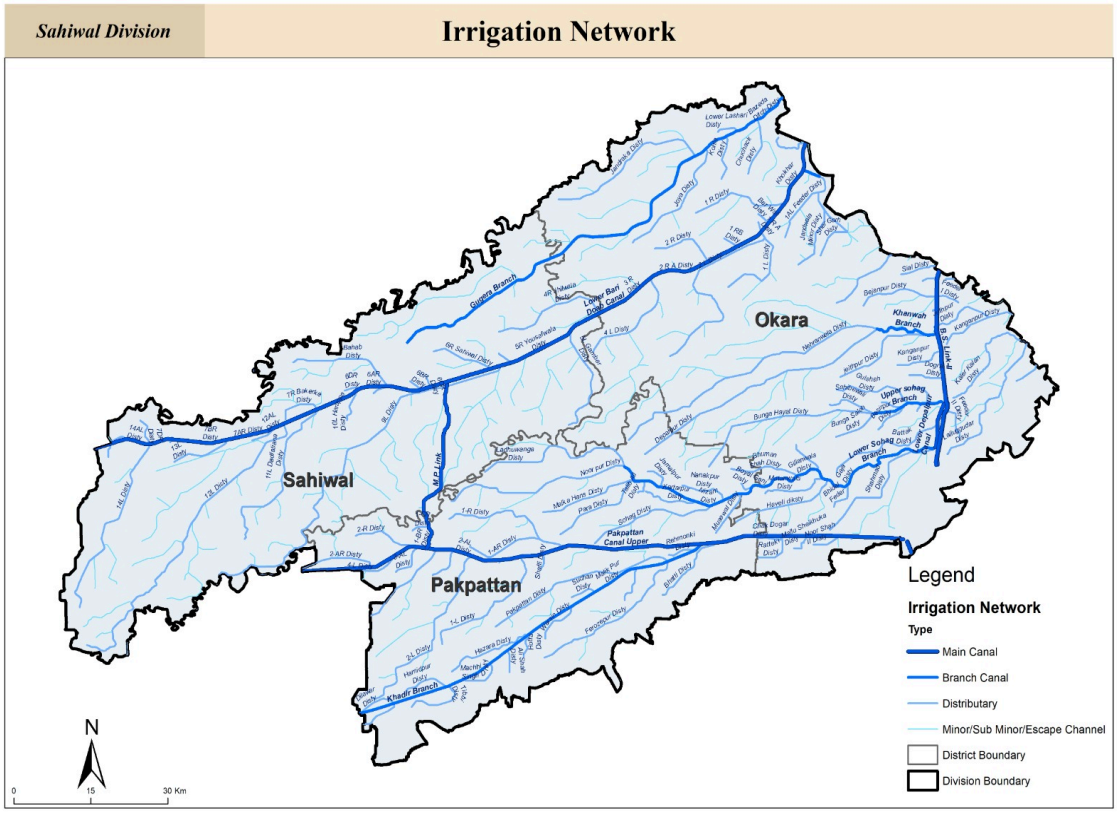


Figure 8: Yield Comparisons (Mund/Acre)

Source: FAO and Crop Reporting Service

8.2. INEFFICIENT WATER MANAGEMENT & POOR GROUNDWATER SUITABILITY

The Sahiwal Division faces critical challenges related to water management and groundwater suitability, significantly impacting the growth and development of essential crops. The region receives only 2.68 feet/acre of surface water, which is lower than the Punjab average of 2.7 feet/ acre. This scarcity severely affects agricultural productivity.

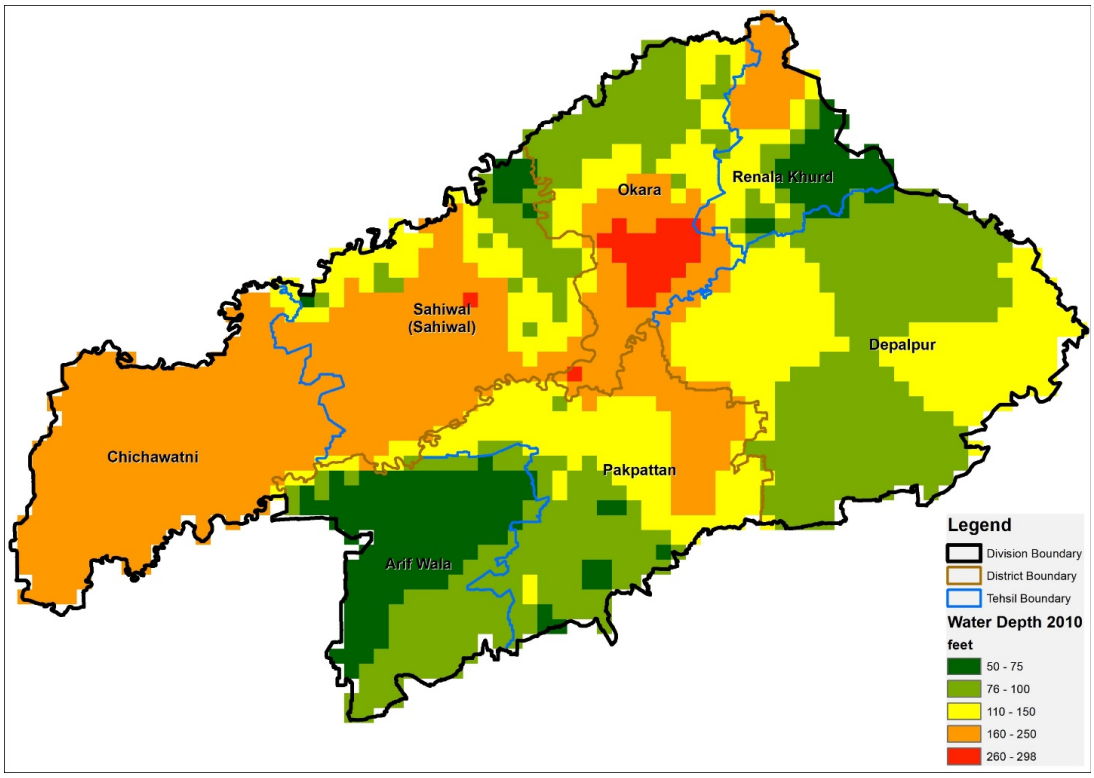


Source: Urban Unit

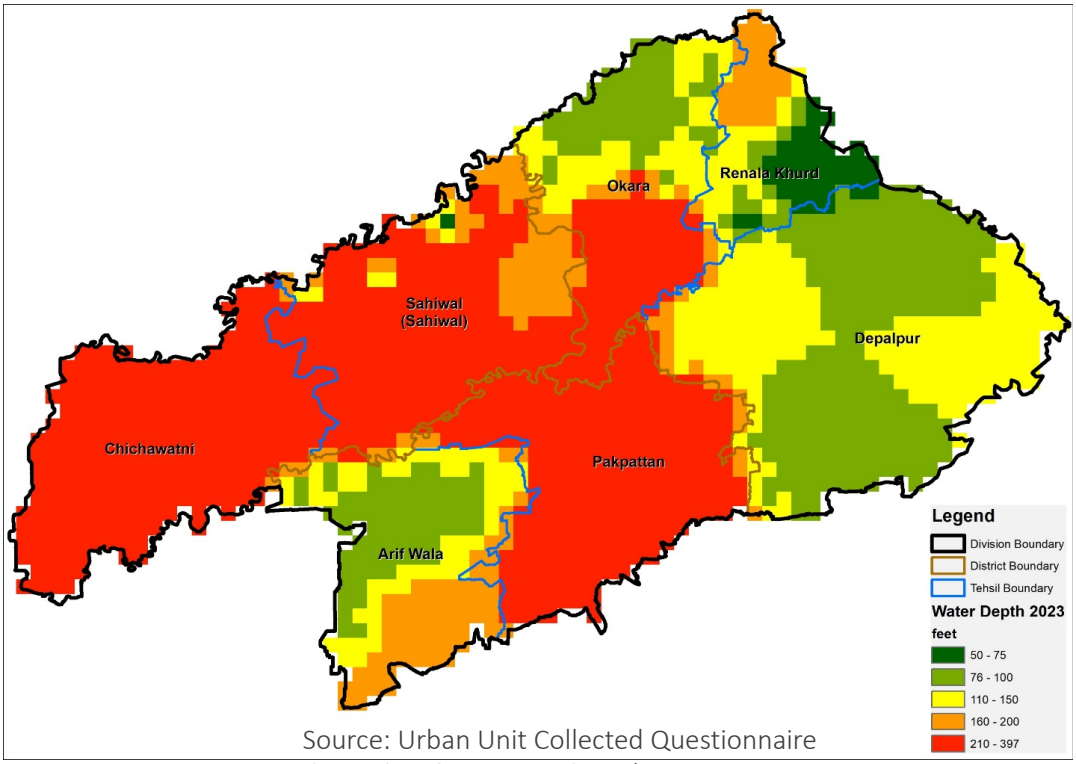
Map 1: Irrigation network

Water Quality: The quality of surface water in Sahiwal is compromised due to the mixing of drainage water in canals, negatively impacting the growth of potato and vegetable crops. Timely water supply is another challenge, leading to extensive use of groundwater and adverse effects on crop yields. Farmers, especially those at the tail end of irrigation systems, are particularly affected.

Ground Water Depth (2010)



Ground Water Depth (2023)



Source: Urban Unit Collected Questionnaire data taken from Agriculture/Irrigation

Map 2: Ground water depth analysis

Groundwater Analysis: The Sahiwal Division relies heavily on a mix of canal and groundwater for irrigation. Over the years, there has been a significant increase in groundwater depth, indicating rapid depletion of these resources. The extensive use of groundwater to obtain three crops a year is exacerbating water scarcity. For instance, the Lower Bari Doab canal circle has 3.44 feet/acre of water available, while the Upper Pakpattan canal circle has only 1.931 feet/acre available. This over-reliance on groundwater poses a serious risk to the sustainability of water resources in the division.

District	Ground Water dept(ft) in 2010	Ground Water dept(ft) in present time
Okara	150	280
Sahiwal	210	235
Pakpattan	110	180
Average of Division	**157**	**232**

The groundwater depths have generally increased across the districts, indicating a decrease in water levels over the specified period.

Table 3: District wise groundwater analysis

Source: Collected Questionnaire data taken from Agriculture/Irrigation Department

District-Wise Analysis

Sahiwal District: Groundwater levels have shown a drastic increase in depth from 70 feet in 2010 to over 120 feet in recent years, indicating significant depletion. The district faces severe problems with water quality due to mixing of drain water in canals, affecting crop growth and yield.

Okara District: Similar trends are observed with increasing depths affecting water availability. The groundwater depth has risen from 100 feet in 2010 to over 150 feet currently. The use of mixed water for irrigation is common, leading to poor crop performance, especially for water-sensitive crops like vegetables.

Pakpattan District: Groundwater depth has increased significantly from 100 feet to 130 feet over the past decade. The district relies heavily on canal water, which is often insufficient, leading to over-extraction of groundwater. This practice is unsustainable and poses long-term risks to water availability.

- **Current Groundwater Depth:** The groundwater depths have generally increased across the districts within the Sahiwal Division, indicating a significant decrease in water levels over the specified period. This trend is concerning as it suggests that groundwater resources are being depleted faster than they are being replenished.
- **Groundwater Suitability**: The quality of groundwater also varies, with some areas experiencing high levels of salinity and other contaminants, further complicating irrigation efforts.
- **Surface Water Issues**: The irrigation network in Sahiwal Division is heavily dependent on the Lower Bari Doab and Upper Pakpattan canal systems. However, the available water per acre is insufficient to meet the agricultural demands, leading to increased reliance on groundwater.
- **Climate Impact:** The region's climate exacerbates water scarcity issues, with erratic rainfall patterns and increased evaporation rates due to higher temperatures, further stressing water resources.

The Sahiwal Division's struggle with inefficient water management and poor groundwater suitability underscores the need for comprehensive and sustainable water management strategies.

This includes improving surface water quality, optimizing irrigation practices, and enhancing the monitoring and management of groundwater resources to secure the future of agriculture in the region. Addressing these issues is crucial for the long-term sustainability and productivity of Sahiwal's agricultural sector.

8.3. POOR FARM MECHANIZATION

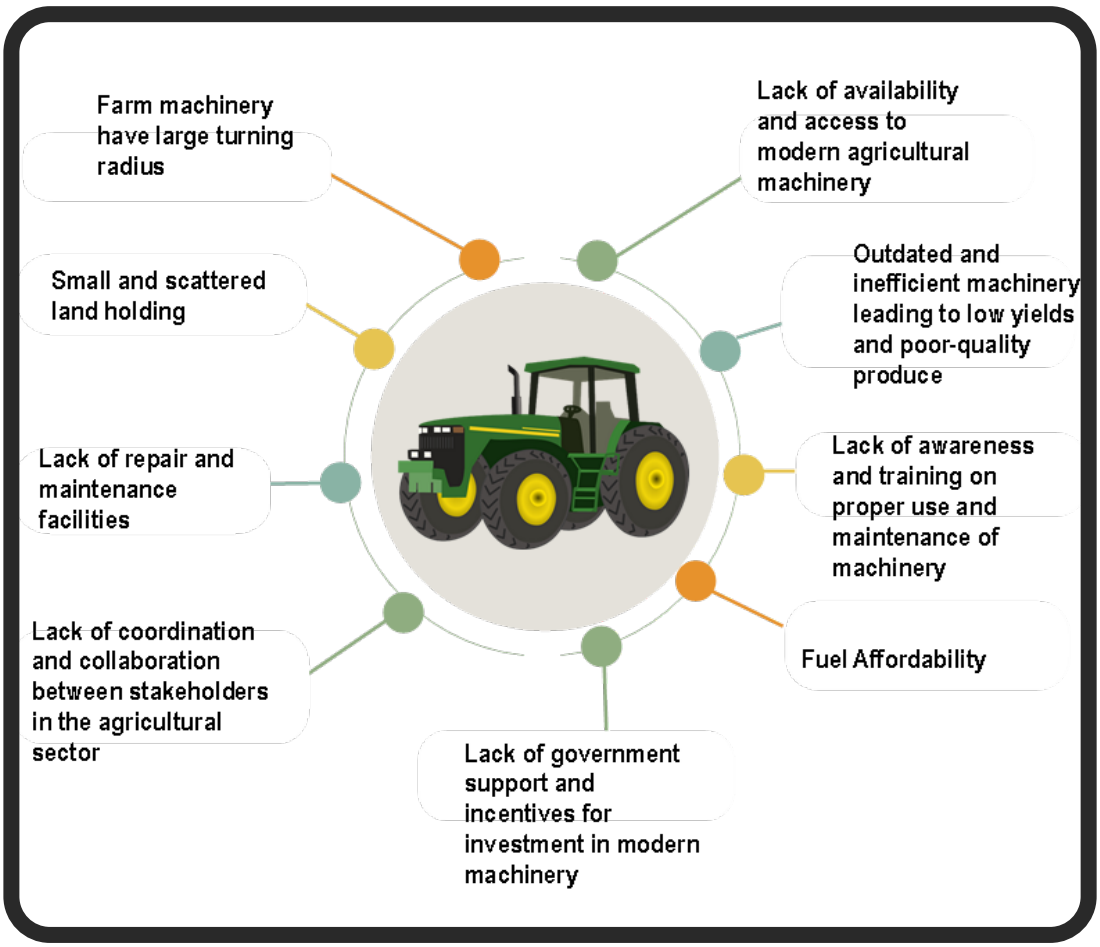
Sahiwal Division faces significant challenges in the domain of agricultural machinery. The availability of machinery tailored to suit the needs of traditional crops remains limited, predominantly relying on older models that have been in use for years. This presents a significant hurdle for farmers seeking to optimize their farming practices and enhance productivity.

A specific concern arises from the lack of specialized machinery designed for crops like wheat, sugarcane, and maize within the division. These crops possess distinct requirements and call for specialized equipment for efficient cultivation and harvesting. Unfortunately, the absence of dedicated machinery for these crops poses a significant obstacle, especially for small-scale farmers operating within these sectors.

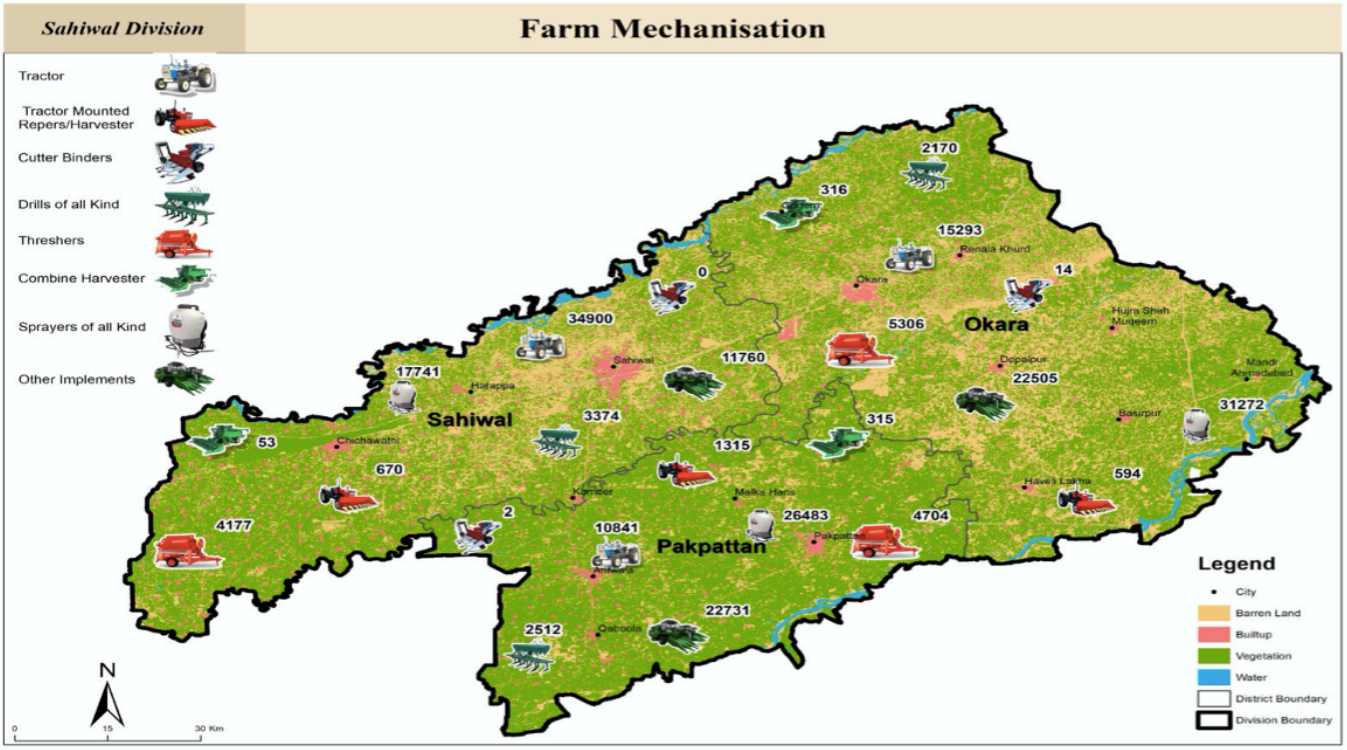
To address this limitation, there is an urgent need to develop and introduce machinery specifically suited to the requirements of small-scale farmers cultivating wheat, sugarcane, maize, and similar crops. By crafting machinery tailored to their needs, farmers can significantly enhance productivity, streamline operations, and ultimately bolster their economic outcomes.

Investing in research and development endeavors to create machinery that tackles the specific challenges faced by small farmers in the Sahiwal Division holds paramount importance. Collaborative initiatives involving agricultural experts, engineers, and the farming community can pave the way for innovative machinery solutions that cater to the diverse needs of these crops. Moreover, ensuring that the newly developed machinery remains not just efficient but also economically feasible for small-scale farmers is essential. Affordable solutions can empower farmers to embrace modern machinery, enabling them to harness its benefits and unlock their full potential while fostering sustainable agricultural practices in the region.

Problems of Poor Farm Mechanization in The Sahiwal Region



Source: Urban Unit



Map 3: Poor Farm Mechanization

Source: Punjab Development Statistics (2019)/ Urban Unit

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%

Table 4: Mechanization Gap in Punjab

Source: Punjab Development Statistics (2019)

8.4. MECHANIZATION GAP IN PUNJAB

The mechanization gap in Punjab, as compared to Indian Punjab, highlights several key areas where the region lags behind. According to Table 2, the coverage of certain implements such as the chisel plough, rotavator, and disc harrow is significantly lower in Punjab compared to Indian

Punjab. This disparity underscores the urgent need to close the mechanization gap by deploying smart tools and establishing service centers in each crop zone to promote mechanization.

Such initiatives are crucial for enhancing agricultural productivity and ensuring sustainable farming practices. The current low adoption rate of advanced agricultural machinery indicates that extension services are inadequate and that many farmers lack awareness of modern methods, including the use of agrochemicals, crop varieties, and fertilizers.

AVAILABILITY OF MACHINERY IN SAHIWAL

Agriculture Machinery	(Farmers/Machine)	Acres / Machine
Threshers	25	140
Self Propelled Combine Harvester	522	2,898
Tractor Mounted Reapers/Harvester	138	769
Cutter Binders	22304	123,909
Sprayers of all Kind	5	26
Drills of all Kind	44	246
Other Implements	6	35
Tractor	6	32

Table 5: Availability of Machinery in Sahiwal Division

Source: Punjab Development Statistics (2019)

Availability of Machinery in Sahiwal Division

These figures illustrate the considerable gaps in machinery availability, which hinders the ability of farmers in Sahiwal to fully optimize their agricultural practices.

To bridge the mechanization gap in Sahiwal Division, the following steps are essential:

1. Deployment of Smart Tools and Service Centers: Establishing service centers equipped with modern agricultural machinery and smart tools across different crop zones can greatly enhance mechanization.
2. Enhanced Extension Services: Improving extension services to educate farmers on the benefits and usage of modern agricultural practices, including the use of advanced machinery, agro-chemicals, and improved crop varieties.
3. Research and Development: Investing in R&D to develop affordable and efficient machinery tailored to the specific needs of crops grown in Sahiwal Division, such as wheat, sugarcane, and maize.
4. Financial Support and Subsidies: Providing financial support and subsidies to small-scale farmers to facilitate the acquisition of modern machinery.

