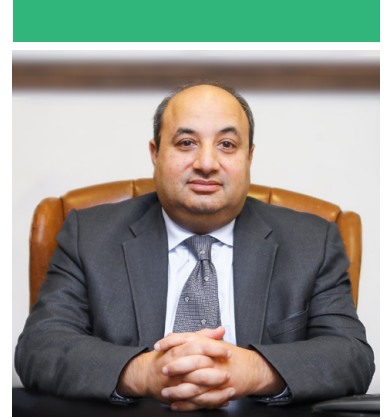


Agri-Tech Report 2024

Transforming Pakistan's Agriculture through
Innovation, Technology, and Policy Frameworks



Foreword by **Chairman**



In an era where technological advancements are reshaping industries worldwide, Pakistan's agriculture sector stands at a pivotal juncture. As a cornerstone of our economy, agriculture not only sustains livelihoods but also holds the potential for significant growth through innovation. Recognizing this, P@SHA has undertaken the Agri-Tech Report 2024 to explore how technology can address the challenges faced by our farmers and agribusinesses. This report delves into the integration of digital solutions within agriculture, aiming to enhance productivity, ensure sustainability, and drive economic prosperity. It is our hope that this comprehensive analysis will serve as a catalyst for collaboration among stakeholders, promoting an ecosystem where technology and agriculture converge to build a resilient and future-ready sector. I would like to extend my sincere gratitude to all the contributors, including the dedicated P@SHA Secretariat and expert reviewers, whose insights and commitment have brought depth and rigor to this report. It is our hope that this comprehensive analysis will serve as a catalyst for collaboration among stakeholders, promoting an ecosystem where technology and agriculture converge to build a resilient and future-ready sector.

Best Regards,

Sajjad Mustafa Syed

Chairman, P@SHA

Message by **Secretary General**



The Agri-Tech Report 2024 embodies P@SHA's commitment to leveraging technology for the advancement of Pakistan's agriculture sector. By providing data-driven insights and highlighting successful case studies, this report offers a roadmap for integrating digital tools into agricultural practices. Our objective is to empower farmers, agribusinesses, and policymakers with the knowledge to make informed decisions that enhance efficiency and sustainability. We extend our gratitude to all contributors whose expertise has enriched this report. Together, we can harness the power of technology to transform agriculture, ensuring food security and economic growth for our nation. This report is the result of the collective efforts of numerous contributors, the tireless P@SHA Secretariat, and our dedicated reviewers, each of whom has played a vital role in ensuring the report's quality and relevance. I extend my heartfelt thanks to each of them for their expertise and support.

Best Regards,

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Preface

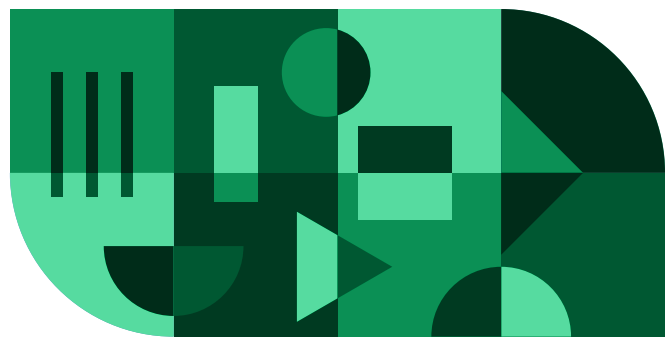


The P@SHA Agri-Tech Report 2024 is a pivotal resource designed to illuminate the untapped potential of Pakistan's agriculture sector through the lens of technology and innovation. For the members of the Pakistan IT Industry Association (P@SHA), this report opens new avenues for growth, collaboration, and investment in a sector that forms the backbone of Pakistan's economy. As the country's leading association of technology companies, P@SHA's role extends beyond conventional IT applications to embrace transformative solutions that can reshape entire industries. Agriculture, as Pakistan's largest sector, offers unprecedented opportunities for our member companies to create scalable, impactful technologies that address the sector's unique challenges and needs.

This report underscores the current state of agri-tech in Pakistan, delving into market dynamics, technological adoption patterns, and key challenges faced by both agribusinesses and farmers. By drawing on survey insights, expert opinions, and comparative analyses with regional advancements, the report offers a roadmap for how member companies can effectively bridge the existing gaps and accelerate the growth of this nascent ecosystem. For our members, this report provides not only a deep understanding of the sector's pressing challenges—from low adoption rates and skill deficits to policy constraints—but also showcases the areas where IT-based solutions like IoT, AI, blockchain, and data analytics can make a transformative impact.