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

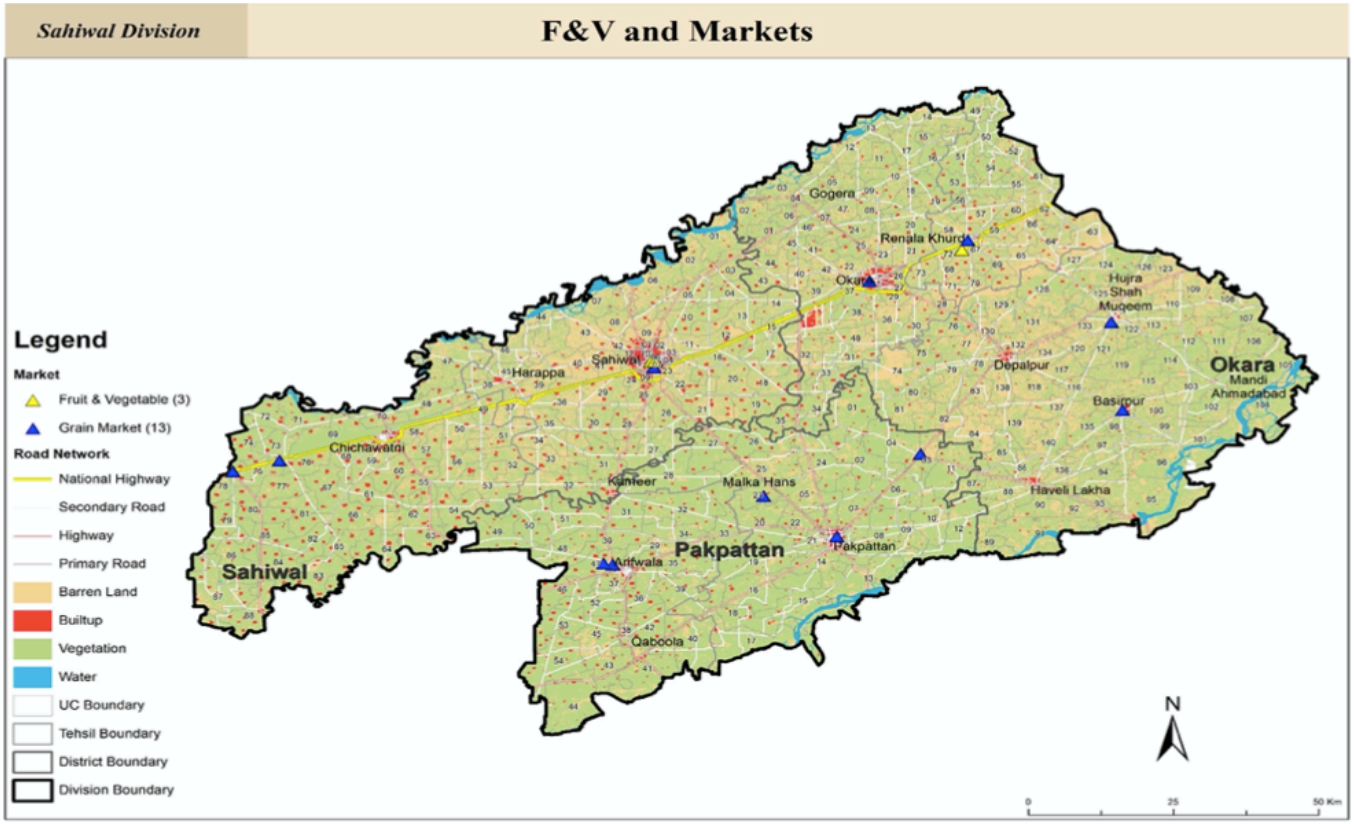
The provided map illustrates the spatial distribution of fruit and vegetable markets, as well as grain markets within the Sahiwal Division. The agricultural and food processing sectors in this division face specific challenges. Primarily, there's a lack of significant value addition in agricultural produce, particularly concerning high-value crops. This underscores the necessity to augment value-added activities and processes to bolster the economic potential of the division's agricultural output.

The Sahiwal Division currently has 3 fruit and vegetable markets and 13 grain markets, which highlights a mismatch in market compatibility. This imbalance indicates a pressing need for more

state-of-the-art storage and market facilities. The absence of advanced storage infrastructure and modern market facilities limits the ability of farmers to store and sell their produce efficiently, leading to post-harvest losses and reduced economic returns.

Moreover, the absence of agro-industrial units in potential crop zones acts as a hindrance to the development and expansion of the agricultural sector. The deficiency of processing industries for fruits and vegetables compounds the limited value addition in these crops. Establishing processing facilities becomes crucial to unleash the complete potential of the division's agricultural resources and foster economic growth.

While there is some presence of traditional agro-based industries such as flour mills, there is a noticeable gap in the availability of production or processing industries for other crops. This reliance on flour mills alone is insufficient for the holistic development of the region's agricultural sector.



Map 4 : Agro-Industry in Sahiwal Division

Source: Urban Unit

Solutions

1. Development of Model Markets: Proposing the establishment of model markets equipped with modern facilities can address the mismatch between fruit and vegetable markets and grain markets. These markets should include state-of-the-art infrastructure for storage, handling, and selling of agricultural produce.

2. State-of-the-Art Storage Facilities: To reduce post-harvest losses and improve the shelf-life of produce, it is essential to develop advanced storage facilities. These facilities should cater to both fruits and vegetables, as well as grains, ensuring that farmers can store their produce safely and sell it at optimal times.

3. Investment in Agro-Processing Units: Encouraging investment in agro-processing units for fruits, vegetables, and other crops can significantly enhance value addition. Processing industries can help convert raw agricultural products into market-ready goods, thereby increasing the economic returns for farmers.

4. Infrastructure Development: Strategic investments in infrastructure, including roads and transportation networks, can facilitate better access to markets and processing units. Improved infrastructure will ensure that agricultural produce can be transported efficiently, reducing costs and increasing profitability.

8.6. PREVIEW OF AGRICULTURAL MARKETS

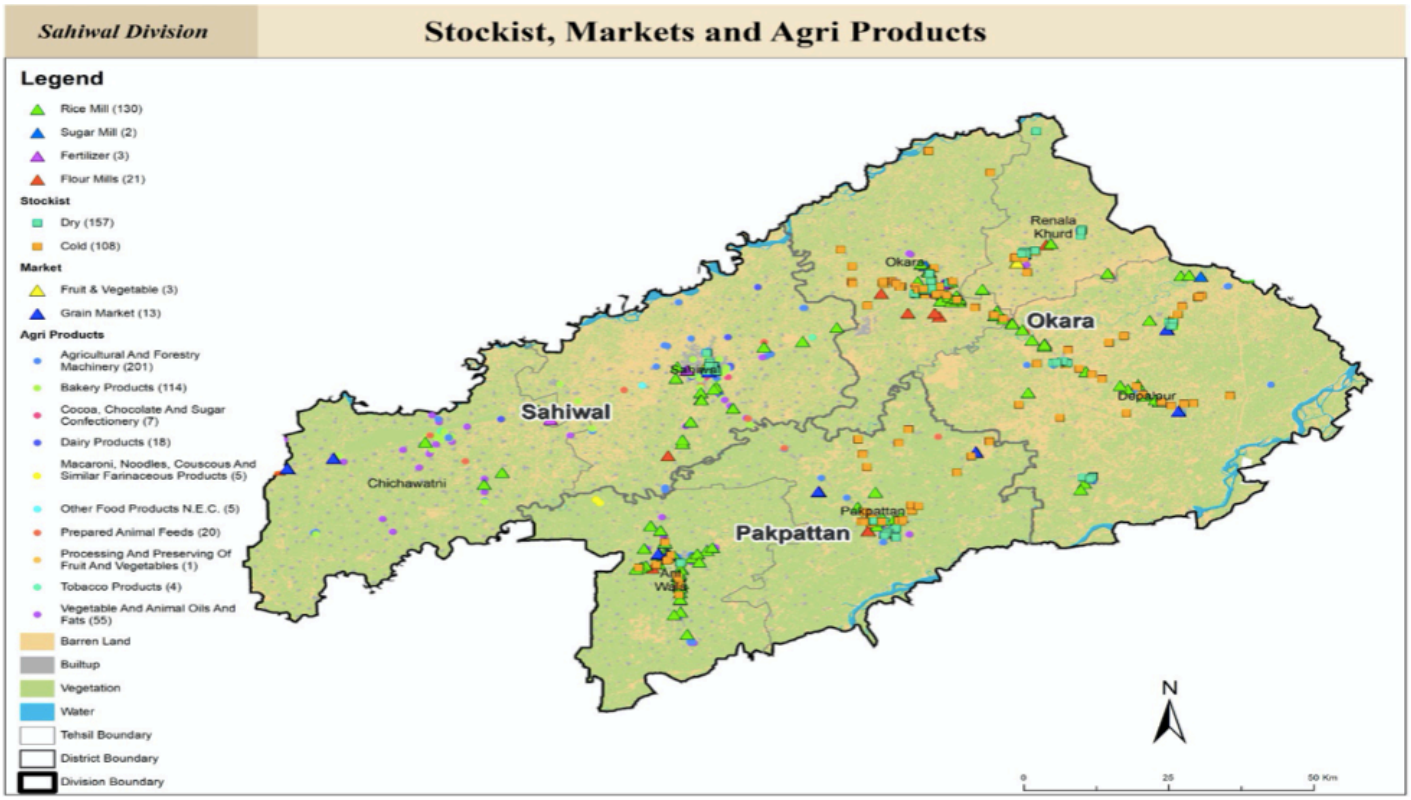
The provided map illustrates the spatial distribution of various agro-industrial units, stockists, and markets within the Sahiwal Division. The agricultural and food processing sectors in this division face specific challenges. Primarily, there's a lack of significant value addition in agricultural produce, particularly concerning high-value crops. This underscores the necessity to augment value-added activities and processes to bolster the economic potential of the division's agricultural output.

Disparity in Market Readiness

The map reveals a disparity in the market readiness for fruits, vegetables, and grains within the Sahiwal Division. While the region boasts numerous stockists, they primarily lack modern amenities, especially cold storage facilities crucial for contemporary agricultural preservation. There are only 108 cold storages, which are insufficient to meet the needs of the entire division.

Inadequate Market Infrastructure

The Sahiwal Division features 3 markets for fruits and vegetables and 13 for grains, revealing inadequate market infrastructure that leads to disparities among farmers in the region. This inadequate infrastructure hampers the efficient marketing and distribution of agricultural produce, causing post-harvest losses and reduced income for farmers.



Map 5: Markets in Sahiwal Division

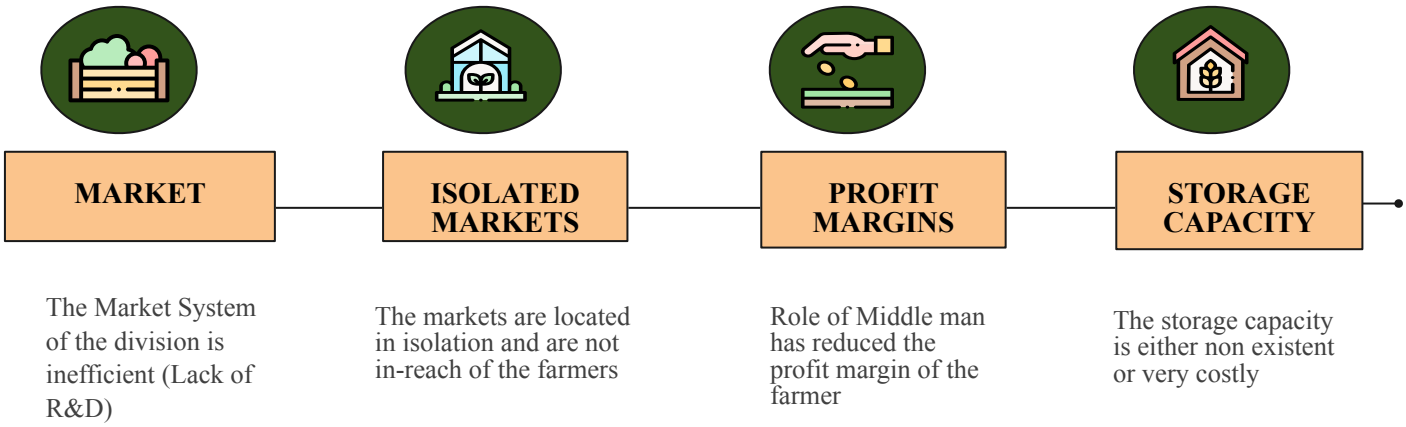
Source: Urban Unit

REASONS FOR INEFFICIENT AGRICULTURAL MARKETS

Table 4 highlights the insufficient storage capabilities within markets in the Sahiwal Division. The available storage is both inadequate and expensive. The prices for multiple crops listed below serve as an illustration, showcasing the inefficient market dynamics within the Sahiwal region. These markets operate in isolation, being inaccessible to farmers. Moreover, the involvement of middlemen has diminished the profit margins of farmers, as evidenced in the subsequent table:

Table 6: Difference Between Farmgate, Retail & Wholesale Prices of Essential Food Commodities

Commodity	Farm gate price (PKR/kg)	Wholesale Market (PKR/kg)	Retail Price (PKR/kg)
Onion	40	80-90	110-140
Garlic	160	350-450	500-650
Potato	25	45-60	65-85
Tinda	33	80-100	120-150



The lack of adequate storage capacity in markets, particularly for perishable commodities, contributes to a prevailing inefficiency. The existing storage facilities are either insufficient or prohibitively expensive, posing significant challenges for preserving perishable goods.

8.7. THE 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 build-

ing 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 SAHIWAL DIVISION

Exposure Index

- Annual temperature
- Annual Rainfall
- Floods

Sensitivity Index

- Population in administrative jurisdiction
- Farm size
- Crop diversification
- Agroforestry potential
- Irrigated land
- Cultivated land

Adaptive Capacity

- Natural capital: Groundwater availability, Land productivity
- Physical capital: Access to the power supply, Agricultural machinery ownership, Access to transport networks
- Human capital: Literacy level, Health attainment
- Financial capital: Livelihhods diversification, Access to credit, Livestock ownership
- Social capital: Access to cooperative societies, Means of social support, Local committees access

The assessment of the vulnerability of agriculture includes the following variables in the respective dimension in the Sahiwal division:

Indicators	Sahiwal	Okara	Pakpattan
Exposure Index	(0.20 - 0.39)	(0.40 - 0.59)	(0.60 - 0.79)
	Low Exposure	Low Exposure	Low Exposure
Sensitivity Index	(0.40 – 0.59)	(0.20 – 0.39)	(0.20 – 0.39)
	Moderate Sensitivity	Low Sensitivity	Low Sensitivity
Adaptive Capacity Index	(0.20 – 0.39)	(0.40 - 0.59)	(0.00 - 0.19)
	Low adaptive capacity	Moderate Adaptive capacity	Very Low Adaptive capacity
Vulnerability index	(0.40 - 0.59)	(0.20 - 0.39)	(0.40 - 0.59)
	Moderate Vulnerability	Low Vulnerability	Moderate Vulnerability

Table 7: Assessing the Vulnerability of Agriculture in Sahiwal Division

Source: (Nadeem et al., 2022)

BUILDING CLIMATE RESILIENCE IN AGRICULTURE: SUSTAINABLE PRACTICES AND TECHNOLOGY ADOPTION IN SAHIWAL DIVISION

To address the effects of climate change in the Sahiwal Division, it's essential to embrace sustainable agricultural practices and encourage the adoption of technologies aiding farmers in adjusting to shifting conditions. This might involve integrating water-conserving irrigation systems, cultivating crop varieties resilient to drought, and allocating resources to enhance soil conservation and management practices.

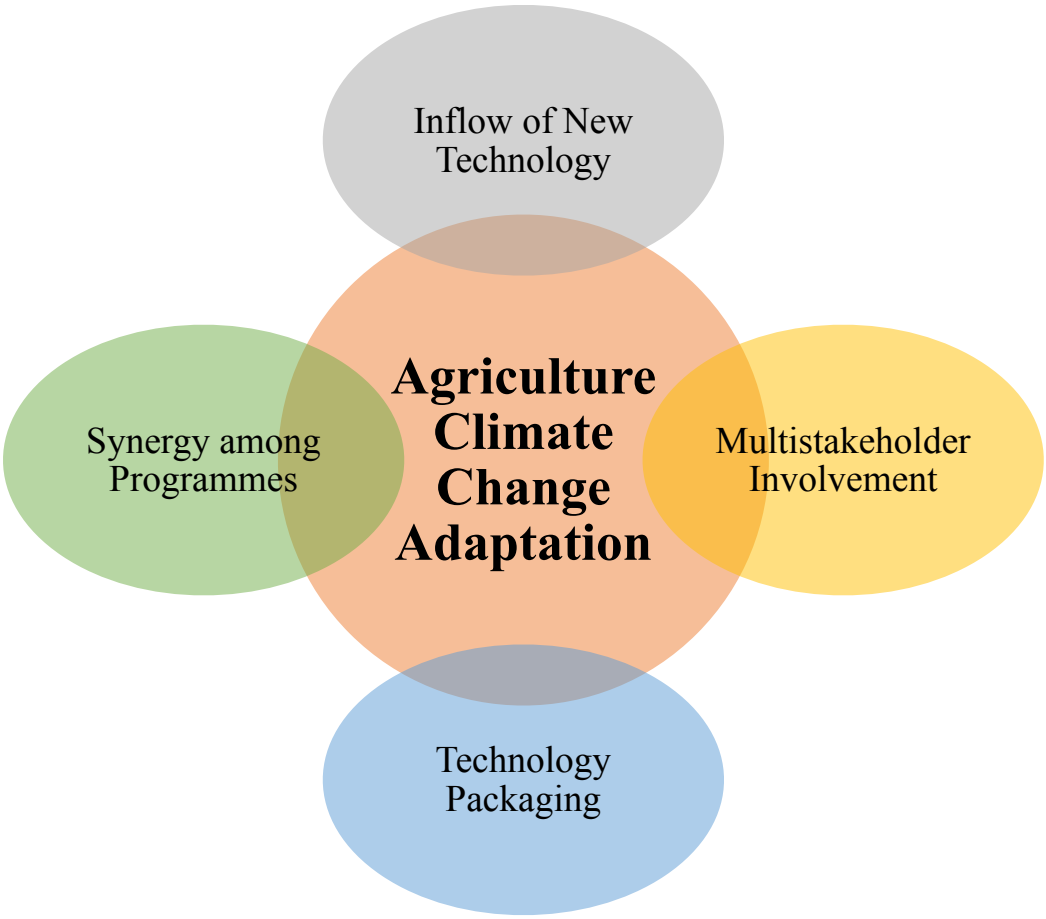


Figure 9: Key strategies essential for Climate change

Source: Rao et al., 2019

A systematic review paper on climate change adaptation in the agricultural sector in Pakistan identified four major themes of adaptation strategies: changing cropping practices, changing

farm management techniques, advanced land use management measures, and non-agriculture livelihood options (Saddique et al., 2022). These themes were further broken down into 16 sub-themes. The review found that factors influencing farmers' adaptation strategies in Pakistan include age, education, farming experience, landholding, access to climate information, access to credit facilities, and access to extension services. Several constraints were identified at the farm level that hindered the adaptive capacity of farm households, including a lack of access to information and knowledge, extension services, credit, and farm resources.

The objective of the Pakistan Punjab Irrigated Agriculture Productivity Improvement Program Project is to enhance the productivity of water use in irrigated agriculture, leading to increased agricultural production, employment, and incomes, as well as improved living standards and positive environmental outcomes. By 2019, the project had installed high-efficiency irrigation systems covering 23,500 hectares, with a further 3,677 hectares in progress. It had also improved 11,916 watercourses with 1,220 more in progress, deployed 5,000 laser land-leveling units, and constructed 621 ponds. The project has directly benefited 500,000 farm families and improved water management on 5.7 million acres of farmland, creating more than 15,000 full-time jobs (Li & Ahmed, 2022).

PxD is working to identify high-impact opportunities for climate change mitigation that leverage local knowledge in low- and middle-income countries, as well as their expertise in combining product development, behavioral science, and human-centered design with robust experimentation. They aim to explore climate financing mechanisms and MRV protocols that bridge the environmental efforts of smallholder farmers and global climate finance, with a focus on benefiting farmers working in the service of mitigation. They aim to partner with nonprofits and research institutions to develop robust mitigation programs and add new agrarian ladders out of poverty to those that have come in decades and centuries past (PAD-admin, 2022).

As a result, climate change is a complex and pressing issue that will require collective action and cooperation from multiple stakeholders to address effectively. It will be important to continue to monitor and understand the impacts of climate change on agriculture in the Rawalpindi division

and to take proactive steps to mitigate these impacts and promote the sustainability of the agricultural sector in the region.

CURRENT IMPACT OF CLIMATE CHANGE

Crop Failures

Rising temperatures and changing rainfall patterns have led to crop failures and reduced yields. Extreme weather events such as droughts and floods have also had a negative impact on agricultural production.

Water Scarcity

The monsoon patterns, which are a critical source of water for the agriculture, have been shifted and delayed, resulting in water scarcity for irrigation and crop growth.

Soil Degradation

Due to the changing climate, the soil health is affected, leading to soil degradation and reduced fertility.

Economic losses:

The above-mentioned issues have resulted in economic losses for farmers and have a negative impact on the livelihoods of people dependent on agriculture

CLIMATE SMART AGRICULTURE

Climate-smart agriculture (CSA) is an approach to farming that seeks to address the interrelated challenges of food security, climate change, and sustainable agriculture. CSA aims to increase agricultural productivity and income, while also improving resilience to climate change and reducing greenhouse gas emissions.

Climate-smart agriculture (CSA) is a comprehensive strategy implemented in the Rawalpindi division to enhance sustainable land management practices. This approach encompasses various techniques such as agroforestry, conservation agriculture, and improved livestock management, aiming to achieve multiple goals. These goals include improving soil health, conserving water resources, and sequestering carbon to mitigate climate change effects.

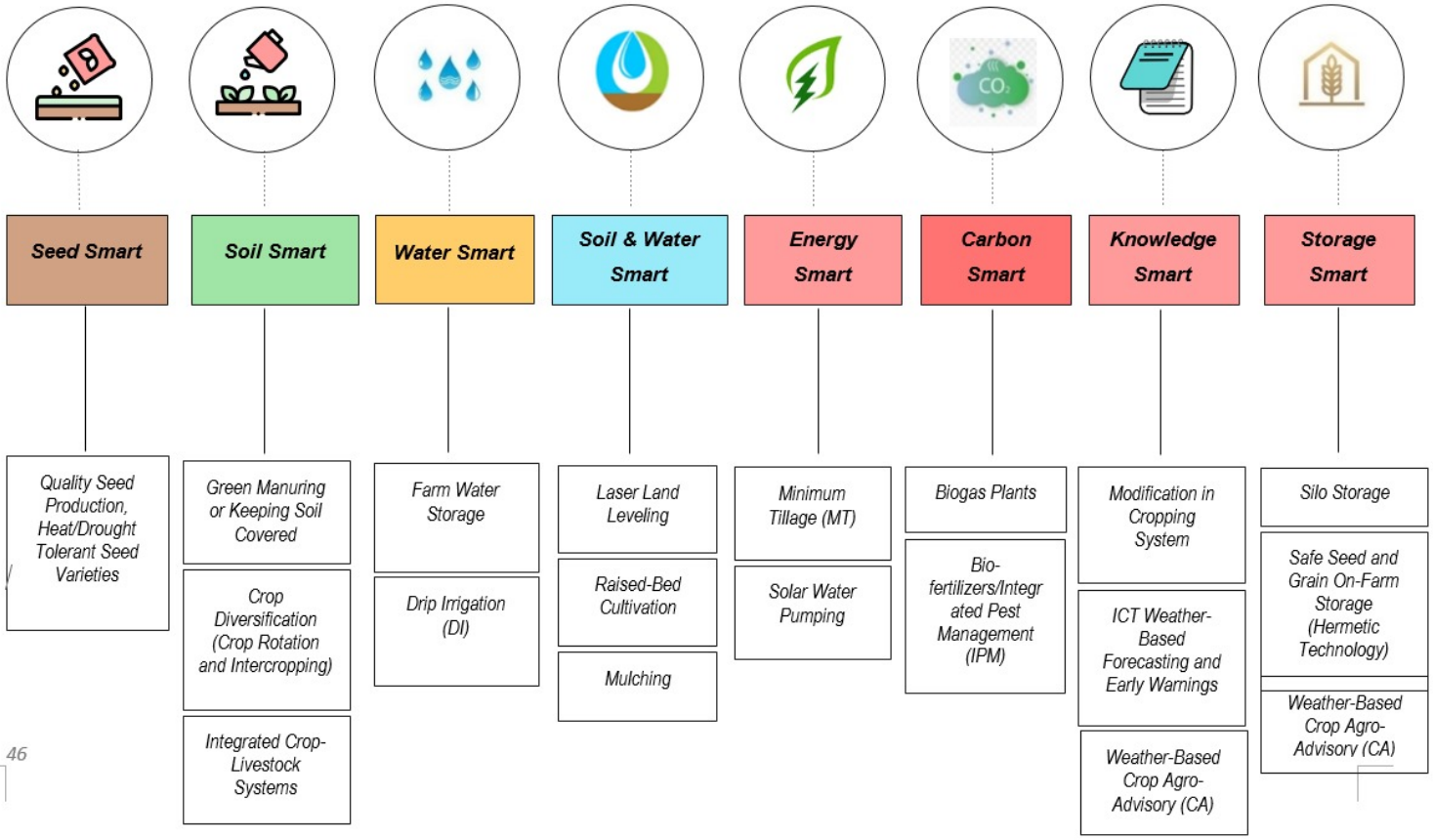
CSA is an integrated approach that requires collaboration among farmers, researchers, policy-makers, and other stakeholders. By combining technical expertise with social and institutional support, CSA seeks to address the challenges posed by climate change while seizing the opportunities it presents. Ultimately, climate-smart agriculture offers a promising pathway towards sustainable agricultural practices in the Rawalpindi division.

Moreover, CSA encourages the adoption of climate-resilient crop varieties and the utilization of technologies that assist farmers in adapting to unpredictable weather patterns. In addition to technical solutions, CSA also takes into account the social and economic dimensions of agriculture. This entails promoting gender equity, fostering rural development, and ensuring access to markets and financial resources.

IDENTIFIED TECHNOLOGIES AND PRACTICES FOR CSA

The diagram below highlights the identified technologies and practices for Climate-smart agricultural plan of Rawalpindi division.

Figure 10: CSA practices



9. 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, primarily due to rising temperatures, alterations in rainfall distribution, and an increased occurrence of extreme weather phenomena globally. Pakistan has notably experienced evident shifts in its weather patterns, which have had repercussions on crop production and could potentially drive changes in cropping patterns within certain districts of the Sahiwal Division.

The Urban Unit has identified different Agro-ecological zones (AEZs) in the Sahiwal Division based on agro-climatic and edaphic variables, which facilitate crop zoning and the assessment of agro-economic performance. The suitability of crops in these AEZs has been identified for sustainability.

Sahiwal Division, located in the Punjab province of Pakistan, features a variety of soil textures, primarily composed of loam and clay loam, as depicted in the provided map. The exact soil texture in the region can vary depending on the specific location and the type of crop being grown.

- Clay Loam (45-60): Predominantly found in the Okara district, characterized by high levels of nutrient retention and suitable for crops that require a lot of moisture, such as wheat.

- Loam (31-45): Widely distributed in Sahiwal and Pakpattan districts, this soil type is a mixture of sand, silt, and clay, and is considered ideal for growing a variety of crops due to its ability to hold moisture and nutrients.

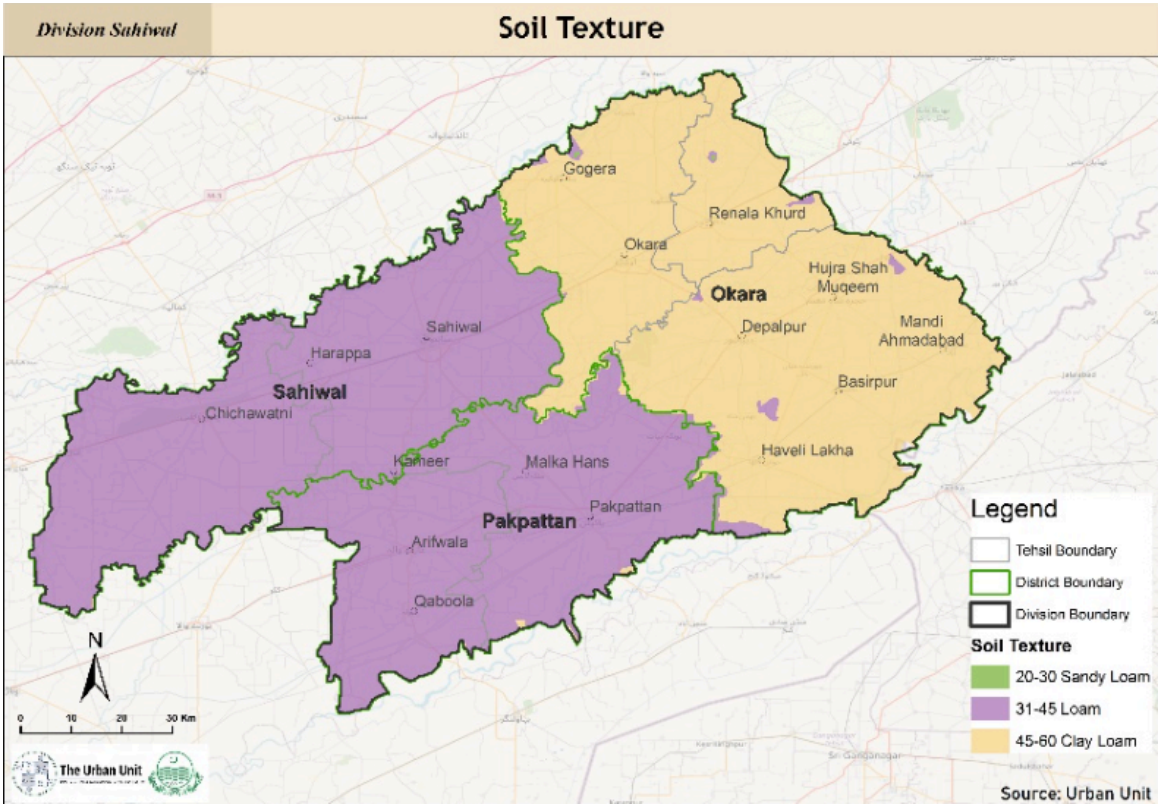
- Sandy Loam (20-30): Less common but present in some areas, this soil type is well-draining and suitable for crops that require less water.

It's important to note that the specific soil characteristics will also be influenced by factors such as soil pH, soil fertility, and soil structure, which can vary depending on the specific location within the region. A comprehensive soil analysis can provide information on the specific soil characteristics and fertility of a particular piece of land, which can be useful in determining the best crops to grow and the most effective methods of cultivation.

The soil is a key element of agriculture, without which we could not grow plants. Each type of soil is not suitable for each crop due to the effect of different crop growth factors. Soil conditions and characteristics are one of the key factors that directly drive crop growth potential and thus, a soil data set is key information when developing agro-ecological zones.

The texture is the most important parameter of soil. There are three different soil textures reflected in the map below: Sandy Loam, Loam, and Clay Loam. Redefining AEZs was based on the moisture index calculated by using ET0 with an overlay of analysis of soil texture. Loam and Clay Loam are mostly dominant in the region, providing a robust foundation for diverse agricultural activities.

By understanding and leveraging the specific soil textures and agro-ecological conditions of the Sahiwal Division, agricultural practices can be optimized to enhance crop productivity and sustainability.



Map 6: Soil Texture of Sahiwal Division

Source: Urban Unit

Fluoride is a naturally occurring element that can be present in varying concentrations in groundwater, and high levels of fluoride in drinking water can have negative health effects. The concentration of fluoride in groundwater in the Sahiwal Division of Pakistan varies depending on the specific location and geological conditions, as illustrated in the provided map.

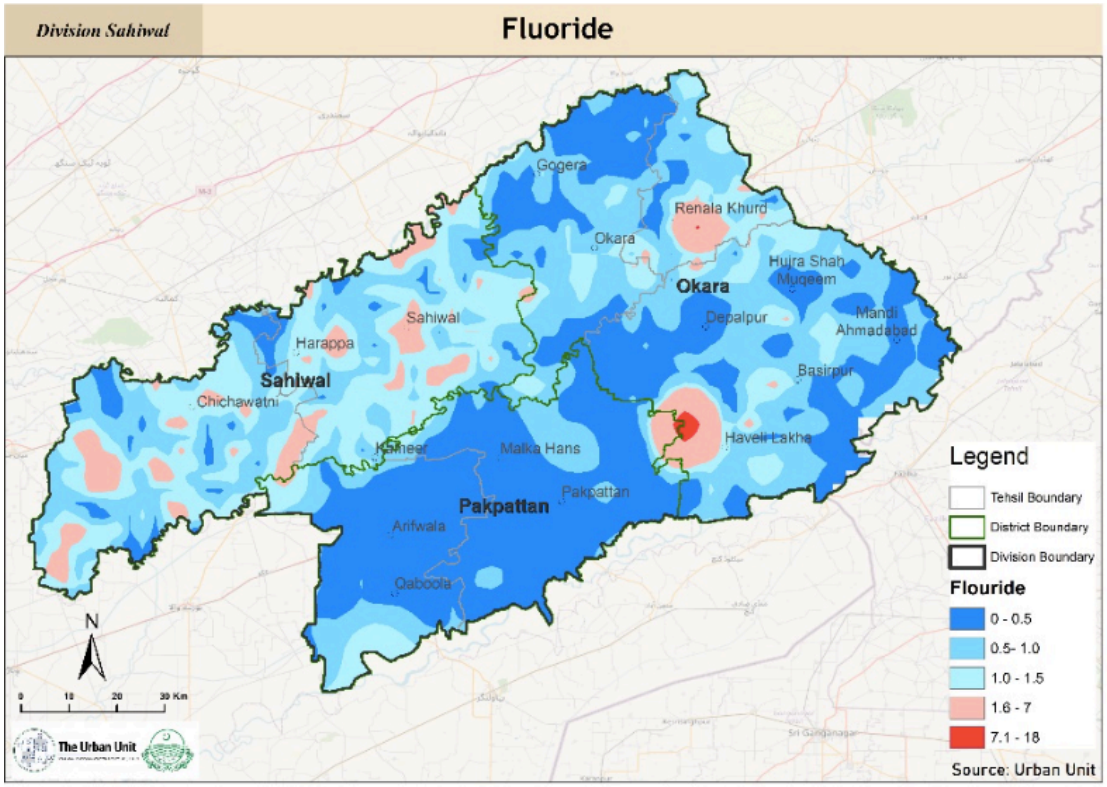
Under the arid climatic conditions of large parts of Pakistan, high fluoride concentrations in the groundwater are to be expected in some areas. Excessive fluoride concentrations are a problem in parts of Punjab, Sindh, and Baluchistan. In the Sahiwal Division, the fluoride levels vary across different districts:

- Sahiwal District: Fluoride levels range from 0 to 1.5 mg/L, with some areas showing concentrations between 0.5 and 1.0 mg/L, and other areas between 1.0 and 1.5 mg/L.

- Pakpattan District: Fluoride levels predominantly range from 0 to 1.5 mg/L, with most areas showing concentrations between 0.5 and 1.0 mg/L.

- Okara District: Fluoride levels vary significantly, with some areas showing low concentrations (0 to 0.5 mg/L) and other areas having higher concentrations (up to 1.8 mg/L), particularly around Haveli Lakha, where fluoride levels reach 1.6 to 1.8 mg/L.

Ingesting high levels of fluoride over a long period of time can lead to a condition known as fluorosis, which can cause damage to teeth and bones. The presence of varying fluoride concentrations in the Sahiwal Division's groundwater indicates the need for regular monitoring and management to ensure safe drinking water for the local population.



Map 7: Fluoride in Total Water Availability

Source: The Urban Unit

Groundwater in the Sahiwal Division of Pakistan contains varying levels of Total Dissolved Solids (TDS), which is a measure of the amount of inorganic and organic substances present in water. High levels of TDS in groundwater can have negative effects on the quality and suitability of the water for various uses, such as drinking, irrigation, and industrial processes. The TDS levels in groundwater across the Sahiwal Division can be influenced by various factors, including the geology of the area, land use practices, and anthropogenic activities. The map provided illustrates the distribution of TDS levels within the division:

- Low TDS (0-300 mg/L): Areas with low TDS levels are depicted in light blue. These areas have groundwater that is generally suitable for most uses, including drinking and irrigation.

- Moderate TDS (310-600 mg/L): Areas shown in darker blue to cyan indicate moderate TDS levels, which are still suitable for most agricultural purposes but may require treatment for drinking water.

- High TDS (610-1000 mg/L): Areas depicted in light red to orange show higher TDS levels, which may affect crop yields and require specific management practices for agricultural use. Water in these areas may also need treatment for human consumption.

- Very High TDS (1100-4000 mg/L): Areas shown in darker red to maroon indicate very high TDS levels, particularly around Okara and Haveli Lakha. Water in these areas is less suitable for both drinking and irrigation without significant treatment.

- Extremely High TDS (4100-8500 mg/L): Areas with extremely high TDS levels are shown in dark maroon. These areas have groundwater that is largely unsuitable for drinking and requires advanced treatment for use in agriculture and industry.

Implications for Agriculture and Water Use

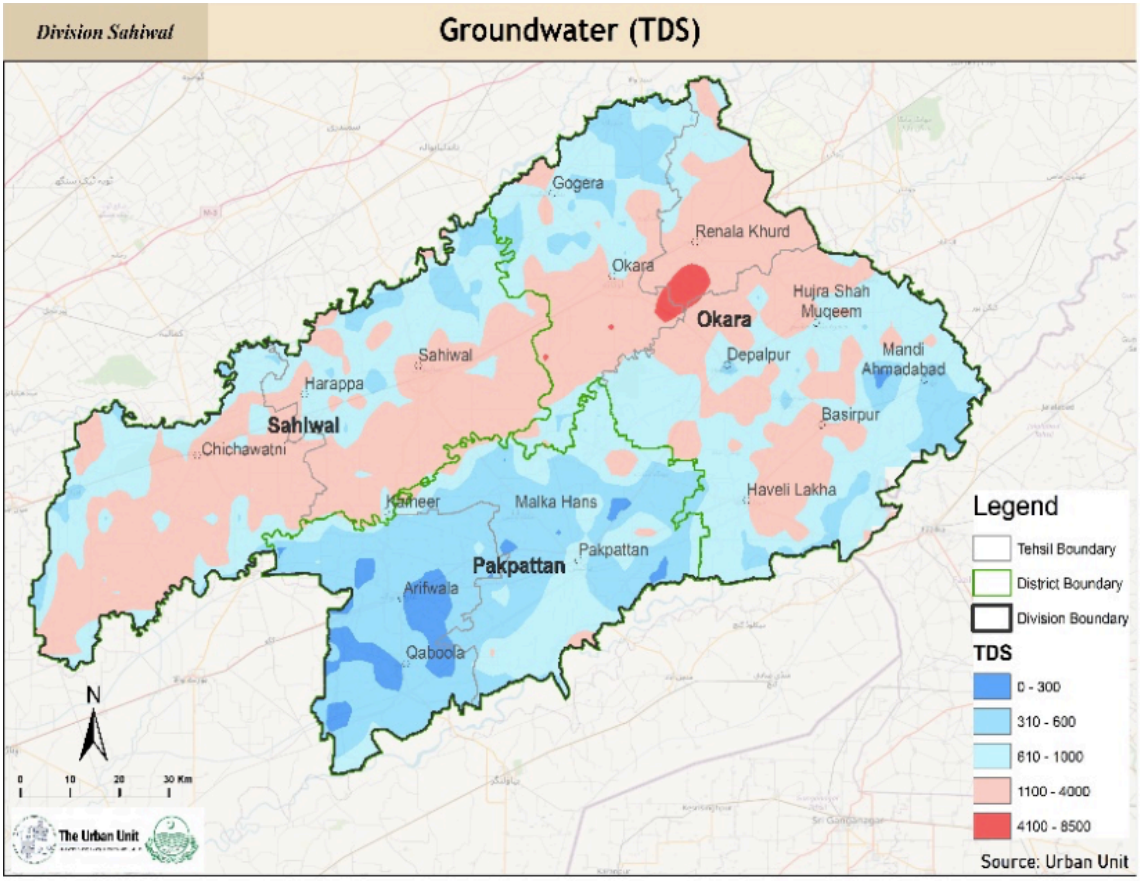
1. Agricultural Adaptation: Access to groundwater with suitable TDS levels can help farmers manage inconsistencies in surface water supplies, enable diversification in crop patterns, and transform uncertain yields into more stable crop production.

2. Water Treatment: In areas with high and very high TDS levels, implementing water treatment solutions such as reverse osmosis or other desalination technologies can make groundwater suitable for various uses.

3. Soil and Crop Management: High TDS levels in irrigation water can lead to soil salinization, which can negatively impact crop health. Adopting soil and crop management practices that mitigate the effects of high salinity is essential.

4. Monitoring and Regulation: Regular monitoring of groundwater quality and strict regulation of industrial and agricultural discharges are necessary to prevent further contamination and ensure sustainable water use.

Given the pivotal role of groundwater quality in successful crop cultivation and the overall well-being of communities, it is crucial to address the varying TDS levels across the Sahiwal Division.



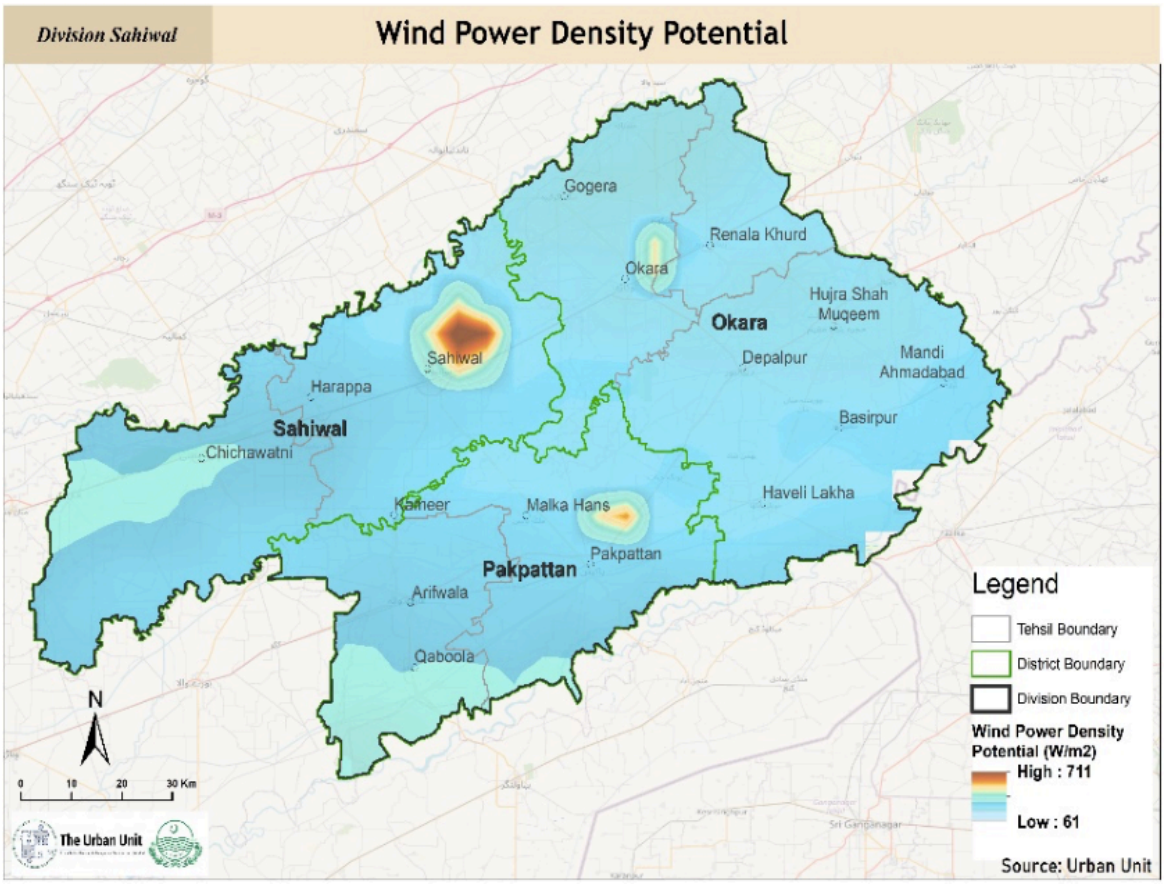
Map 8: Groundwater (TDS)

Source: Urban Unit

The spatial distribution of weather station data points is crucial for regional planning in the Sahiwal Division. The weather stations collect data on various parameters, including wind power, average yearly temperature, and solar irradiance. The provided map displays the observed wind power density potential (W/m²) in the Sahiwal Division, which varies from a high of 711 to a low of 61 density potential.

The map shows areas with varying wind power density potential, which can be leveraged for different applications, including renewable energy generation and agricultural planning.

- High Wind Power Density Areas:Certain areas in the Sahiwal district exhibit high wind power density, particularly around the central region, with potential reaching up to 711 W/m². These areas are suitable for wind energy projects and may impact crops during windy periods.
- Moderate Wind Power Density Areas: Some regions in the Pakpattan district also show moderate wind power density, making them viable for smaller-scale wind energy applications.
- Low Wind Power Density Areas: Most of the Okara district, as well as other parts of the Sahiwal and Pakpattan districts, exhibit lower wind power density, ranging from 61 to 300 W/m². These areas are less suitable for wind energy projects but still provide valuable data for agricultural and environmental planning.



Map 9: Wind Power

Source: The Urban Unit

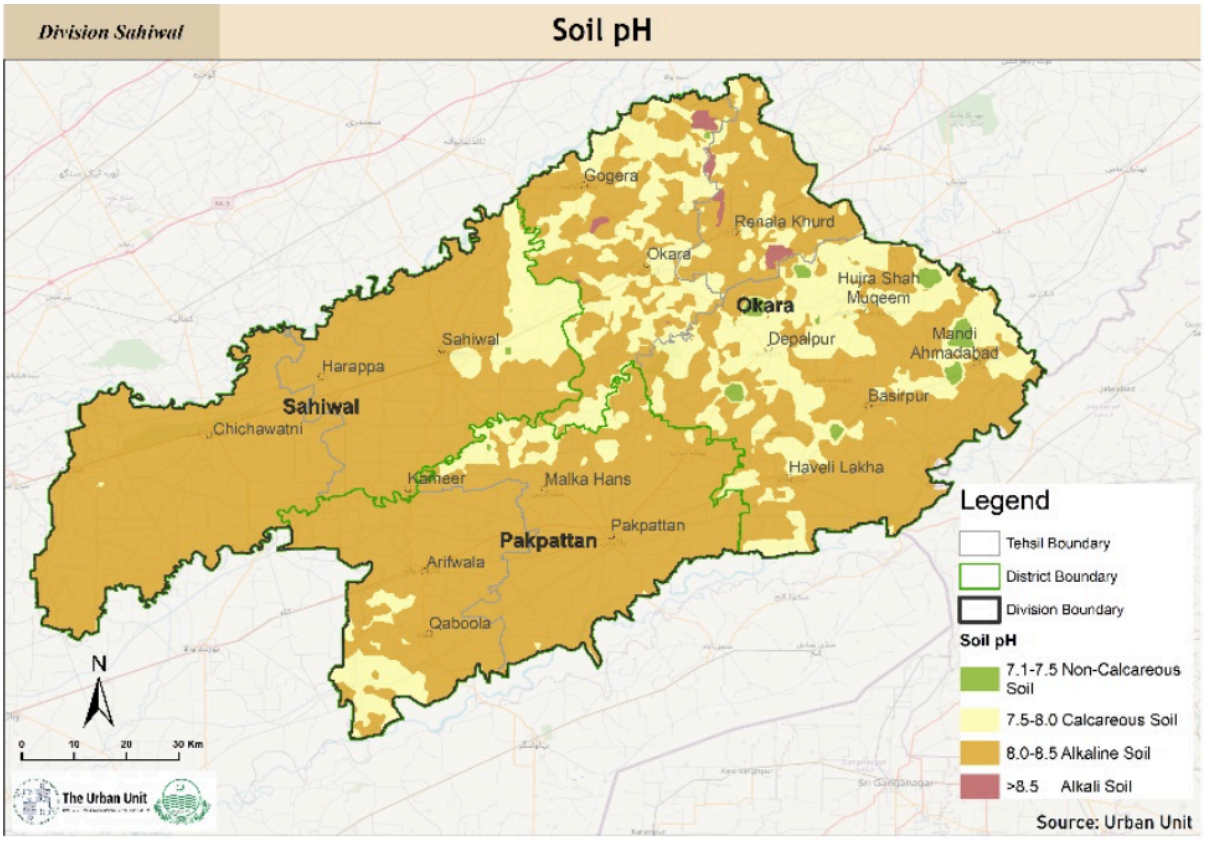
Soil pH is a critical factor impacting the growth and health of crops in the Sahiwal Division of Pakistan. The pH of soil refers to its acidity or alkalinity and is expressed on a scale of 0 to 14, with 7 being neutral. Soil pH influences the availability of essential nutrients for plant growth and the presence of certain chemicals that can be harmful to crops.