Through this report, P@SHA highlights how its member companies can play an integral role in facilitating sustainable agriculture by developing digital marketplaces, enabling precision farming solutions, optimizing supply chains, and enhancing access to finance. The agri-tech sector in Pakistan presents a vast canvas for innovation, ripe for initiatives that can enhance productivity, promote climate resilience, and create efficiencies at every stage—from input selection to processing and market access. The report not only identifies the high-impact areas but also suggests actionable policy recommendations that, if supported by government and private-sector collaboration, can establish a robust agri-tech ecosystem benefiting the entire agriculture value chain.

Executive Summary



Pakistan, with its population currently at 242 million and growing at a rate of 2.55%, is on track to double by 2050. This rapid growth will place tremendous pressure on the country's agricultural production, especially in the context of food security. The agriculture sector is already grappling with challenges such as unpredictable climatic conditions and deteriorating soil quality, which have negatively impacted crop yields. **Agri-Tech services** have emerged as a critical driver for the future of agriculture, offering innovative solutions that enable farmers to boost production without relying on additional resources.

Snapshot of Global Agri-Tech Solutions:

- **In the U.S., precision agriculture** has increased yields by 15–20% while reducing resource use by 30%.
- **European farmers** (62% adoption rate) benefit from smart irrigation systems and farm management software, increasing water efficiency and sustainability.
- **The Netherlands**, through **vertical farming**, uses controlled environments to grow crops year-round, minimizing land use.

However, despite these global advancements, **Pakistan's Agri-Tech adoption remains** far below the global average.¹ Yet, the severe crop damage caused by the 2022 floods has highlighted the urgent need for these technologies, sparking growing interest among farmers.

Our survey data highlights that **Climate-Smart Agriculture Solutions and Agri-Finance** and **Insurance Services** are the most sought-after services in the local agritech market. Similarly, **Precision Farming Technologies, Market Linkages**, and **Capacity Building** are critical areas to address the challenges faced by the agriculture sector. **Supply Chain and Market Linkages and Cropping Systems** were identified as segments with substantial growth potential for agritech companies.

While global markets have seen rapid **Agri-Tech adoption**, Pakistan lags behind. Nonetheless, **Precision Agriculture and Agri-Fintech** are emerging technologies that hold promise for revolutionizing farming in Pakistan by optimizing resource use and financial management. **Advanced technologies** such as **AI, machine learning, and IoT** are just beginning to penetrate the market, offering solutions for improving access to inputs, mitigating price volatility, and enhancing productivity.

Impact of Agri-Tech Adoption in Pakistan

- **A precision farming project** in Punjab reported a 10% increase in yields and a 20% reduction in water usage.
- **Agri-Fintech** solutions have extended financial services to 25% of smallholder farmers, enabling better access to inputs.
- **Crop monitoring systems** used during the 2022 flood recovery helped recover 15% of threatened crops by identifying early pest infestations and water stress.

¹https://www3.weforum.org/docs/WEF_Agritech_2024.pdf

While Agri-Tech in Pakistan is in its infancy, these pilot successes emphasize the importance of scaling technology adoption to address local challenges effectively.

Existing solutions in Pakistan's Agri-Tech landscape have improved access to information and productivity, yet obstacles remain. Low adoption rates, a **fragmented ecosystem**, and skills shortages are critical issues. Additionally, policy and regulatory barriers—including the **lack of a comprehensive regulatory framework and limited access to finance**—are slowing the sector's growth. Addressing **logistical challenges** such as inadequate distribution networks, poor customer education, and infrastructure constraints is also essential for future expansion.

To overcome these challenges, **public-private partnerships** could emulate successful international models to create sustainable infrastructure for Agri-Tech in Pakistan. Building **an integrated ecosystem involving all stakeholders**—government, the private sector, and farmers—is crucial for scaling adoption and ensuring the long-term resilience of the agricultural sector. Focusing on **making technology affordable for smallholder farmers** and facilitating the necessary regulatory changes will be key to unlocking Agri-Tech's potential in Pakistan's future.





Introduction

Agriculture has long been the backbone of Pakistan's economy, employing nearly **half of the country's workforce and contributing 24% to its GDP**.² Historically, Pakistan's agricultural sector experienced rapid growth during the **Green Revolution of the 1960s and 1970s**. The introduction of high-yielding crop varieties, chemical fertilizers, and expanded irrigation systems led to significant productivity gains, establishing Pakistan as a food-secure nation. However, by the 1980s, these gains began to stagnate. Over-reliance on traditional methods, inefficient irrigation systems, and limited access to modern agricultural inputs **started to erode** the sector's growth. **Socio-political challenges**, such as inequitable land distribution and inadequate investment in rural infrastructure, further compounded the sector's decline.

In recent decades, the sector has been burdened by **unpredictable climate patterns, deteriorating soil quality, and water scarcity**, all of which have severely impacted crop yields. The catastrophic floods of 2022 revealed the vulnerability of the agriculture sector to climate-induced shocks, intensifying the need for resilient and innovative solutions. Despite these growing challenges, Pakistan has been slow to adopt modern agricultural technologies, leading to a critical juncture where **technological innovation** is not just an option but a necessity for **ensuring food security**.