The map provided illustrates the distribution of soil pH levels within the Sahiwal Division:

- Non-Calcareous Soil (7.1-7.5): Areas depicted in light green, such as parts of Sahiwal and Pakpattan, have non-calcareous soils with a pH range of 7.1 to 7.5. These soils are near neutral and suitable for a wide variety of crops.
- Calcareous Soil (7.5-8.0): Areas shown in yellow, found across all districts including Sahiwal, Pakpattan, and Okara, have calcareous soils with a pH range of 7.5 to 8.0. These soils are slightly alkaline and suitable for most crops but may require specific management practices to optimize nutrient availability.
- Alkaline Soil (8.0-8.5): Areas depicted in brown, particularly in the central regions of Sahiwal and Pakpattan, have alkaline soils with a pH range of 8.0 to 8.5. These soils can limit the availability of certain trace elements and may require amendments such as sulfur to lower the pH for optimal crop growth.
- Alkali Soil (>8.5): Areas shown in dark brown indicate alkali soils with a pH greater than 8.5, found in scattered regions across the division. These soils can significantly impact crop growth and may require substantial reclamation efforts to make them suitable for agriculture.

Understanding and managing soil pH is crucial for optimizing crop growth and yield in the Sahiwal Division. Most crops thrive in soils with a pH between 6.0 and 7.5, though specific crops may require different pH levels. Soil pH, influenced by factors like geology, soil type, and land use practices, affects nutrient availability, with high pH soils often limiting trace elements such as iron and zinc. Regular soil analysis and appropriate soil amendments, such as sulfur or

organic matter, can help manage pH levels. For citrus cultivation, an acidic pH range of 5.5 to 6.0 is ideal. Annual soil pH assessments are recommended to ensure optimal conditions for crop cultivation, thereby supporting sustainable agricultural practices and improving economic outcomes for farmers.



Map 10: Soil pH

Source: Urban Unit

Direct normal irradiance (DNI) refers to the amount of solar radiation received on a surface perpendicular to the sun's rays. This type of irradiance is crucial for applications such as photovoltaic power generation, solar water heating, and crop cultivation. Solar irradiance is the strength received from the Sun in the form of electromagnetic waves within a specific wavelength range.

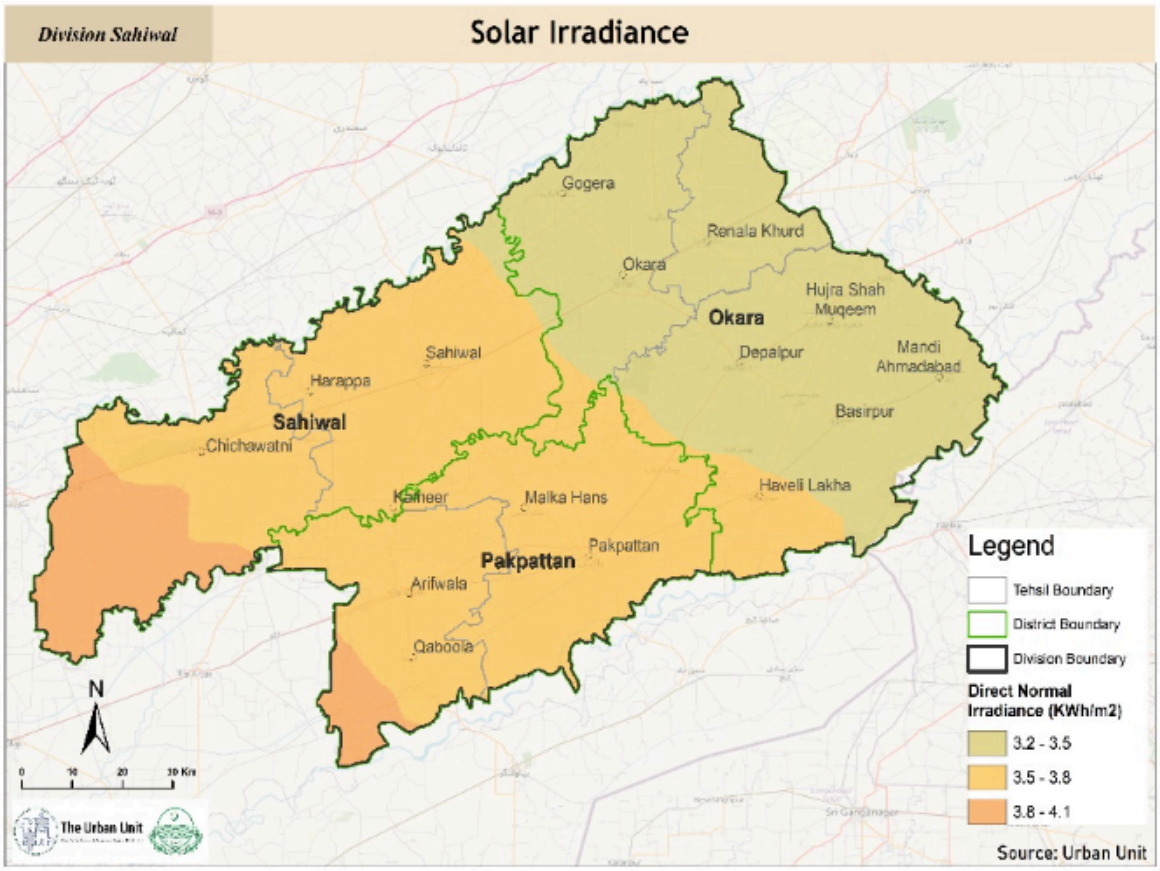
The map provided illustrates the variation in direct normal irradiance across the Sahiwal Division, influenced by factors such as time of year, latitude, and weather conditions. The Sahiwal Division, located approximately between 30.6646 to 31.8656 degrees North latitude and 72.4815 to 73.5408 degrees East longitude, experiences climatic conditions with hot and dry summers and relatively cool winters.

- High DNI Areas (3.8 - 4.1 kWh/m² per day): Regions in the southern part of Sahiwal, as well as parts of Pakpattan, exhibit high DNI values, making them suitable for solar energy projects and agricultural applications that benefit from high solar exposure.

- Moderate DNI Areas (3.5 - 3.8 kWh/m² per day): The central areas of Sahiwal and Pakpattan districts receive moderate levels of DNI, suitable for various solar applications, though slightly less intense than the highest zones.

- Low to Moderate DNI Areas (3.2 - 3.5 kWh/m² per day): Northern parts of Okara and scattered regions in Sahiwal and Pakpattan show lower DNI values. These areas still receive sufficient solar irradiance for many applications but may require optimization for maximum efficiency.

High direct normal irradiance (DNI) areas in the Sahiwal Division are ideal for photovoltaic power generation, ensuring efficient energy production and contributing to the region's energy needs. Regions with moderate to high DNI can also utilize solar water heating systems efficiently, reducing reliance on conventional energy sources and promoting sustainable practices. Adequate solar irradiance supports the cultivation of various crops, enhancing photosynthesis and promoting healthy growth, especially for crops requiring high sunlight exposure. Seasonal variations in DNI, with higher values in summer, should be considered when planning solar projects to optimize energy production. Local weather conditions, such as cloud cover and air pollution, also influence actual irradiance levels and should be monitored for accurate assessment and planning. Leveraging the high solar irradiance potential in the Sahiwal Division can enhance renewable energy capacity, support sustainable agricultural practices, and promote overall economic development.



Map 11: Solar Irradiance

Source: Urban Unit

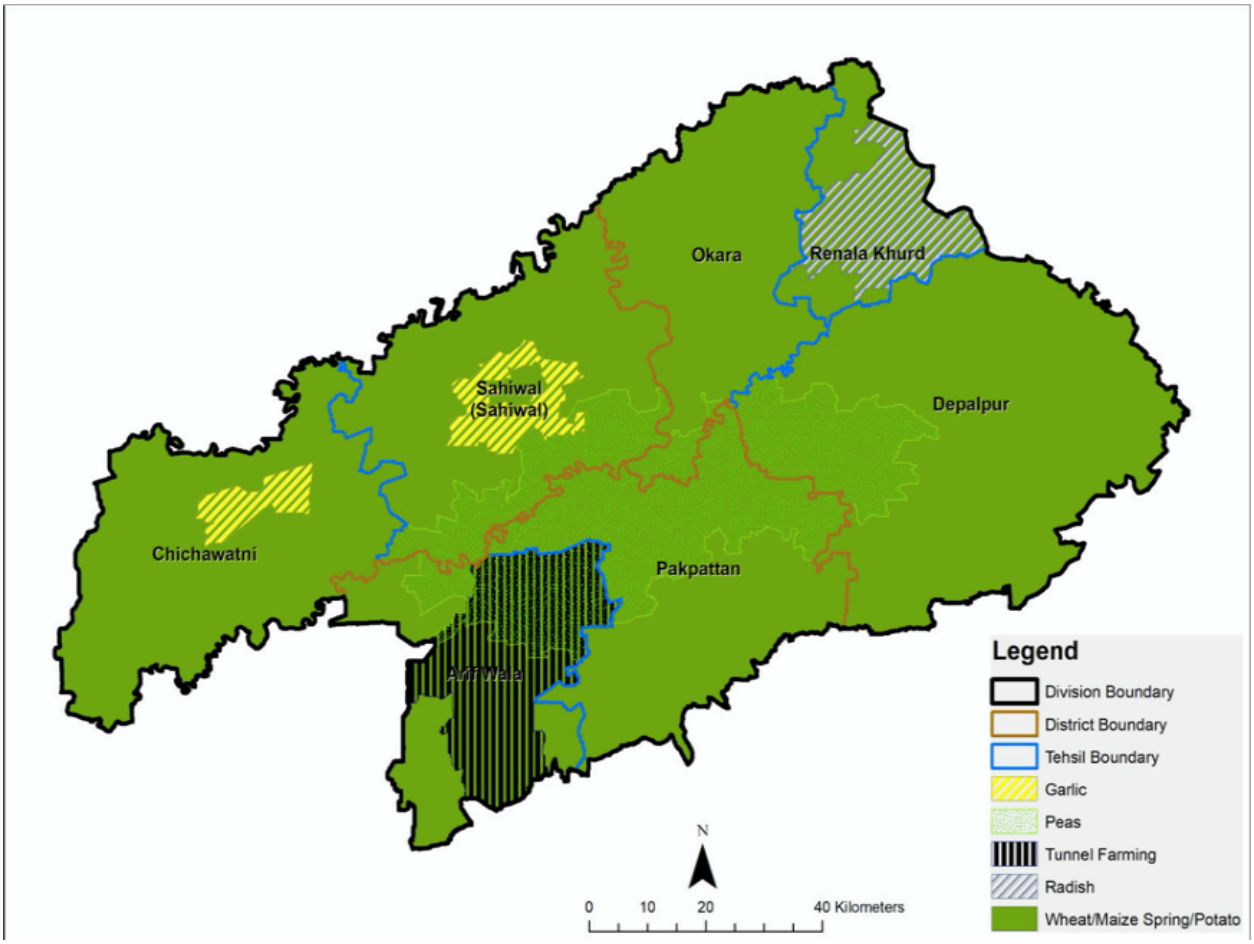
10. WAY FORWARD

The agriculture sector in the Sahiwal Division is pivotal for ensuring food security and fostering economic growth. The current state of agriculture in Sahiwal requires prioritization for sustainable development, necessitating the implementation of effective interventions to achieve the desired outcomes. Improving the Rabi/Kharif crop patterns in Sahiwal will further enhance agricultural output and necessitate capacity-building training for farmers. Emphasis should be placed on using high-quality seeds and modern technologies to improve the agricultural landscape and ensure food security.

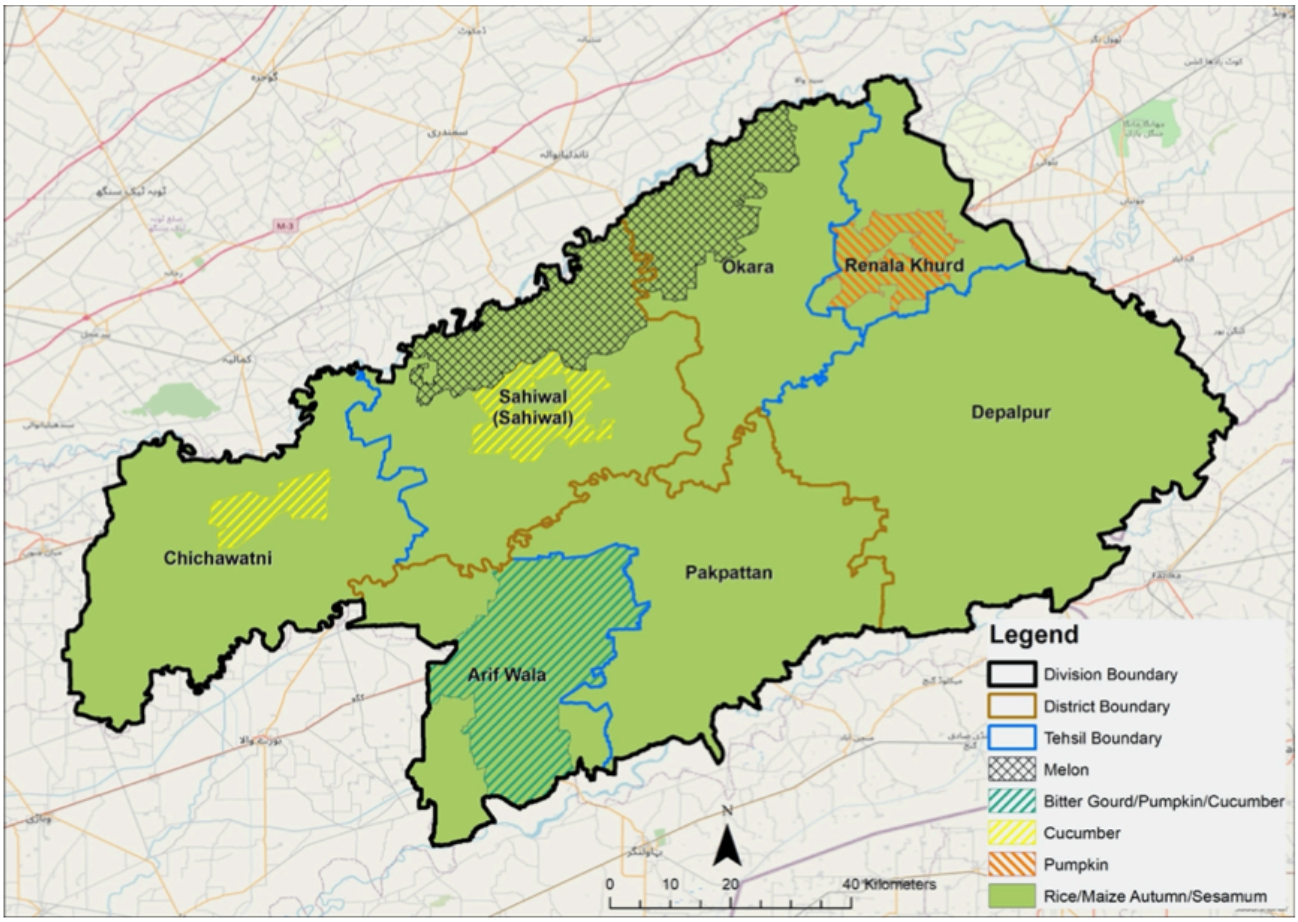
10.1. PROPOSED CROPPING PATTERN

Based on agro-ecological conditions, production, yield & value, and logistics analysis, 12 crops are recommended for the Sahiwal Division. The spatial distribution of Rabi and Kharif crops within the division is illustrated in the provided maps. For the Rabi season, crops such as wheat, maize, potatoes, radish, garlic, and peas are proposed. For the Kharif season, recommended crops include bitter gourd, pumpkin, cucumber, melon, rice, maize (autumn), and sesame. The maps delineate specific clusters for each crop, highlighting current contributions and potential growth.

Enhancing the cultivation area within these designated clusters is essential for maximizing productivity. Establishing specialized support systems in each cluster, from seed production to international market access, is imperative. This approach ensures optimal resource utilization, increased crop yields, improved water efficiency, and the adoption of international agricultural standards and best practices. By focusing on these high-yielding crops and their respective zones, the Sahiwal Division can significantly boost its agricultural output and economic contribution, potentially increasing from the current Rs. 451 billion to Rs. 840 billion.



Map 12: Proposed Cropping Pattern of Rabi Crops



Map 13: Proposed Cropping Pattern of Kharif Crops

Source: The Urban Unit

10.2. IMPACT OF PROPOSED CROPPING PATTERN

Efficient use of resources is essential to enhance productivity and generate value addition in agriculture, promoting the economic well-being of people, especially in rural communities. The proposed cropping pattern in Sahiwal Division focuses on value chain development through crop zoning. The primary goal is to increase crop yields to the level of progressive farmers, thereby achieving surplus, increasing exports, and creating sustainable value addition.

The maps and data demonstrate the potential of various crops. If yield levels of progressive farmers are achieved, along with better quality and market strategies, the agricultural GDP of Sahiwal Division can increase significantly from the current Rs. 451 billion to Rs. 840 billion. Efforts are required to boost the yield of staple crops such as wheat and maize, while high-value crops like bitter gourd, pumpkin, cucumber, melon, rice, and sesame have considerable potential. Interventions to increase their cultivation area and provide specialized support systems are necessary to develop the value chain of these crops. This includes everything from seed production to international market access, ensuring optimal resource utilization, improved water efficiency, and adherence to international agricultural standards and best practices.

The growth policy areas for rural transformation in the Sahiwal Division focus on transitioning from subsistence-level agriculture to high-value-added export-oriented farming to boost economic returns. This includes increasing productivity across all crops and livestock, identifying potential areas for each crop and creating specific clusters/zones to optimize production. Providing ancillary facilities and specialized support systems for each crop cluster/zone is essential, as is gradually shifting from low-value to high-value crops over the next five years. Coordination among all departments to implement a comprehensive action plan is critical. By focusing on these strategies, the Sahiwal Division can maximize its agricultural potential, enhance productivity, generate value addition, and improve the economic well-being of rural communities.

11. VALUE CHAIN ANALYSIS

Agri-food value chains are structured to enhance competitive advantage through strategic collaboration among producers, processors, marketers, food service companies, retailers, and supporting entities like shippers, research groups, and suppliers. These value chains encompass several stages: input supply, production, collection, processing, and retailing. Intermediaries, which include local and inter-provincial commissions, play crucial roles at each stage of the value chain. In some instances, a single actor may participate in multiple stages.

The diagram also highlights institutions that support the value chain actors. Within this framework, specific value chains for each crop have been developed to facilitate analysis, strategy development, planning, and implementation, providing a comprehensive overview of the proposed value chain projects. The following sections discuss the recommended value chains for various crops in this region, detailing their structure and strategic importance.

11.1. POTATO VALUE CHAIN

Potato (Solanum tuberosum) is a prominent crop in the Sahiwal District, celebrated for its high yield and nutritional value. Its cultivation has expanded beyond traditional areas, finding adaptability in diverse climatic conditions, including those in Pakistan.

Notably, in the Sahiwal District, the potential of potato cultivation has gained attention for its economic significance. Different varieties of potatoes have been introduced and studied for their adaptability to the region's climate. Varieties such as Cardinal, Diamant, and Sante have been recommended for cultivation in Sahiwal due to their high performance in yield and quality produce.

The economic significance of potato production is influenced by factors such as climate, genetic variability of the varieties, cultivation methods, and timing of planting and harvesting. To address these considerations and harness the potential of potatoes in Pakistan, comprehensive research initiatives have been undertaken. The Ayub Agricultural Research Institute (AARI) has established a potato germplasm unit, housing various potato varieties to assess their adaptability and performance in the Sahiwal region.