Globally, the Agri-Tech sector is expanding at an unprecedented rate, with a market size of **USD 24.5 billion in 2023**, projected to reach **USD 76 billion by 2032**.³ While North America and Europe lead in adoption, countries like India have made significant strides in integrating technology into agriculture. India's agri-tech sector is set to grow exponentially, supported by hundreds of startups and innovations that address everything from farm management to market access.⁴

In contrast, Pakistan's agri-tech ecosystem remains nascent, despite the size and significance of its agriculture sector. The adoption of **precision farming, climate-smart agriculture, and digital tools** has been slow, mainly due to infrastructure constraints, **limited access to finance, and a lack of awareness** among farmers. However, the urgency for technological intervention has never been greater. According to estimates, adopting Agri-Tech solutions in Pakistan could **increase crop yields by 30% and reduce post-harvest losses by 75%**, potentially generating an additional **USD 8-10 billion** in economic impact annually.⁵

² <https://www.pbs.gov.pk/content/agriculture-statistics#:~:text=Introduction,source%20of%20foreign%20exchange%20earnings>.

³ <https://www.sphericalinsights.com/reports/agritech-market>

⁴ https://www.bain.com/globalassets/noindex/2021/bain_brief_indian_agriculture_ripe_for_disruption.pdf

⁵ <https://tabadlab.com/wp-content/uploads/2022/07/AgriTech-Report-07-07-22.pdf>

While some initiatives from the public sector—through the State Bank, SECP, and various provincial governments—have sought to create a more conducive regulatory environment, much more needs to be done. This report aims to provide a **comprehensive analysis** of Pakistan’s agri-tech landscape, drawing on **primary data** collected from key stakeholders, including farmers, private sector companies, and policymakers.

The report identifies key challenges, such as the **fragmented ecosystem, policy gaps, and infrastructural deficiencies**, while outlining the potential of emerging technologies like **precision agriculture, AI, and blockchain** to revolutionize Pakistan’s agriculture. The report also highlights opportunities for scaling up successful solutions by leveraging global best practices, with the ultimate goal of building a resilient, efficient, and **sustainable agri-tech** ecosystem that meets the needs of Pakistan’s growing population.



Methodology



This research employed a mixed-methods approach, integrating both quantitative and qualitative methodologies, as well as primary and secondary data sources. The quantitative component consisted of a survey distributed to approximately **250 entities**, including agri-tech start-ups, firms, and individuals across Pakistan, with a few participants from the U.S. Of these, **32 entities** responded, representing a significant cross-section of the agri-tech ecosystem.

The qualitative component involved semi-structured, in-depth interviews with key experts selected from the survey respondents. These interviews provided deeper insights into sector trends, challenges, and opportunities. Secondary data was also collected from academic articles, industry reports, and other publications to contextualize the findings and compare global trends with Pakistan's agri-tech landscape.

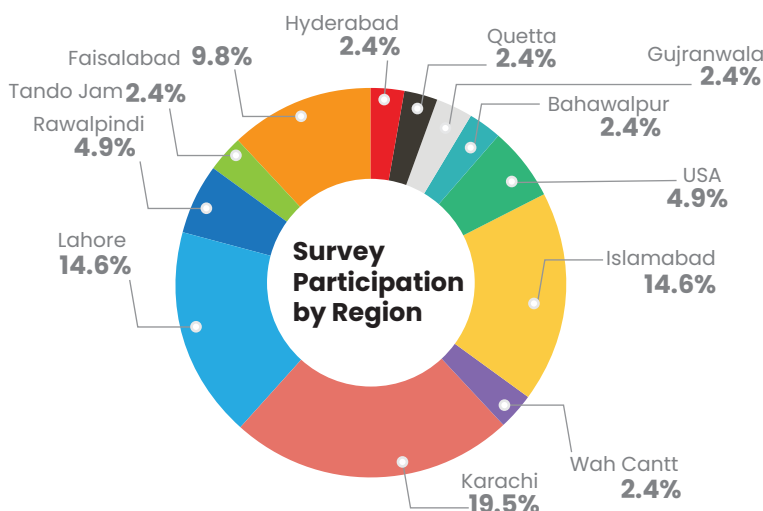
Sampling Strategy and Rationale

The sampling aimed to include a diverse range of agri-tech players, from start-ups to established firms to provide a comprehensive view of the sector. While the sample size of 32 is relatively small, it captures a significant portion of active participants in Pakistan's nascent agri-tech ecosystem.

Limitations

The voluntary nature of participation introduces potential self-selection bias, as more established or motivated entities may have been more likely to respond. Additionally, the sample size may limit the generalizability of findings, particularly for smaller or underrepresented regions. While the interviews offered in-depth insights, they may reflect subjective views, further influenced by the limited geographical diversity of respondents.