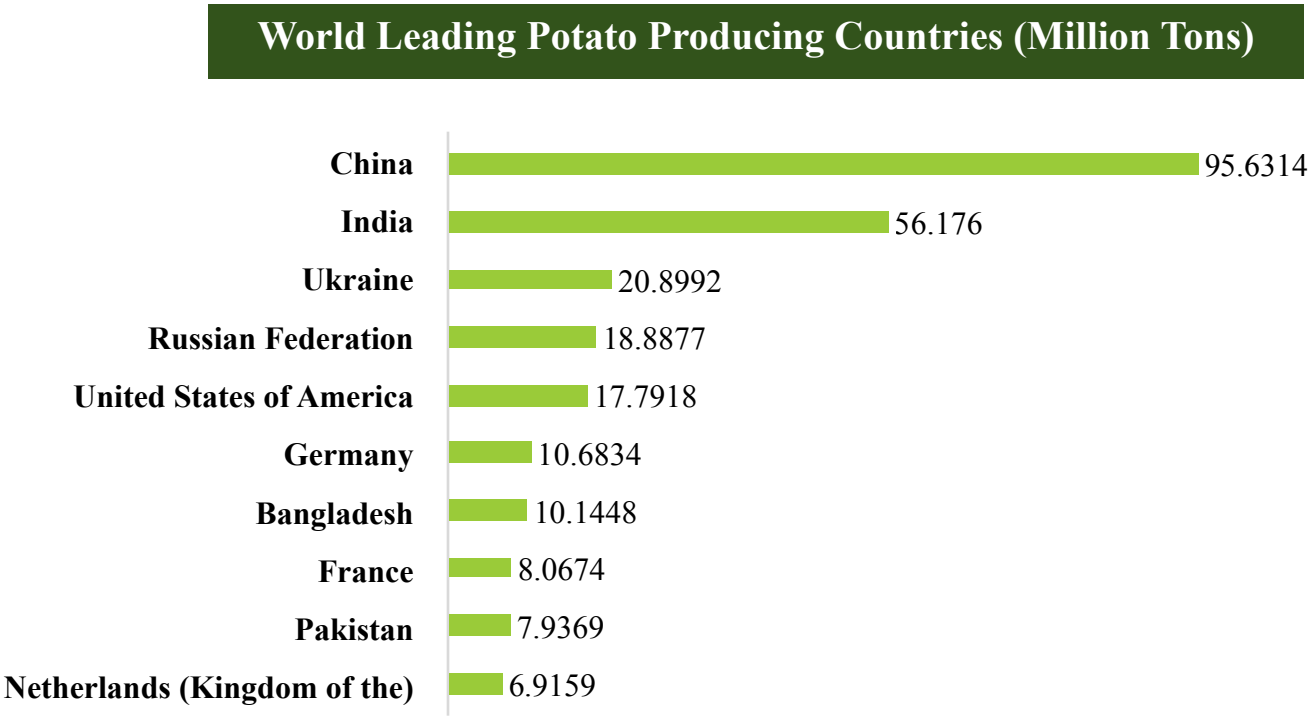


Figure 11: World leading potato producing countries (million tons)

Source: Trademap

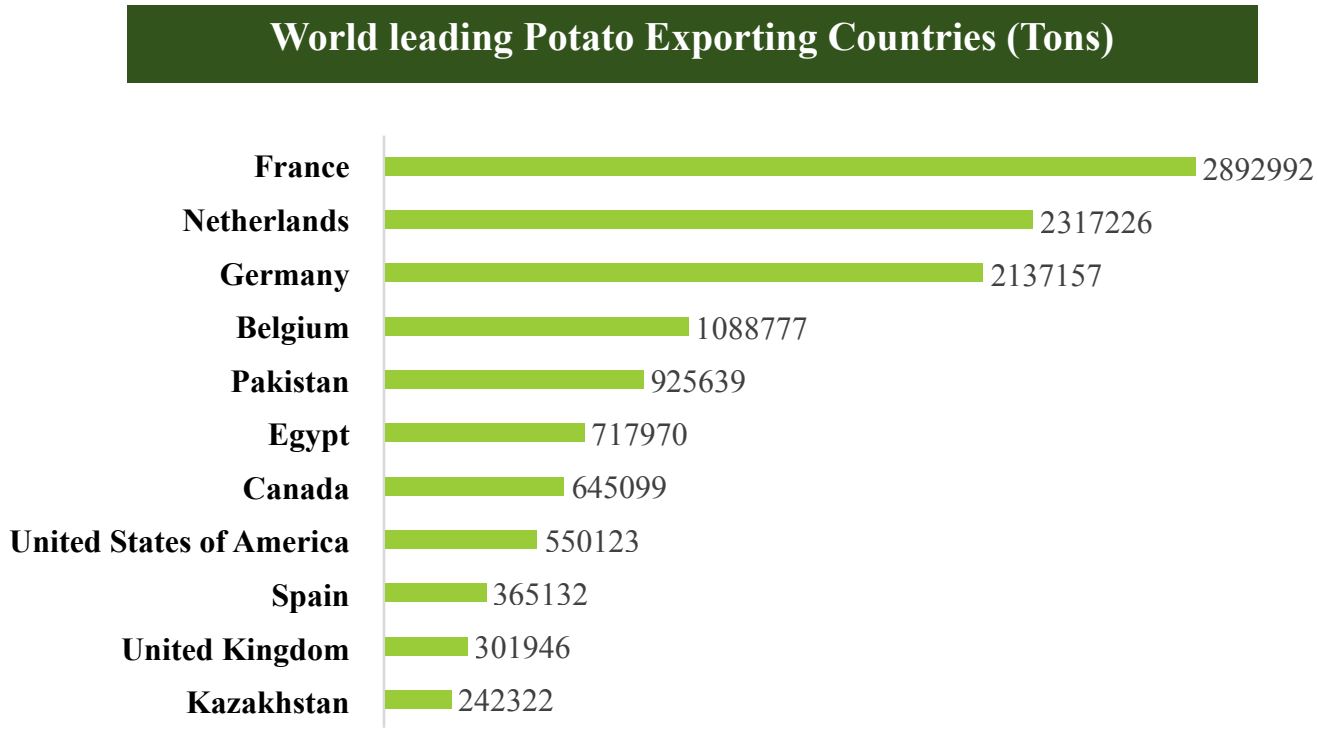


Figure 12: world leading potato exporting countries (million tons)

Source: Trademap

Figure 13: Potato Export Status (Source: Trademap)

Through systematic research, these initiatives have facilitated the comparison and evaluation of different potato varieties based on production data and economic returns. This comprehensive approach aids potato growers in selecting suitable varieties based on their technical expertise and available resources. Moreover, selected potato varieties have been registered with the Federal Seed Certification and Registration (FSC&RD), marking a significant step towards establishing a thriving potato production industry in Pakistan.

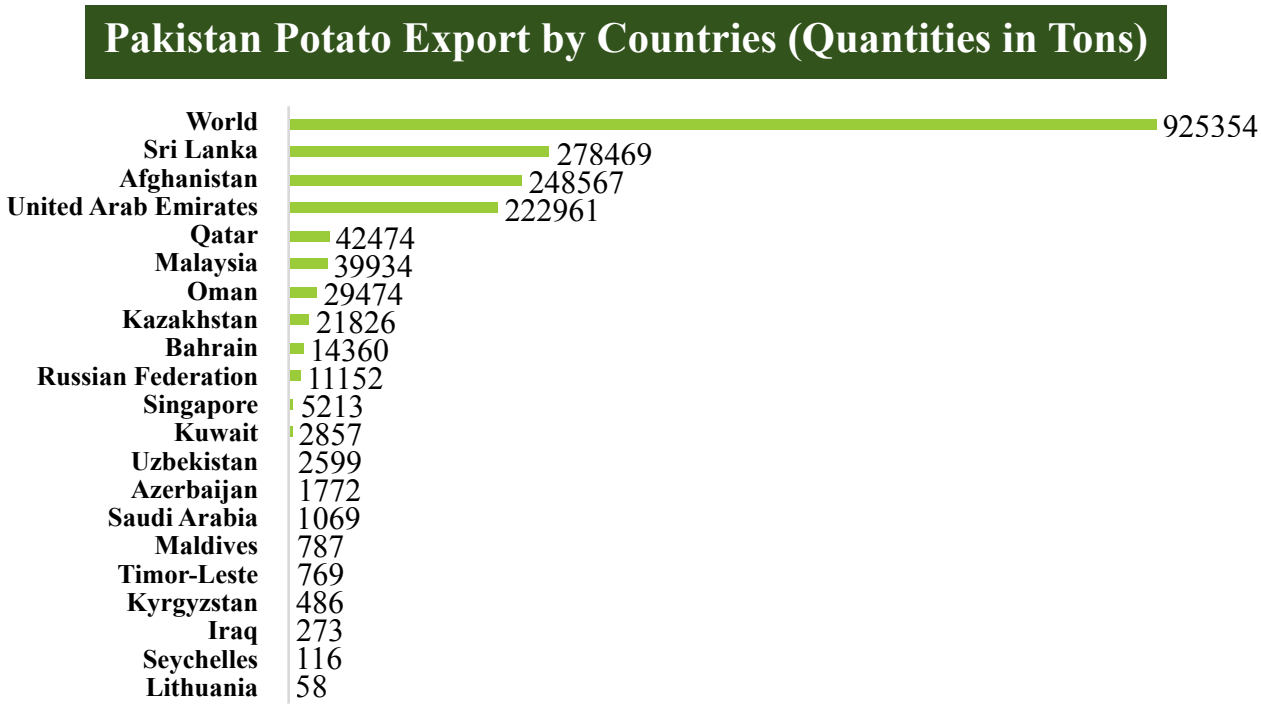


Figure 14: Pakistan's potato export by countries (Source: Trademap)

The focus on identifying and recommending specific potato varieties underscores the aim of not only enhancing crop production but also elevating the income prospects for potato growers in the region. Such efforts contribute to the overarching goal of integrating the potato economy effectively into the agricultural landscape of the area, promoting sustainable agricultural practices and improving the economic well-being of rural communities.

Potato cultivation in Sahiwal District holds promise due to its adaptability to varied climates, reducing risks for farmers. Specific high-performing potato varieties, like Sahiwal White, PRI-Red, and SH-5, ensure consistent, profitable yields. Growing demand for potato-based products, driven by nutritional benefits and culinary uses, creates a lucrative market. Governmental interest in supporting potato farming through subsidies and infrastructure boosts its appeal. Research centers like AARI provide valuable insights, aiding investors in choosing varieties and practices. Potatoes' high yield and market demand offer stable, long-term returns, solidifying its attractiveness for sustained investment.

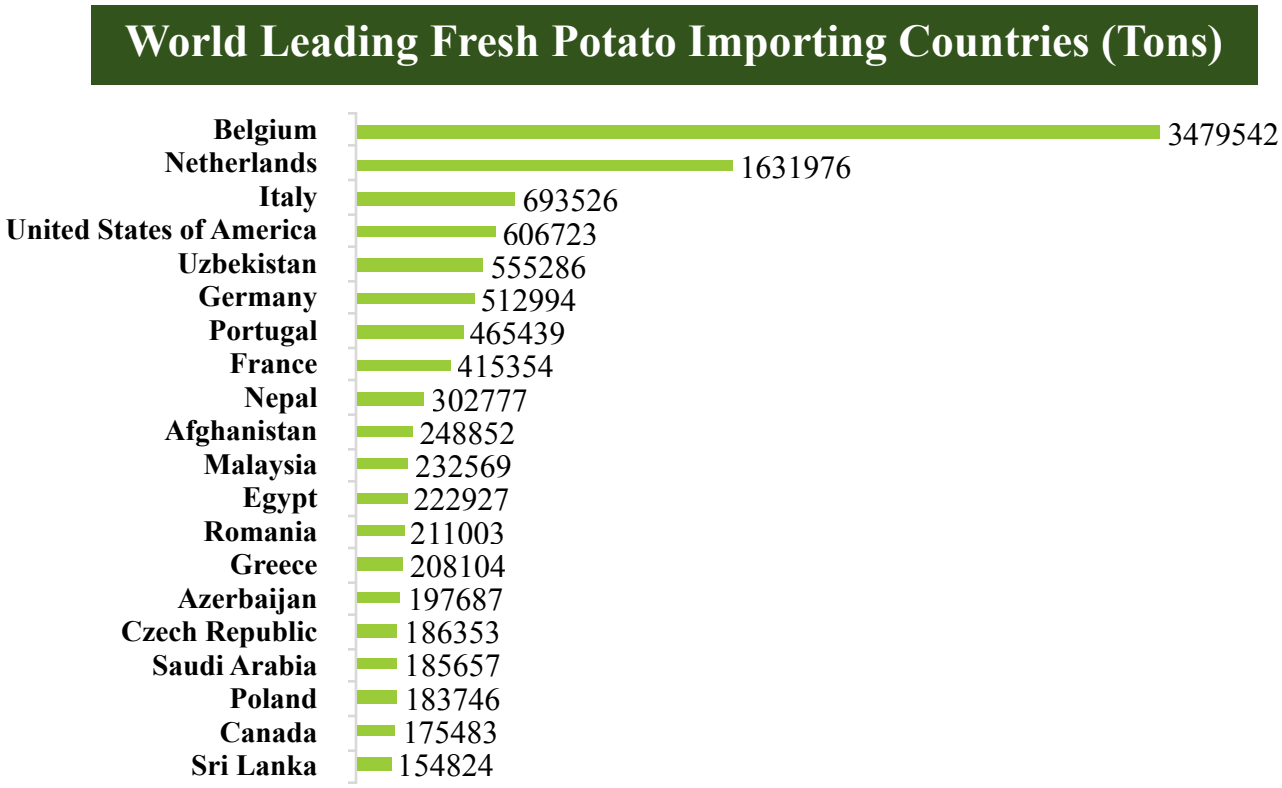


Figure 15: World leading potato importing countries

Source: Trademap

11.2. POTATO PRODUCTION ANALYSIS

Production

Potato is a significant crop in the Sahiwal District and Pakistan, valued for its high yield and nutritional content. Globally, Pakistan ranks as one of the top potato-producing countries, with a production of approximately 7.9369 million tonnes. This places Pakistan among the leading potato producers, contributing significantly to both local and global food supplies.

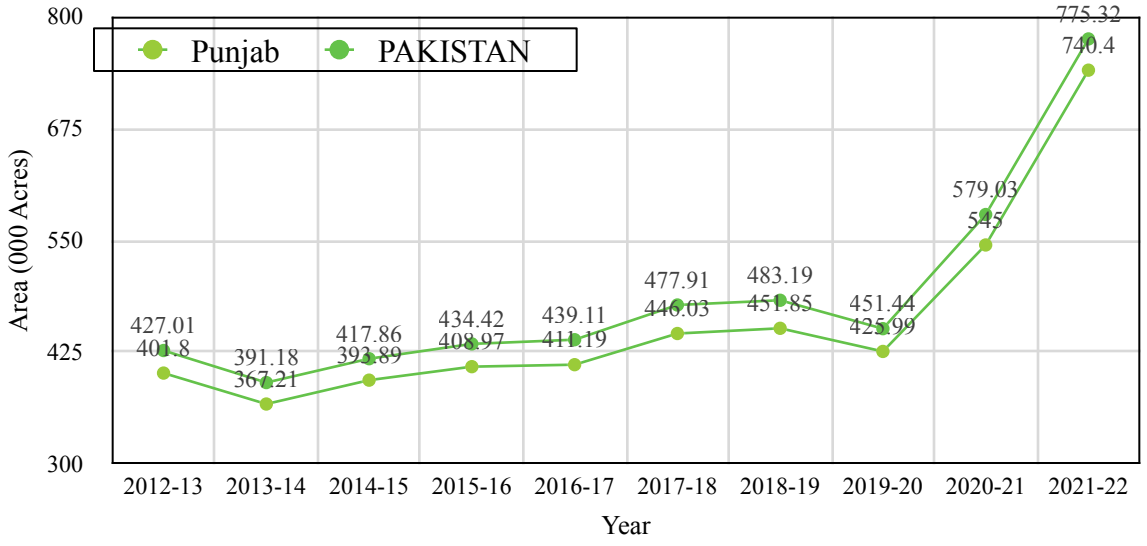
Global Production and Export

China and India dominate global potato production, with outputs of 95.6314 million tonnes and 56.176 million tonnes, respectively. In contrast, Pakistan's production, while substantial, still offers room for growth to match the leading nations. The export landscape reveals that Pakistan is also a significant player in the global potato market, ranking as one of the top exporters. In 2022, Pakistan's potato export value was approximately $216.591 million USD, reflecting the country's strong export capabilities.

Key Export Markets

Pakistan's primary potato export destinations include Sri Lanka, Afghanistan, and the United Arab Emirates, with export quantities of 278,469 tons, 248,567 tons, and 222,961 tons, respectively. The high export volume underscores the importance of potatoes in Pakistan's agricultural export portfolio.

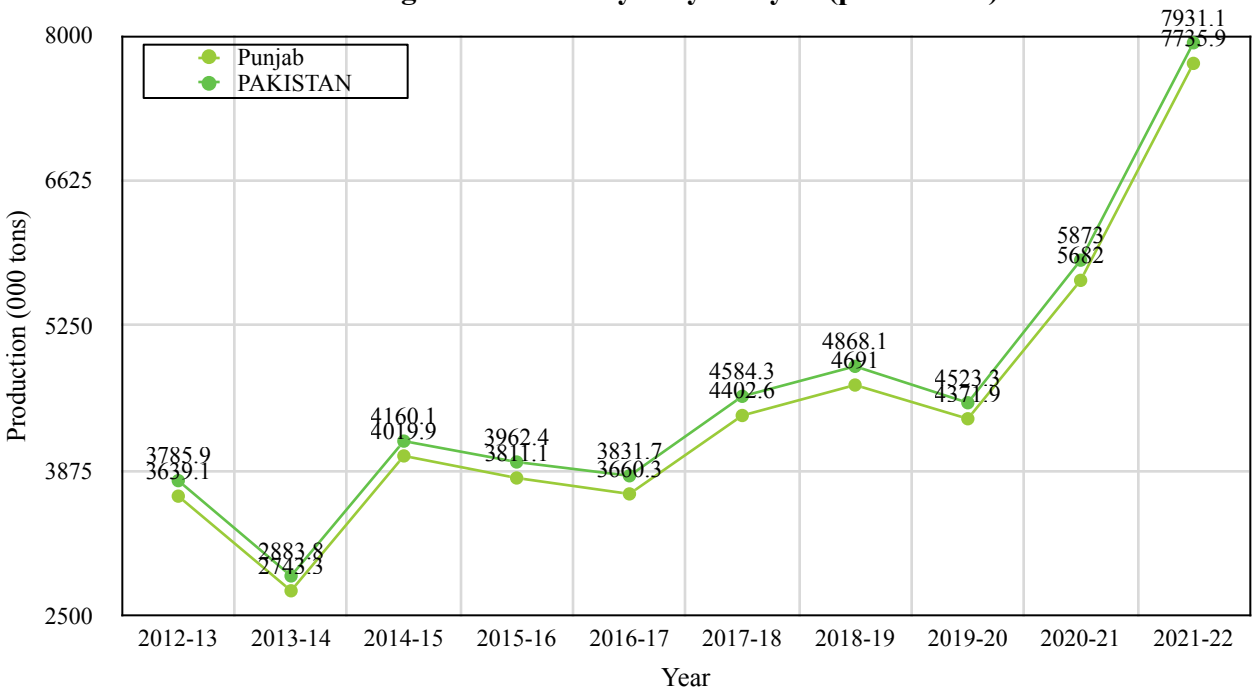
Figure 16: Potato yearly analysis (area)



Economic Impact

The economic significance of potato production in Pakistan is evident through its substantial contribution to the agricultural GDP. Efforts to improve the yield and quality of potato crops can further enhance this impact, driving economic growth in regions like Sahiwal. The development of efficient value chains, from production to processing and distribution, is crucial to maximizing the economic benefits of potato cultivation.

Figure 17: Potato yearly analysis (production)

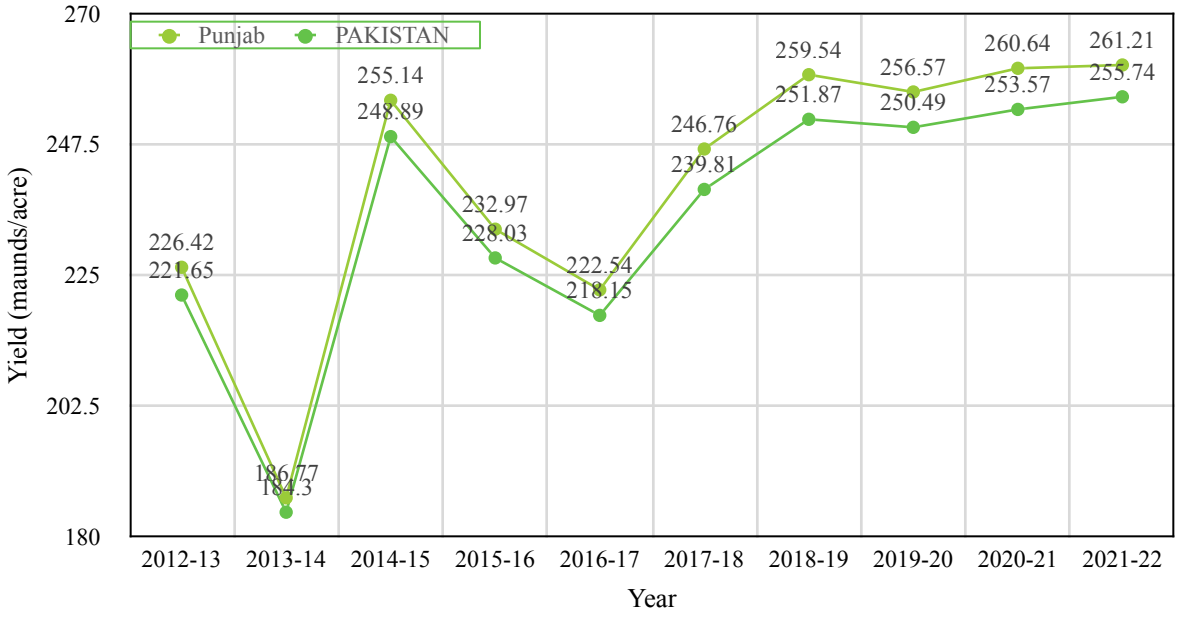


Source: AMIS

Market Dynamics and Opportunities

The global market for potatoes is robust, with significant import demands from countries such as Belgium, the Netherlands, and Italy. Pakistan's competitive advantage in potato production, coupled with its growing export capabilities, positions it well to capitalize on these market opportunities. Furthermore, the rising global demand for potatoes and potato-based products presents lucrative prospects for Pakistani farmers and exporters.

Figure 18: Potato yearly analysis (yield)



Source: AMIS

Challenges and Strategic Initiatives

Despite the promising outlook, challenges such as the need for advanced processing facilities and efficient distribution networks remain. Addressing these challenges through strategic investments and technological innovations can enhance the value chain, ensuring higher product quality and market access. Additionally, educating farmers on best practices and providing incentives for private sector investment are essential steps toward achieving sustainable growth in the potato sector.

11.3. POTATO PRODUCTION IN PUNJAB AND SAHIWAL

From 2012-13 to 2021-22, both Punjab and Pakistan have experienced a significant increase in potato cultivation area. In Punjab, the cultivation area for potatoes nearly doubled, growing from 401.8 thousand hectares in 2012-13 to 740.4 thousand hectares in 2021-22. Sahiwal Division plays a pivotal role in this expansion, with the primary cultivation area covering 2,104,440 acres. During this period, Pakistan's total potato cultivation area increased from 427.01 thousand acres to 775.32 thousand acres, with Punjab showing the most rapid growth.

Production trends also reflect this growth. Punjab's potato production generally follows the national trend but often exceeds it in quantity. The production gap between Punjab and the rest of Pakistan became particularly notable in 2020-21 and 2021-22, highlighting Punjab's increasing dominance in potato production. For instance, in 2021-22, Punjab produced 7931.1 thousand tons of potatoes compared to Pakistan's total of 775.9 thousand tons. Yield analysis indicates that Punjab has consistently achieved higher yields than other regions in most years. Factors contributing to this success include favorable agro-climatic conditions, advanced farming practices, and access to improved technologies and inputs. In 2021-22, Punjab's yield reached 261.21 mounds per acre, demonstrating the province's sustained productivity in potato farming.

Overall, the data underscores the strategic importance of the Sahiwal Division in Punjab's potato production landscape. With continued focus on advanced agricultural practices and infrastructure development, the region holds significant potential for further growth in potato cultivation and production, contributing to both regional and national agricultural outputs.

VALUE CHAIN ASSESSMENT OF POTATO CROP ISSUES

The value chain assessment for potato crops in Sahiwal Division identifies several key issues.

Seed	Farm	Harvest & Logistics
• Lack of Certified Seed Potato • Lack of awareness about certified seed varieties. • Lack of Value-Added Potato Varieties • Improper storage and handling of seed. • Declination of genetic	• High Cost of Production • Improper Use of Inputs • Diseases (e.g. potato scab) and insect pest attack • Inconsistent Irrigational Water Supply • Unavailability of modern machinery • Biotic and Abiotic Stresses	• High post-harvest losses due to improper storage and handling. • Limited transportation infrastructure in rural areas. • Low efficiency of existing planting and harvesting machinery (lower plant population & 30% is left in the soil after digging). • Challenges in timely harvesting and delivery to processing units.

These include the lack of certified seed potatoes and awareness, high production costs, diseases, and inconsistent water supply at the farm level. Harvest and logistics face high post-harvest losses and poor transportation infrastructure. Processing is hindered by the lack of mechanized facilities and improper handling. Market challenges include fluctuating prices, lack of export facilities, quality issues, heavy taxation, and limited access to high-value markets. Addressing these issues is essential for improving the potato value chain in the region.

Processing

- Lack of Mechanized Grading and Packing Facilities.
- Limited access to technological advancements
- Improper handling and storage practices
- Improper Packing in Gunny Bags

Markets

- Fluctuating market prices
- No facilities for exporters
- Quality issues, especially in terms of an export market
- Heavy taxation on exports
- Inefficiency of local markets

Value addition is needed to diversify the use of potato. This includes producing value-added products such as potato starch, potato flakes, potato chips, dried potato slices, potato cakes, potato cutlets, potato soups and exporting.

POTATO VALUE CHAIN DEVELOPMENT INTERVENTIONS

1. Seed Development:

Seed Certification Framework:

Enhance seed certification for top-quality potatoes, meeting global standards.

Promote Awareness and Training: Organize training programs to educate farmers on the benefits of using certified seeds, proper storage techniques, and the significance of genetic purity.

Research and Development Investment: Establish partnerships with research institutions and private enterprises to accelerate the development and dissemination of improved potato varieties.

2. Production:

- **Cost-Effective Agricultural Practices:** Promote the adoption of cost-effective and sustainable agricultural practices through training programs, extension services, and incentives.
- **Efficient Input Use:** Implement educational campaigns to enhance farmers' knowledge about proper input use, including fertilizers, pesticides, and other agrochemicals.
- **Integrated Pest and Disease Management:** Develop and implement policies that support integrated pest and disease management strategies.
- **Irrigation Infrastructure Development:** Invest in irrigation infrastructure to ensure consistent water supply for crops.
- **Access to Modern Machinery:** Introduce policies to facilitate the availability and affordability of modern agricultural machinery through subsidies, loans, or leasing programs.
- **Climate-Resilient Agriculture:** Develop and promote policies that focus on climate-resilient agricultural practices to mitigate biotic and abiotic stresses.

3. Post-Harvest & Marketing and Distribution Handling:

- **Cold Storage Infrastructure:** Invest in the development and

4. Value Addition:

- **Diversification into High-Value Potato Products:** Encourage farmers to explore new products such as potato flour, potato flakes, dried potato slices, potato starch, potato cakes etc.
- Provide financial incentives, grants, or tax breaks to encourage the establishment and expansion of potato processing facilities.
- Implement training programs for farmers and processors to enhance skills in potato value addition techniques.
- Facilitate market access for processed potato products through trade agreements, and export incentives.

5. Capacity Building and Training:

- **Training Programs for Farmers:** Initiate comprehensive training programs for potato farmers on modern cultivation techniques, pest management, and best agronomic practices.
- **Partnerships with NGOs and Private Sector:** Forge partnerships with non-governmental organizations (NGOs) and the private sector to expand the reach and effectiveness of capacity-building initiatives.

6. Infrastructure Development:

- **Processing Plants and Technology:** Facilitate the establishment of modern processing plants for value-added potato products.
- **Transportation Networks:**
- Improve transportation infrastructure to ensure efficient and timely movement of potatoes from farms to storage facilities and markets.
- Invest in the development of well-maintained roads and logistics hubs, particularly in potato-producing regions.
- **Research and Innovation Hubs:** Create research and innovation hubs focused on potato cultivation, post-harvest management, and processing technologies

BENEFITS TO SMALL HOLD FARMERS

1. Food and Nutrition Security

- Potatoes are a rich source of carbohydrates, providing a significant portion of dietary calories.
- These are a good source of dietary fiber, including both soluble and insoluble fibers. This fiber content aids in digestion, helps regulate blood sugar levels, and contributes to a feeling of fullness, which can be beneficial for weight
- It contain essential vitamins and minerals, including vitamin C, potassium, vitamin B6, and folate. These nutrients are vital for various bodily functions, including immune system support, cell metabolism, and the formation of red blood cells.
- Potatoes have good storage stability, which allows them to be stored for extended periods without significant loss of nutritional value.

2. Livestock Feed and Nutrition

- Potatoes can be incorporated into various forms in animal diets, such as being fed raw, boiled, or processed into by-products like potato meal or silage.
- Potatoes have high digestibility, making them an efficient feed option for livestock.
- Some by-products of potato processing, such as potato peels and pulps, can be used as feed additives.

3. Soil Fertility and Environmental Benefits

- Alternating potato cultivation with other crops enhances nutrient cycling and prevents the depletion of specific nutrients in the soil.
- After harvesting, the leftover potato vines and residues decompose, adding organic matter to the soil.
- Potatoes can be grown in various climates and soil types, making them adaptable to different agricultural settings.

4. Income Generation

- Potatoes have high demand in local and global markets provides opportunities for farmers to sell their produce and engage in commercial farming.
- Farmers involved in certified seed potato production can generate income by selling high-quality potato seeds to other

5. Women's Empowerment

- Women provide support with all kinds of harvest and post-harvest practices.
- Engaging women in competitive markets empowers them economically and socially.

11.2. MAIZE VALUE CHAIN

Maize cultivation in Sahiwal Division, Pakistan, is a crucial agricultural activity due to the region's favorable climatic conditions and soil suitability. Known for its diverse agriculture, including cereals, vegetables, and fruits, Sahiwal Division also sees extensive cultivation of maize.

The region's moderate climate, with warm temperatures and adequate rainfall during the growing season, offers ideal conditions for maize cultivation. The well-drained sandy loam and loam soils prevalent in Sahiwal Division are conducive to maize growth, aiding in good root development and ensuring high yields.

Farmers in Sahiwal Division typically cultivate maize during both Rabi and Kharif seasons. They use improved maize varieties developed by the Maize and Millets Research Institute (MMRI) in Yusafwala, Sahiwal. These varieties, such as Sahiwal-2002, Pearl, and Malka-2016, exhibit traits like disease resistance, higher yield, and better quality. Modern agricultural practices, including proper irrigation techniques and fertilization methods, are employed to maximize maize yields.

The produced maize serves various purposes, including animal feed, human consumption, and as a raw material for various industrial products. The MMRI also emphasizes developing hybrid maize seeds and promoting their adoption among farmers to enhance productivity further. Additionally, maize cultivation significantly contributes to the local economy by providing income to farmers and supporting the agricultural sector's diversity in the region.

However, challenges such as weather fluctuations, pest infestations, and market volatility can affect maize cultivation in Sahiwal Division. The MMRI addresses these challenges by conducting research on pest management, improving crop varieties, and providing training to farmers on advanced farming techniques. This continued research, coupled with improved farming practices and support from agricultural authorities, is essential to sustain and enhance maize production in the area.

11.3. MAIZE PRODUCTION ANALYSIS

Maize production is a significant agricultural activity worldwide, with the United States leading the production at 348.75 million tonnes, followed by China and Brazil with 277.42 and 109.42 million tonnes respectively. Pakistan, though lower on the list, still plays a crucial role with a production of 10.18 million tonnes.

Figure 19: Maize exporting countries

Source: Trademap

In terms of exports, the United States also tops the chart, exporting 58.60 million tonnes of maize, followed by Brazil and Argentina. Pakistan, while producing a notable amount, exports around 827,788 tonnes, reflecting its growing potential in the global maize market. The major importers of maize include China, Japan, and South Korea, showcasing significant global demand.

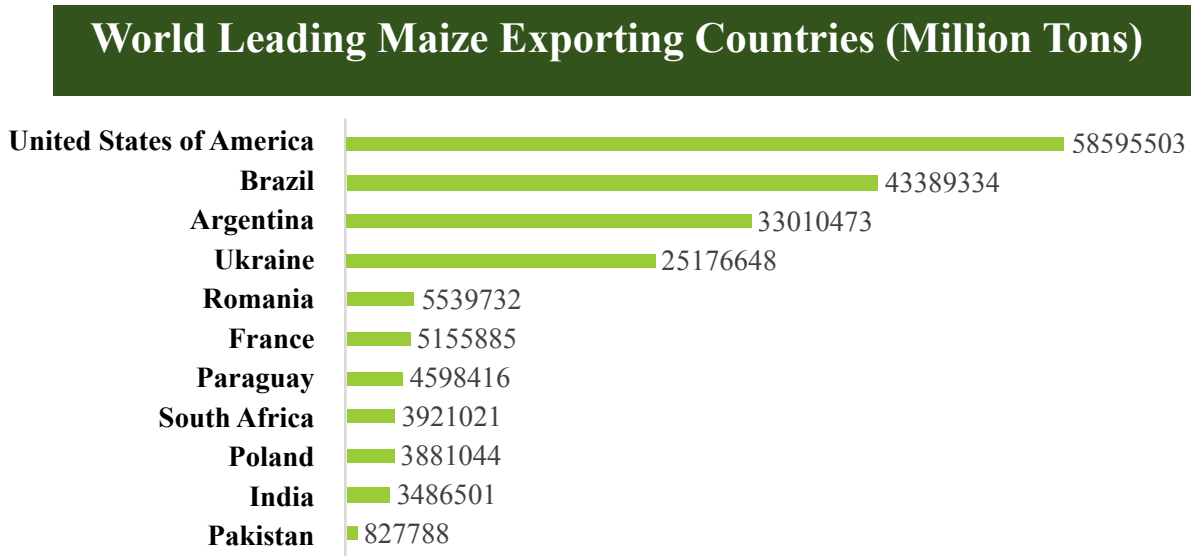


Figure 20: Leading Maize exporting countries (Source: Trademap)

The economic significance of maize for Pakistan is highlighted by its export value of USD 264.02 million in 2022, contributing to the global export value of USD 68.16 billion in 2021.The key markets for Pakistani maize include Vietnam, Malaysia, and Oman, with varying export quantities and values.

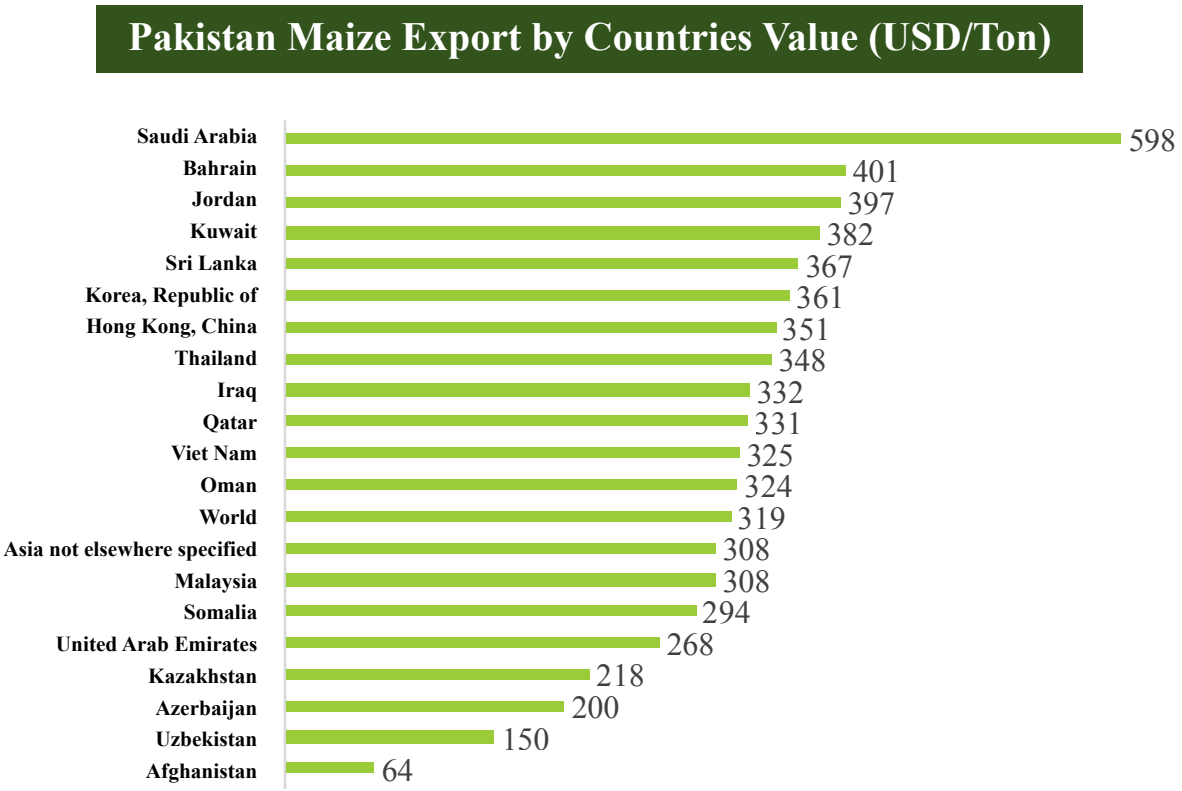


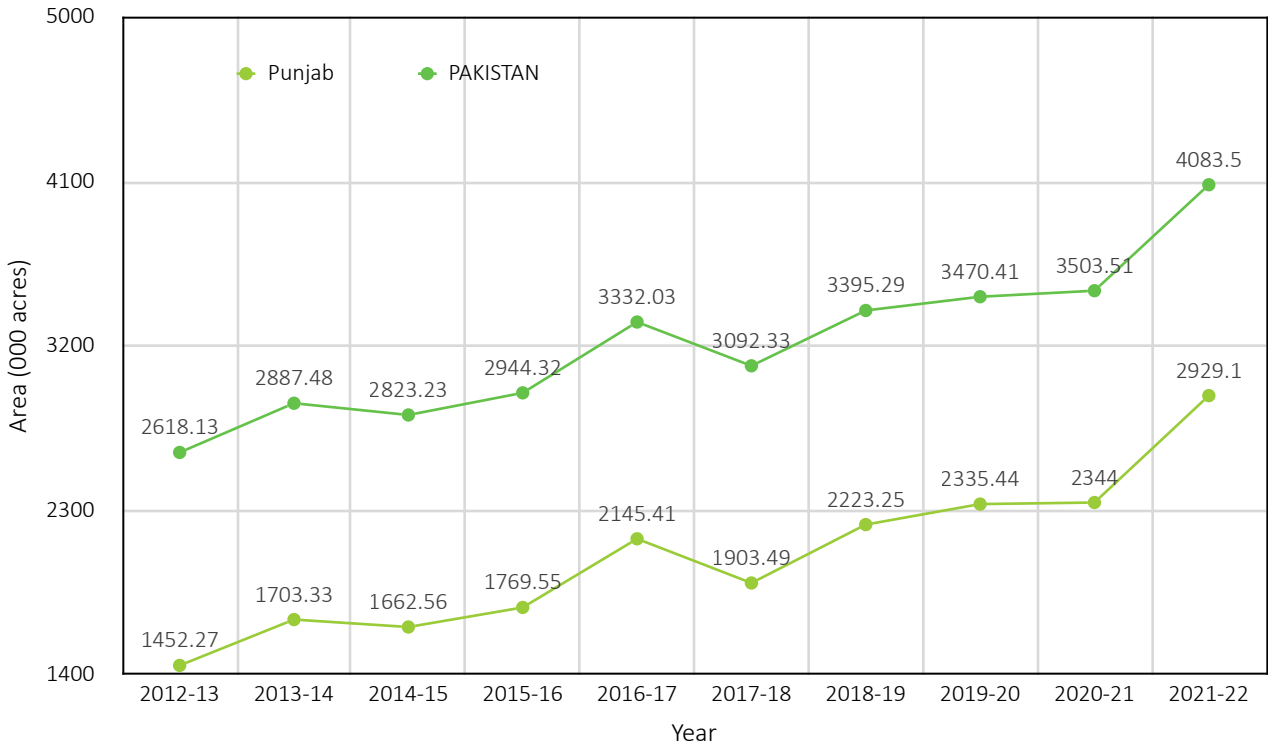
Figure 21: Pakistan Maize export value (Source: Trademap)

11.4. MAIZE COMPARISON ANALYSIS IN PUNJAB AND PAKISTAN

Area Analysis

From 2012-13 to 2021-22, both Punjab and Pakistan have experienced a significant increase in maize cultivation areas. In Punjab, the cultivation area has nearly doubled, growing from 1,452.27 thousand acres in 2012-13 to 2,929.1 thousand acres in 2021-22. Sahiwal Division stands out as a primary cultivation area, covering 2,104,440 acres. During the same period, Pakistan's overall maize cultivation area has expanded from 2,618.13 to 4,083.5 thousand acres, with Punjab showing the most rapid growth.

Figure 22: Maize yearly analysis (area)

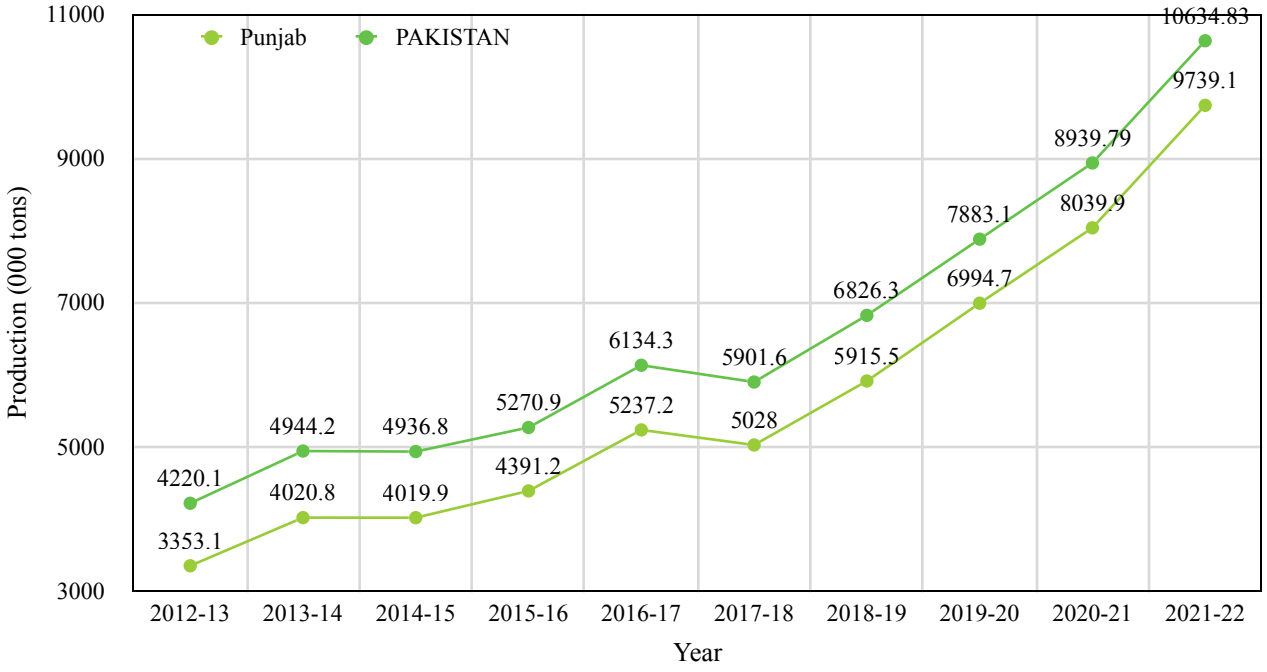


Source : AMIS

Production Analysis

Punjab is a major contributor to maize production in Pakistan. The production trends in Punjab generally mirror the national trends, though Punjab consistently produces a larger quantity. The gap in production between Punjab and the rest of Pakistan became particularly notable in 2020-21 and 2021-22, underscoring Punjab's increasing dominance in maize production. In 2021-22, Punjab's production reached 10,634.83 thousand tons, compared to Pakistan's total production of 9,739.1 thousand tons.

Figure 22: Maize yearly analysis (production)

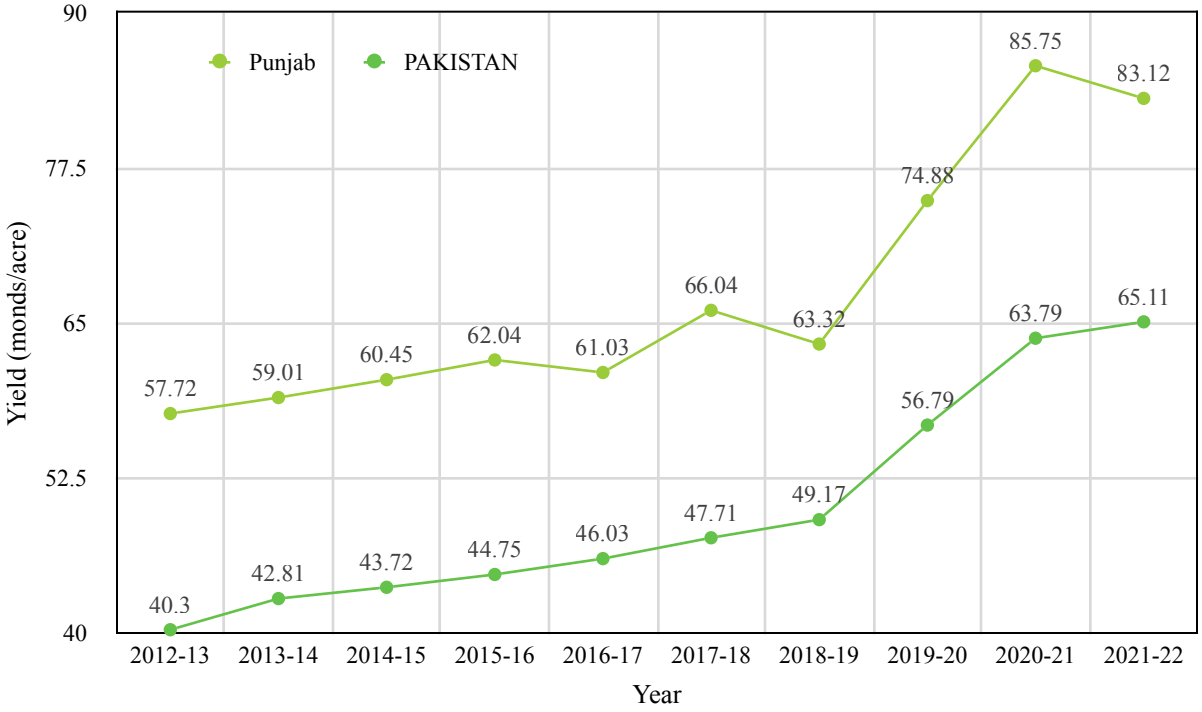


Source: AMIS

Yield Analysis

Punjab has consistently achieved higher yields (measured in monds/acre) than other regions in most years. The higher agricultural yields in Punjab can be attributed to favorable agro-climatic conditions, advanced farming practices, and improved access to technologies and inputs. These factors have contributed to Punjab's sustained success in producing higher maize yields. In 2021-22, Punjab's yield was 83.12 monds/acre, significantly higher than the national average of 65.11 monds/acre.

Figure 24: Maize yearly analysis (yield)



Source: AMIS

Overall, the data highlights Punjab's critical role in maize production within Pakistan, with Sahiwal Division being a significant area of cultivation. The steady increase in area, production, and yield over the years reflects the province's robust agricultural practices and potential for further growth in maize production.

VALUE CHAIN ASSESSMENT

Seed	Farm	Harvest & Logistics
• High Seed Costs. • Limited availability of maize varieties adapted to changing climatic conditions. • Limited farmer awareness on new seed technologies • Research land encroachment	• High Cost of Production • Unavailability of Inputs. • Attack of diseases (e.g. stalk rot) and insect pests (e.g. fall armyworm).	• Unavailability of silage machinery. • Unavailability of drying machinery. • Limited access to real-time market information.

Processing

- Inadequate processing facilities, including milling plants and processing units.
- Limited access to modern and efficient processing equipment.
- Dependence on a limited range of maize products.

Markets

- Price Instability.
- No proper export setup.
- Insufficient access to real-time market information.

Value Added Products

The value added products of maize include multigrain flours, corn starch, corn oil, corn steep liquor, cornflakes and feeds.

INTERVENTIONS

1. Allocate funding for ongoing research and development programs focused on breeding maize varieties adapted to Sahiwal Division's specific agro-climatic conditions
2. Establish a comprehensive seed certification and distribution system to ensure the availability of certified, high-quality seeds for maize.
3. Invest and upgrade efficient irrigation infrastructure, focusing on efficient water distribution systems, water-saving technologies, and reliable water sources to ensure consistent and optimal irrigation for maize.
4. Develop and implement policies that promote IPM practices for maize.
5. Promote climate-resilient agricultural practices such as conservation tillage, cover cropping, and agroforestry to mitigate the impact of climate change.
6. Facilitate market linkages for maize farmers, ensuring fair pricing and reducing post-harvest losses through improved storage and transportation facilities.
7. Increase value addition by incentivizing the private sector and processing industry for export enhancement

11.2. SESAMUM VALUE CHAIN

Sesamum (Sesame) stands as a significant crop in the Sahiwal District, valued for its high-quality oil-rich seeds that are beneficial for human health. Its cultivation has expanded beyond traditional regions, finding popularity in diverse climatic conditions across various regions worldwide, including Pakistan.

Notably, in the Sahiwal District, the potential of sesame cultivation has gained attention for its economic significance. Different varieties of sesame have been introduced and studied for their adaptability to the region's climate. Varieties such as TS-3, S-17, and S-18 have been recommended for cultivation in Sahiwal due to their high yield and oil content.

The economic significance of sesame production is contingent upon factors such as climate, genetic variability of the varieties, extraction methods, and duration of seed harvesting. To address these considerations and harness the potential of sesame in Pakistan, comprehensive research initiatives have been undertaken. The Ayub Agricultural Research Institute (AARI) has established a framework for evaluating different sesame varieties to assess their adaptability and performance in various regions, including Sahiwal.

Through systematic research, these initiatives have facilitated the comparison and evaluation of different sesame varieties based on production data and economic returns. This comprehensive approach aids sesame growers in selecting suitable varieties based on their technical expertise

and available resources. Moreover, selected sesame varieties have been registered with the Federal Seed Certification and Registration (FSC&RD), marking a significant step towards establishing a thriving sesame production industry in Pakistan.

The focus on identifying and recommending specific sesame varieties underscores the aim of not only enhancing edible oil production but also elevating the income prospects for sesame growers in the region. Such efforts contribute to the overarching goal of integrating the sesame economy effectively into the agricultural landscape of the area. Sesame cultivation in Sahiwal District holds promise due to its adaptability to varied climates, reducing risks for farmers. Specific high-performing sesame varieties, like TS-3, S-17, and S-18, ensure consistent, profitable oil yields. Growing demand for sesame-based products, driven by health benefits and culinary uses, creates a lucrative market. Governmental interest in supporting sesame farming through subsidies and infrastructure boosts its appeal. Research centers like AARI provide valuable insights, aiding investors in choosing varieties and practices. Sesame plants' resilience and adaptability offer stable, long-term returns, solidifying its attractiveness for sustained investment.

11.3. SESAMUM PRODUCTION ANALYSIS

Production

Sesamum, commonly known as sesame, is a notable crop in the Sahiwal District and Pakistan, valued for its oil-rich seeds. Pakistan is a significant producer of sesame, with an annual production of approximately 0.1523 million tonnes. Although this production volume is modest compared to global leaders, it reflects the crop's importance within the country's agricultural sector.

Global Production and Export

On the global stage, Sudan, India, and Myanmar are the top sesame producers, with outputs of 1.2317 million tonnes, 0.7887 million tonnes, and 0.7609 million tonnes, respectively. Pakistan, while not among the top producers, plays a crucial role in the global sesame market. As one of the leading exporters, Pakistan exported 96,410 tonnes of sesame in the recent year. This strong export performance underscores Pakistan's potential in the international sesame market.

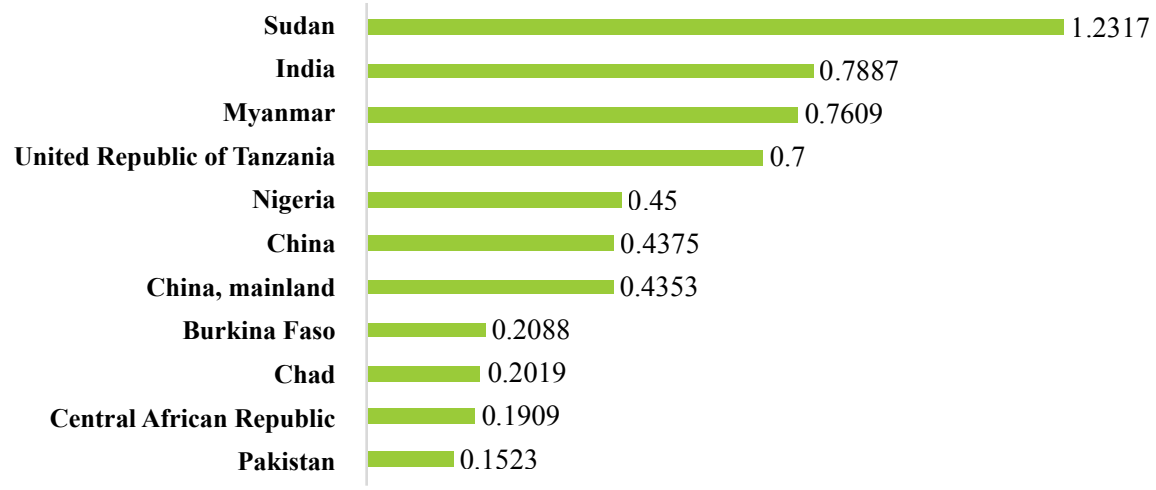


Figure 25: world leading sesamum producing countries (Source: Trademap)

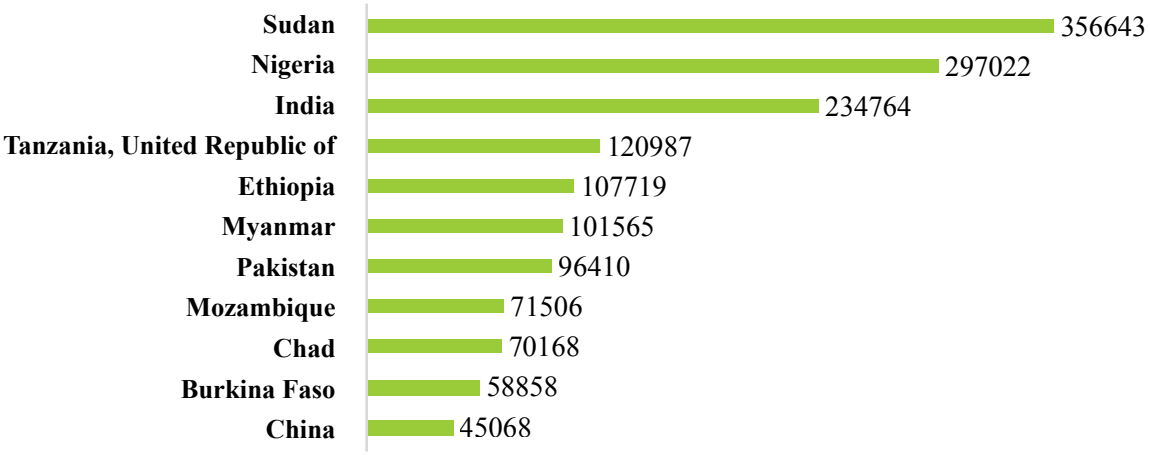


Figure 26: world leading sesamum exporters

Source: Trademap

Key Export Markets

Pakistan's primary sesame export destinations include China, which imported 59,286 tonnes, followed by Kazakhstan and Afghanistan with 8,507 tonnes and 6,027 tonnes, respectively. These markets highlight the strategic importance of sesame in Pakistan's agricultural export portfolio and the country's ability to meet international demand.

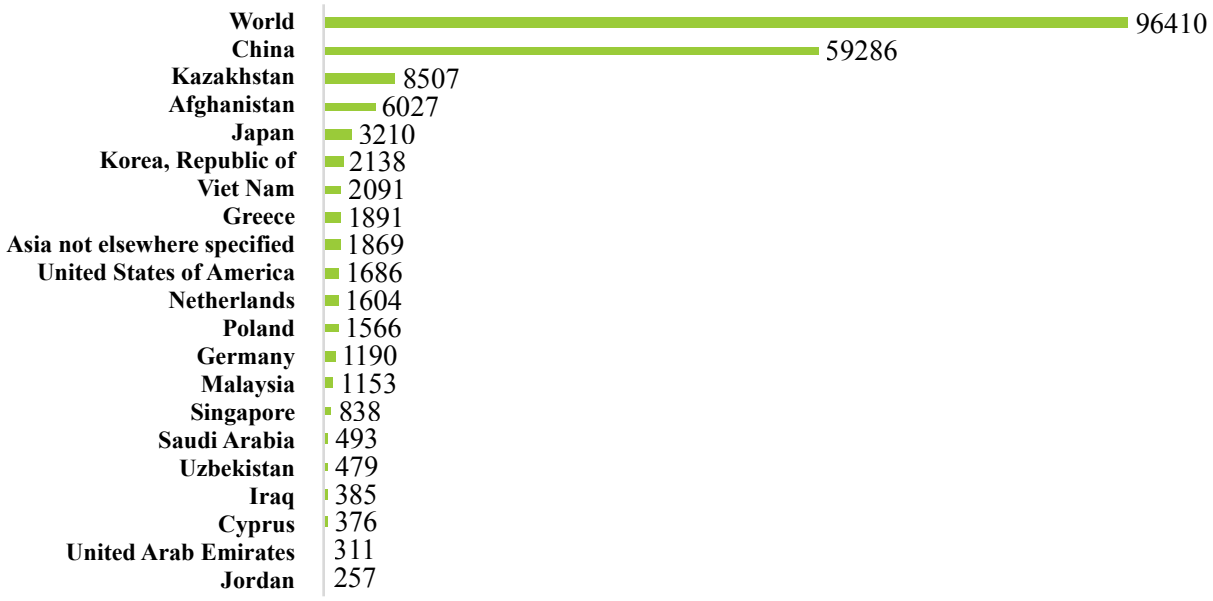


Figure 27: Pakistan sesamum exports by countries (Source: Trademap)

Economic Impact

Sesame production significantly contributes to Pakistan's agricultural GDP. The export value of Pakistani sesame reached 148.062 million USD in 2022, showcasing the crop's economic impact. Improving yield and quality can further enhance this contribution, driving economic growth in regions like Sahiwal. Effective value chain development, from production to processing and distribution, is essential to maximizing the economic benefits of sesame cultivation.

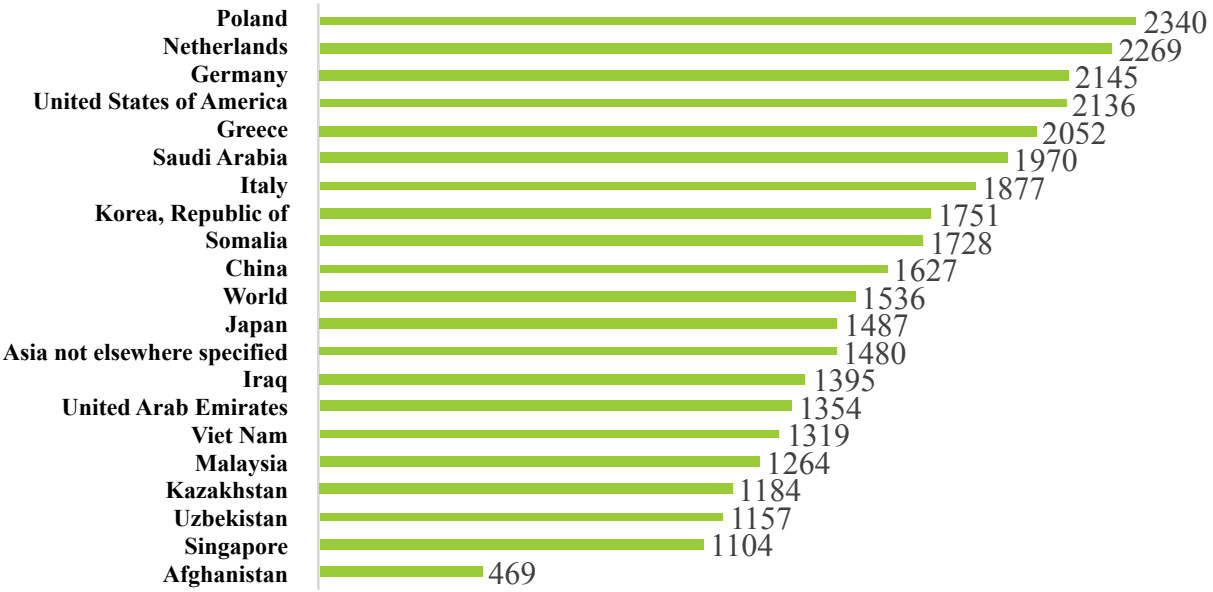


Figure 28: Pakistan's sesamum export value (Source: Trademap)

Market Dynamics and Opportunities

The global market for sesame is robust, with substantial import demands from countries such as China, Türkiye, and Japan. Pakistan's competitive advantage in sesame production, combined with its growing export capabilities, positions it well to capitalize on these market opportunities. The increasing global demand for sesame and its products offers lucrative prospects for Pakistani farmers and exporters.

Challenges and Strategic Initiatives

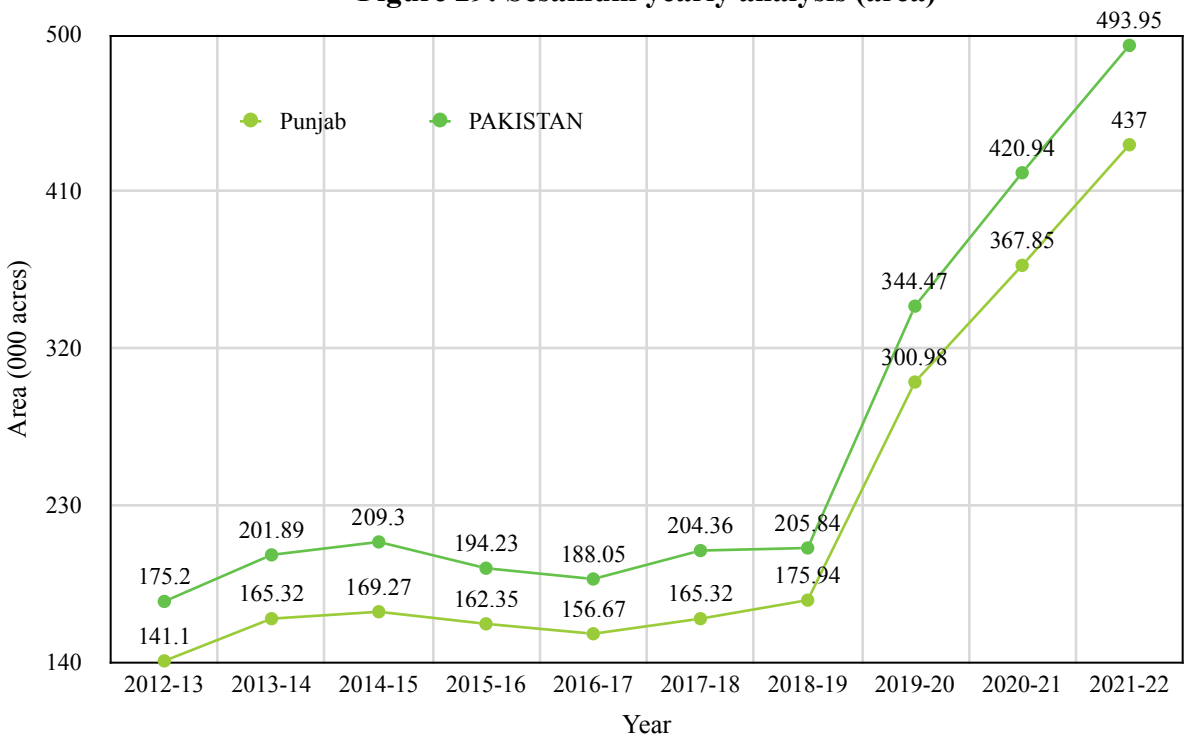
Despite the promising outlook, challenges such as the need for advanced processing facilities and efficient distribution networks persist. Addressing these challenges through strategic investments and technological innovations can enhance the value chain, ensuring higher product quality and better market access. Additionally, educating farmers on best practices and providing incentives for private sector investment are crucial steps toward achieving sustainable growth in the sesame sector.

11.4. SESAMUM COMPARISON ANALYSIS IN PUNJAB

Cultivation Area Analysis

From 2012-13 to 2021-22, both Punjab and Pakistan have experienced a notable increase in sesamum cultivation area. In Punjab, the cultivation area for sesamum more than tripled, growing from 141.1 thousand acres in 2012-13 to 437 thousand acres in 2021-22. The primary cultivation area is in the Sahiwal Division, which covers 2,104,440 acres. Meanwhile, in Pakistan, the cultivation area expanded from 175.2 to 493.95 thousand acres, with Punjab showing the most rapid growth.

Figure 29: Sesamum yearly analysis (area)

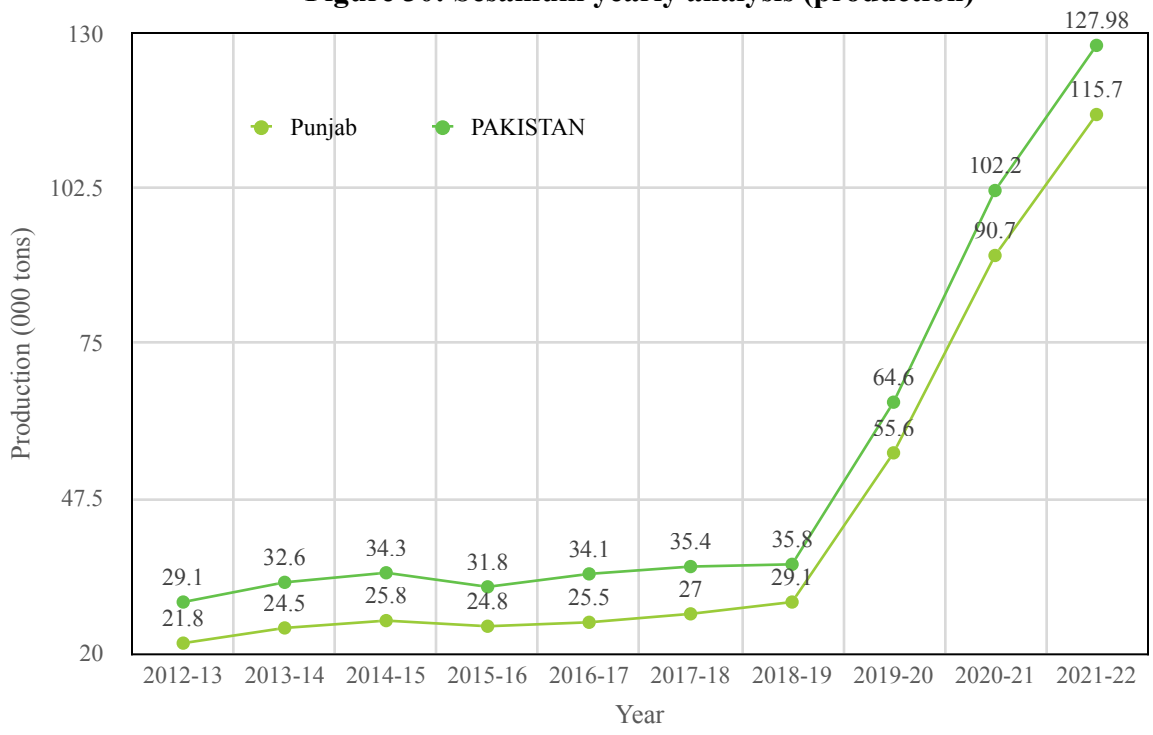


Source: AMIS

Production Analysis

Punjab is a significant contributor to sesamum production in Pakistan. The production trend in Punjab generally follows the national production pattern but often yields a larger quantity. The production gap between Punjab and Pakistan became particularly notable in 2020-21 and 2021-22, indicating Punjab's increasing dominance in sesamum production. For instance, in 2021-22, Punjab produced 115.7 thousand tons, while Pakistan's total production reached 127.98 thousand tons.

Figure 30: Sesamum yearly analysis (production)

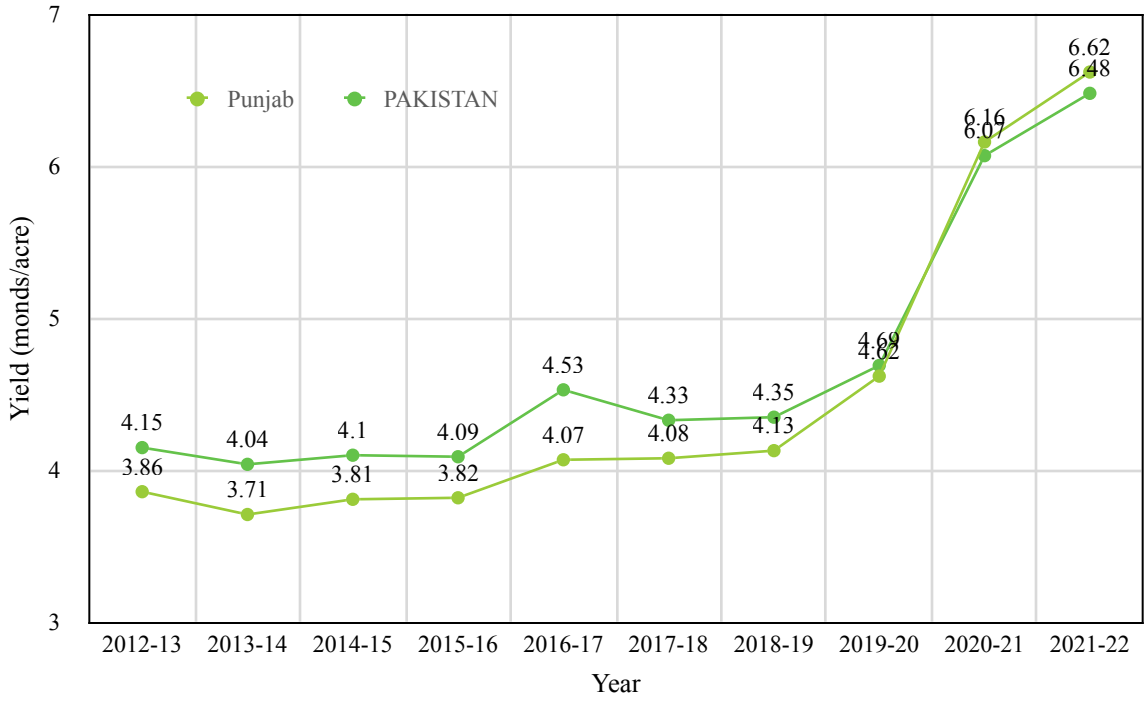


Source: AMIS

Yield Analysis

Punjab has consistently achieved a higher yield of sesamum compared to other regions in the country. This higher yield can be attributed to several factors, including favorable agro-climatic conditions, advanced farming practices, and access to improved technologies and inputs. The yield in Punjab has shown a steady increase over the years, reaching 6.62 kg/ha in 2021-22, compared to 6.48 kg/ha for Pakistan overall.

Figure 30: Sesamum yearly analysis (yield)



Source: AMIS

Production Dominance of Sahiwal

Within Punjab, the Sahiwal Division stands out as a major sesamum producer. The division's contribution is integral to Punjab's overall sesamum output. The production trends in Sahiwal mirror the overall growth in Punjab but at a potentially higher intensity due to focused agricultural development programs in the division. The notable production increase in 2020-21 and 2021-22, where Punjab's output reached 115.7 thousand tons, underscores the division's critical role in this agricultural success.

Yield Superiority in Sahiwal

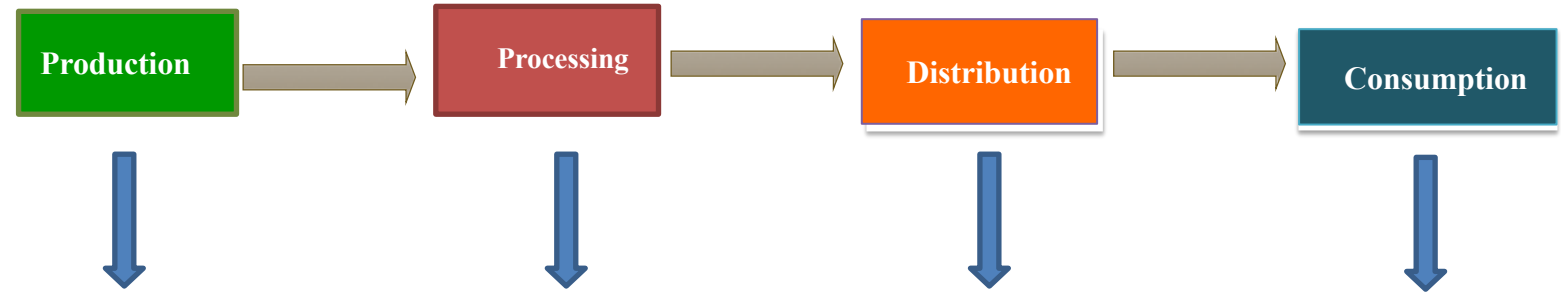
Sahiwal's sesamum yield consistently outperforms other regions. This superior yield is a result of several key factors:

1. **Agro-Climatic Conditions**: Sahiwal's climate is highly conducive to sesamum cultivation, providing optimal growing conditions that enhance yield quality and quantity.

2. **Advanced Farming Practices**: The adoption of modern farming techniques, including precision agriculture, better irrigation methods, and integrated pest management, has significantly boosted yields.

3. **Access to Technology and Inputs**: Farmers in Sahiwal have better access to high-quality seeds, fertilizers, and other agricultural inputs. This access is supported by government initiatives and agricultural research centers, which provide critical resources and training to farmers.

POTENTIAL FOR INVESTMENT IN SESAMUM



• The production of sesamum in the Sahiwal Division has been on the rise. This is a significant and favorable trend as it suggests that the local sesamum industry is growing and becoming more productive.	• Currently sesamum processing is missing in Sahiwal Division. • Various incentives are available for private sector investment, offering great potential for growth in the region.	• Currently, there is no state-of-the-art distribution system available in this region.	• Rising consumer demand for sesamum represents a promising investment opportunity in the Sahiwal Division. • 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

SESAMUM VALUE ADDED PRODUCTS

The value added products of sesame include sesame oil, sesame paste, baking additives, antioxidants, massage oil, feed, fertilizer, sesame biodiesel, pesticide, cosmetics ingredients, medical ingredients or to decorate other foods

SESAMUM INTERVENTIONS

Seed

To enhance the yield and quality of sesamum crops, it is crucial to provide high-quality seeds. Addressing the low yields of sesamum requires a dual approach: enhancing production both vertically and horizontally. Ensuring the availability of hybrid seeds through national and multinational seed companies is essential to achieve this goal.

Farm

To increase the production of oil seed crops, subsidies on inputs are necessary. Organizing seminars at the district level in sesamum-growing areas can create awareness about best management practices and advanced production technologies for selected crops. Recognizing and appreciating the best growers at the provincial and district levels can encourage farmers to adopt better practices. The development of model farms and the provision of specialized extension services are also critical to improving farm productivity.

Harvest & Logistics

Promoting mechanization in sesamum farming can significantly minimize post-harvest losses and improve yields. Capacity building of local human resources is essential to support this mechanization drive. Strengthening local research and development facilities in oilseed research institutes for sesamum will provide the necessary scientific support. Creating new jobs in the public and private sectors related to sesamum cultivation, processing, and logistics will further enhance the value chain.

Process

The establishment of oil extraction units in clusters can facilitate efficient processing. Promoting value addition by encouraging the development of processing units in the Sahiwal Division can boost sesamum exports. This development is crucial for increasing the economic viability of sesamum cultivation in the region.

Markets

Incentivizing the sesamum crop until market development can ensure sustained farmer interest and investment in sesamum cultivation. Establishing state-of-the-art sesamum markets will provide farmers with better access to buyers and fair prices, enhancing their income and contributing to the overall development of the sesamum sector.

11.5. VEGETABLE INTERVENTIONS

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.

13. RECOMMENDED INTERVENTIONS FOR AGRICULTURE

1. **Certified/ Quality Seed Development:** New Seed Varieties | Seed Replacement Program | Certification & Provision ***21 projects for Rs. 6,323 mn***
2. **On Farm Management:** IPM Practices | Availability of high quality inputs | Production Technologies ***27 projects for Rs. 12,736 mn***
3. **Mechanization:** Subsidy on Implements | Smart Tool Mechanization| Capacity Building ***10 projects for Rs. 3,726 mn***
4. **Logistics & Markets:** Model Markets | Storages and Warehouse | Grain silos ***17 projects for Rs. 7,135 mn***
5. **Value Addition Process:** Processing Units | Juice and Peeling Units | Ginning and Spinning Mills ***13 projects for Rs. 3,450 mn***
6. **Improve Water Efficiency:** Water Channel Improvement| HEIS | On Farm Water Storages ***5 projects for Rs. 14,981 mn***
7. **Structural Reforms:** Extension Services | Ease of Financial Access | Support Systems ***5 projects for Rs. 1,610 mn***

CROP SPECIFIC INTERVENTIONS

Crops	Seed	Farm	Harvest & Logistics	Process	Markets
Wheat	Seed replacement programs Special program for the Seed Companies for certified wheat seed production Implementation of amended seed act for wheat varieties registration Develop climate-smart high yielding, rust and heat-stress-tolerant varieties of wheat Scale up the foundation cell for seed program	Subsidy on Weedicide Subsidy on gypsum & green manuring	Development of Smart tools for mechanization especially for small farmers Subsidy on implements for wheat	Wheat value addition enhancement program	Establishment of Grain Silos
Onion	Development of Certified Seed (Pre-basic, basic, and multiplication) to the Farmer of Onion Local onion seed varieties replacement program	Provision of Inputs (Fertilizer, Pesticides, and Implements) on subsidy to develop onion cluster Provision of specialized extension services for vegetable crops	Capacity building and specialized labor for onion harvesting	Incentivize onion processing by development of onion by-products such as paste, dehydrated flakes, powder, rings, puree, vinegar, pickle, juice, and oil	Establishment of onion market in onion cluster

Crop	Seed	Farm	Harvest & Logistics	Process	Markets
Rice	Development of Certified Seed varieties (Pre-basic, basic and multiplication) Local rice seed varieties replacement program	Provision of Inputs (Fertilizer, Pesticides, and Implements) on subsidy	Capacity building and specialized labor for rice harvesting	Rice value addition enhancement program	Establishment of rice market in rice cluster
Ladyfinger	Development of Certified Seed varieties (Pre-basic, basic and multiplication) Local ladyfinger seed varieties replacement program	Provision of Inputs (Fertilizer, Pesticides, and Implements) on subsidy	Capacity building and specialized labor for ladyfinger harvesting	Ladyfinger value addition enhancement program	Establishment of ladyfinger market in ladyfinger cluster

Vegetables	Seed	Farm	Harvest & Logistics	Process	Markets
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	Capacity building and specialized labor for tomato harvesting	Establishment of CA (Control Atmosphere) storage by incentivizing its Import	Establishment of tomato market in tomato cluster

Melon	Establishment of melon seed systems Development of Certified Seed (Pre-basic, basic and multiplication)	Melon climate-smart agronomic practices Good Agricultural Practices (GAP) and Food Safety Management System (FSMS) Improve extension services or access to improved technology or demonstrations Climate change and climate smart agriculture	Melon harvesting and post-harvest management trainings Mechanization of watermelon production activities	Melon value addition enhancement program by creating linkages with Agri. Universities and Research institutes	Empower farmer groups to explore market opportunities by incentivizing them by giving them trainings

Crops	Phase	Interventions	Cost (Tentative) in Million Pkr
Potato	Short-term	Establish seed banks to provide certified seed potatoes to farmers at subsidized rates	314
	Short-term	Organize workshops in collaboration with local agricultural extension services to educate farmers on the advantages of certified seeds and training on cost-effective production practices	150
	Short-term	Conduct training sessions on proper storage and post-harvest handling practices.	90
	Short-term	Distribute informational materials on integrated pest management techniques	40
	Medium-term	Establish regional seed production centers for certified seed potatoes	200
	Medium-term	Encourage the establishment of small-scale processing units for value-added products	50
	Medium-term	Upgrade existing storage facilities and build new ones with modern technologies	250
	Medium-term	Collaborate with agricultural experts to develop an integrated disease and pest management strategy	50
	Medium-term	Introduce precision irrigation systems and techniques to maximize water use efficiency	300
	Medium-term	Facilitate affordable access to modern farming machinery through structured financing programs	250
	Medium-term	Advocate for and participate in initiatives to improve rural transportation networks	400
	Medium-term	Introduce and popularize mechanized grading and packing systems	70
	Long-term	Conduct long-term studies on the impact and benefits of sustainable practices in potato cultivation	400
	Long-term	Create a centralized hub for continuous research and development of innovative potato products.	450
	Long-term	Encourage collaboration between researchers, farmers, and industries to drive product diversification	300
	Long-term	Develop a nationwide network of state-of-the-art seed storage facilities	800
	Long-term	Develop long-term strategies for minimizing the impact of emerging diseases and pests on potato crops	200

	Long-term	Implement policies and practices for sustainable water use in potato cultivation.	200
	Long-term	Invest in research and development for locally adaptable and sustainable farming machinery	450
	Long-term	Collaborate with regional and local authorities to improve transportation networks in rural areas.	800
	Long-term	Provide subsidies and incentives for farmers adopting smart irrigation practices	450
	Long-term	Develop markets and distribution channels for organic potato products, both domestically and internationally	500
	Long-term	Collaborate with climate scientists to anticipate and mitigate the impact of climate change on potato farming	270
	Long-term	Develop a national forecasting system for predicting pest and disease outbreaks	300
Total			**7,284**

Crops	Phase	Interventions	Cost (Tentative) in Million Pkr
Maize	Short-term	Provide farmers with subsidized maize seeds to reduce the financial burden.	60
	Short-term	Conduct workshops and awareness programs to educate farmers on maize varieties suitable for changing climatic conditions.	80
	Short-term	Facilitate a program ensuring timely and sufficient availability of essential inputs such as fertilizers and pesticides.	170
	Short-term	Conduct campaigns on integrated pest and disease management practices, providing farmers with effective strategies.	60
	Short-term	Establish a digital platform or SMS service providing farmers with up-to-date market information. (50 MILLION)	50
	Medium-term	Establish a comprehensive seed system to ensure sustainable access to quality seeds.	80
	Medium-term	Collaborate with research institutions to develop and introduce climate-resilient maize varieties through field trials and farmer engagement programs.	150
	Medium-term	Conduct farmer field schools, demonstration plots, and extension programs to educate farmers on the benefits and proper usage of modern seed technologies.	200
	Medium-term	Implement an early warning system, conduct regular field inspections, and promote the use of biopesticides to control diseases and pests effectively.	100
	Medium-term	Collaborate with financial institutions to provide subsidized loans for farmers to purchase or lease modern farming equipment and machinery.	300
	Medium-term	Provide financial incentives and support to processing units for the adoption of modern technology, leading to increased efficiency and product quality.	450
	Medium-term	Support research and development for new maize-based products, provide training on value addition, and create market linkages for these products.	500

	Long-term	Establish community-managed seed banks, invest in research for locally adapted seed varieties, and implement training programs on seed saving and preservation.	250
	Long-term	Conduct long-term genomic research, implement genetic modification strategies for climate resilience, and establish a national gene bank for maize diversity conservation.	320
	Long-term	Implement land protection measures, and establish community watch programs.	100
	Long-term	Promote precision irrigation techniques, introduce drought-resistant maize varieties, and provide training on water-efficient farming practices.	270
	Long-term	Invest in the construction and upgrade of silage and drying facilities, encouraging private sector participation and community-based cooperatives.	320
	Long-term	Provide financial incentives and support to processing units for the adoption of modern technology, leading to increased efficiency and product quality.	400
	Long-term	Enhance transportation networks, and reduce post-harvest losses through better storage and transportation practices.	800
	Long-term	Establish export protocols, address quality standards, and promote maize products in international markets.	350
Total			**5,010**

Crops	Phase	Interventions	Cost (Tentative) in Million Pkr
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	250
		Introducing policy for incentivizing sesamum crop production till market development.	150
		Organizing competitions for the appreciation of best growers on provincial and district level.	150
		Arrange seminars at district level in core oilseed districts to create awareness about best management practices/production technology for selected crops during Rabi and Kharif season.	150
		Provision of inputs (Fertilizer, Pesticides and Implements) on subsidy to develop crop clusters.	533
		Promote mechanization for oilseed crops in order to minimize post-harvest losses and get good yields.	300

	Medium-term	Ensure Hybrid Seed Availability through National and Multinational Seed Companies.	300
		Incentivizing private sector by credit through banks for the establishment of Oil extraction units in clusters.	600
	Long-term	Establishment of state-of-the-art oilseed market with storage, packing and grading facilities to ensure quality.	160
Total			2,593

Crops	Phase	Interventions	Cost (Tentative) in Million Pkr
Lady Finger	Short-term	Seed replacement program; through multiplication of pre-basic and basic quality seed developed by VRI by introducing private seed companies to reduce import bill	314
		Provision of inputs (Fertilizer, Pesticides and Implements) on subsidy to develop ladyfinger cluster	171
	Medium-term	Organizing labor training programs with the help of VRI to ensure skill labor availability in the Crop Cluster	150
		Establishment of market in the crop cluster with storage, packing and grading facilities to ensure quality	200
		Establishment of value-added production unit by incentivizing private sector	60
	Long-term	Development of Certified Seed Varieties (Pre basic, basic and multiplication)	200
Total			1,095
	Short-term	Good Agricultural Practices (GAP) and Food Safety Management System (FSMS)	170
		Provision of High-Quality seed; through multiplication of pre-basic and basic quality seed developed by Research Institute by introducing private seed companies to reduce import bill	180
	Mediu	Introducing melon climate-smart agronomic practices with the help of HRI	110

Melon	m-term	Integrated soil and water management practices for melon production	
		Incentivize and subsidize farmers for melon harvesting and post-harvest management	130
		Incentivizing private sector by credit through banks for to introduce melon value addition	200
	Long-term	Incentivize and subsidize farmers for Mechanization of melon production activities	250
		Development of Certified Seed (Pre basic, basic and multiplication) to the Farmer of peas.	200
Total			**1,240**
Tomatoes	Short-term	Provision of inputs (Fertilizer, Pesticides and Implements) on subsidy to develop tomato cluster.	696
		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 Certified Seed (Pre basic, basic and multiplication) to the Farmer of Tomato.	300
Total			**1,876**

Crops	Phase	Interventions	Cost (Tentative) in Million Pkr
Wheat	Short-term	Provision of subsidized support for gypsum & green manuring	1117
		Provision of financial assistance for wheat cultivation implements	900
		Support seed replacement through subsidy programs	1300
		Financial assistance for weedicide Procurement for wheat	1200
	Medium-term	Development of Smart tools for mechanization especially for small farmers.	1000
		Special program for the Seed Companies for Wheat Seed Production.	700
	Long-term	Climate Smart breeding program (Rebreeding, Hybridization, and innovative technologies for various zones: Rust and heat stress tolerant varieties, Spring Wheat , Durum Wheat, Triticale etc.).	500
Total			**6,717**
Matter Peas	Short-term	Provision of inputs (Fertilizer, Pesticides and Implements) on subsidy to develop peas cluster.	696
		Local seed varieties replacement program.	300
	Medium-	Establishment of Peas paste production unit	200
		Establishment of food processing units in peas processing (frozen peas) to meet the local need during scarcity period	180

	term	Establishment of peas market in peas cluster.	200
	Long-term	Development of Certified Seed (Pre basic, basic and multiplication) to the Farmer of peas.	300
Total			1,876
Tunnel Farming of: Cucumber, Grapes, Strawberries, Bitter-Gourd, Onion, and Melon	Short-term	Conduct research to locally produce hybrid seeds of vegetables &Train farmers on seed breeding techniques to locally produce hybrid seeds of vegetables.	25
	Short-term	Establish a packing house in Dhanote for the vegetable cartel.	70
	Short-term	Grade vegetables to have an export-oriented approach.	30
	Short-term	Explore value-added opportunities, such as the production of pulps for strawberries and tomatoes.	80
	Short-term	Promote growing exotic vegetables like cherry tomatoes, asparagus, iceberg, and broccoli.	150
	Short-term	Establish cold stores at Multan airport to support the export of mangoes and vegetables & for vegetable growers to store their crops.	100
	Short-term	Improve the road infrastructure (Farm to Market) from Kehror Pakka to Mailsi to Vehari to Arif Wala to Burewala till Chichi Watni and Pakpattan.	200
	Medium-term	Provide financial assistance to farmers to maintain the supply chain.	15
	Medium-term	Develop seed varieties with universities and research institutes.	150
	Medium-term	Train farmers on grape pruning techniques and how to increase its shelf life.	10
	Medium-term	Certify nurseries to ensure plant sustainability.	30
	Long-term	Encourage tunnel farming in the region.	5
	Long-term	Establish a farm-to-market linkage.	15
	Long-term	Develop a 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
	Long-term	Increase the cultivation of sweet corn and explore its export potential.	70
Total			1,110

Crops	Phase	Interventions	Cost (Tentative) in Million Pkr
	Short-term	Establish seed banks to provide certified seed potatoes to farmers at subsidized rates	314
	Short-term	Organize workshops in collaboration with local agricultural extension services to educate farmers on the advantages of certified seeds and training on cost-effective production practices	150

Potato	Short-term	Conduct training sessions on proper storage and post-harvest handling practices.	90
	Short-term	Distribute informational materials on integrated pest management techniques	40
	Medium-term	Establish regional seed production centers for certified seed potatoes	200
	Medium-term	Encourage the establishment of small-scale processing units for value-added products	50
	Medium-term	Upgrade existing storage facilities and build new ones with modern technologies	250
	Medium-term	Collaborate with agricultural experts to develop an integrated disease and pest management strategy	50
	Medium-term	Introduce precision irrigation systems and techniques to maximize water use efficiency	300
	Medium-term	Facilitate affordable access to modern farming machinery through structured financing programs	250
	Medium-term	Advocate for and participate in initiatives to improve rural transportation networks	400
	Medium-term	Introduce and popularize mechanized grading and packing systems	70
	Long-term	Conduct long-term studies on the impact and benefits of sustainable practices in potato cultivation	400
	Long-term	Create a centralized hub for continuous research and development of innovative potato products.	450
	Long-term	Encourage collaboration between researchers, farmers, and industries to drive product diversification	300
	Long-term	Develop a nationwide network of state-of-the-art seed storage facilities	800
	Long-term	Develop long-term strategies for minimizing the impact of emerging diseases and pests on potato crops	200
	Long-term	Implement policies and practices for sustainable water use in potato cultivation.	200
	Long-term	Invest in research and development for locally adaptable and sustainable farming machinery	450
	Long-term	Collaborate with regional and local authorities to improve transportation networks in rural areas.	800
	Long-term	Provide subsidies and incentives for farmers adopting smart irrigation practices	450
	Long-term	Develop markets and distribution channels for organic potato products, both domestically and internationally	500

	Long-term	**Collaborate with climate scientists to anticipate and mitigate the impact of climate change on potato farming**	270
	Long-term	**Develop a national forecasting system for predicting pest and disease outbreaks**	300
Total			**7,284**

Crops	**Phase**	**Interventions**	**Cost (Tentative) in Million Pkr**
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	141
	Short-term	Provision of inputs (Fertilizer, Pesticides and Implements) on subsidy to develop garlic cluster.	130
	Medium-term	Organizing labor training programs with the help of VRI to ensure skill labor availability in the Crop Cluster	90
	Medium-term	Establishment of garlic market in garlic cluster with storage, packing and grading facilities to ensure quality.	110
	Medium-term	Incentivizing private sector by credit through banks for Establishment of Garlic powder and paste production unit	70
	Medium-term	Strengthen and capacity building programs for the provision of specialized extension services.	80
	Long-term	Development of Certified Seed (Pre basic, basic and multiplication) to the Farmer of Garlic.	245
	Long-term	Incentivize and subsidize farmers for Mechanization of Garlic production activities	220
Total			**1,086**

Crops	**Phase**	**Interventions**	**Cost (Tentative) in Million Pkr**
	Short-term	Local onion seed varieties replacement program	314

Onion	Short-term	Provision of inputs (Fertilizer, Pesticides and Implements) on subsidy to develop onion cluster	171
	Medium-term	Capacity building of labor for onion harvesting	150
	Medium-term	Establishment of 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	200
	Long-term	Development of Certified Seed Varieties (Pre basic, basic and multiplication)	60
Total			**1,095**
WATER EFFICIENCY			
WATER EFFICIENCY	Short-term	Climate Smart Water Management and Information Services	304
	Short-term	•Development of a Water Accounting System	
	Short-term	•Development of an Evapotranspiration-based Water Management System	
	Short-term	•Development of an Early Warning System	
	Short-term	•Provision of Information and Data to Facilitate Climate Change Adaptation	
	Short-term	Building on-Farm Resilience to Climate Change	348
	Short-term	•Development of practices for climate change resilient	
	Short-term	•Training of extension workers and farmer facilitators	
	Short-term	Establishment of Technology Transfer Centers (TTCs) in Sahiwal Division for the demonstration to enhance water use efficiency through;	655
	Short-term	•Farm layout planning/ designing, precision / LASER land leveling and water budgeting & accounting.	
	Short-term	•Provision of rapid soil testing kits to the farmers at TTCs for application of balanced fertilizer.	
	Short-term	•Fixation of pipe nakkas according to soil type and water flow for channelized stream flows.	
	Short-term	•Installation of flow measurement devices for open channels and tubewells for measuring the discharge of water for water accounting.	
	Short-term	•Installation of soil moisture monitoring gadgets.	
	Short-term	•Application of Alternate Wetting & Drying (AWD) and Direct Seeding Rice (DSR) water saving techniques in rice fields to increase the water productivity.	
	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
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.	
TOTAL		**16,243**