Despite these limitations, the data provides a robust snapshot of the current state of Pakistan's agri-tech sector and offers a strong foundation for future policy development.

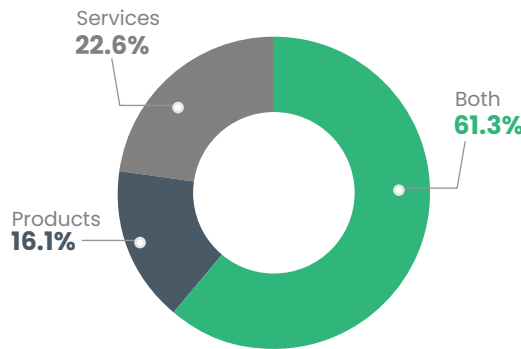


For contributing to our survey, agri-tech firms and start-ups from Karachi lead with 19.5% of responses, followed by Lahore and Islamabad at 14.6%. Agri-tech companies and start-ups from Faisalabad also contributed significantly at 9.8%. Similarly, participating firms are also based in Rawalpindi, Hyderabad, Quetta, Gujranwala, Bahawalpur, Wah Cantt, and TandoJam. Interestingly, few Agri-tech companies that operate from the US also participated in the survey. This indicates a wide geographical spread of responses, with a concentration in major cities like Karachi, Islamabad, and Lahore

Significant Insights from the Survey & Expert Consultations

1. Company Category

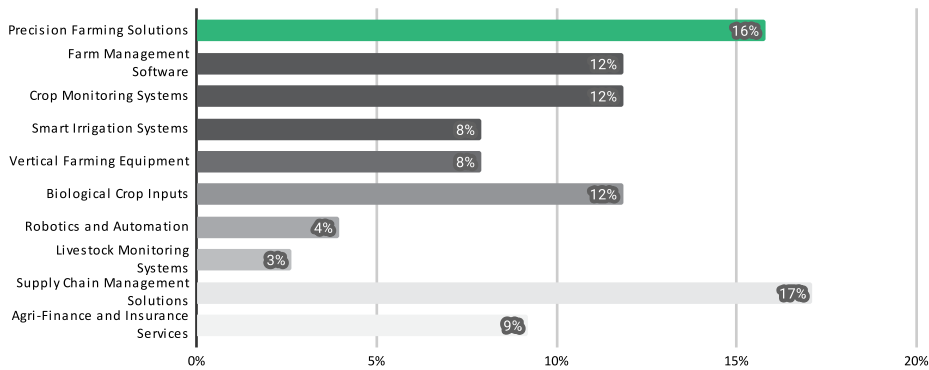
Q. What category of Agri-Tech does your company fall in?



The agritech sector in Pakistan represents a dynamic and multifaceted approach to modern agriculture, effectively combining both product and service offerings to create a robust ecosystem that supports farmers and enhances agricultural productivity. This dual focus is crucial for addressing the complex challenges faced by the agricultural industry, including resource scarcity, climate change, and the need for increased efficiency. Interestingly, the emphasis on both products and services fosters a more sustainable approach to agriculture. Companies that provide data-driven insights and precision farming techniques enable farmers to use resources more efficiently, reducing waste and minimizing environmental impact. This is particularly important in a country like Pakistan, where water scarcity and soil degradation are pressing concerns. By promoting sustainable practices, agritech companies contribute to the long-term viability of the agricultural sector and help ensure food security for the growing population.

2. Products/Services Specification

Q. Please specify the Product(s)_Service(s) your company offers in the realm of Agri-Tech



Agri-tech companies in Pakistan offer diverse solutions addressing logistical, financial, and productivity challenges, closely aligning with regional market demands. The majority focus on **supply chain management solutions** to improve **logistics, traceability, and distribution efficiency**. Companies like **Mandi Express** and **Peepu** facilitate

farm-to-market connections, showing promising adoption in Punjab and Sindh, though infrastructure limitations affect rural uptake. This trend mirrors regional priorities, as seen in **India** and **Indonesia**, where supply chain platforms like e-NAM and Tanihub bridge gaps in market access.

Precision farming and crop monitoring tools, such as those from **ITROOS** and **AirNex**, are helping Pakistani farmers optimize resource use through IoT and satellite-based insights, particularly in water-scarce areas. Although adoption remains low in Pakistan, similar solutions have gained traction regionally to address climate variability and improve productivity.

Farm management software and biological crop inputs are also gaining traction, particularly among medium to large farms in Punjab, with companies like **Concave Agri Services** and **Vital Agri Nutrients** leading the market. Sustainable inputs, including organic fertilizers, are being adopted in Sindh, aligning with global moves toward eco-friendly farming but are still in early stages, especially in regions favoring traditional methods.

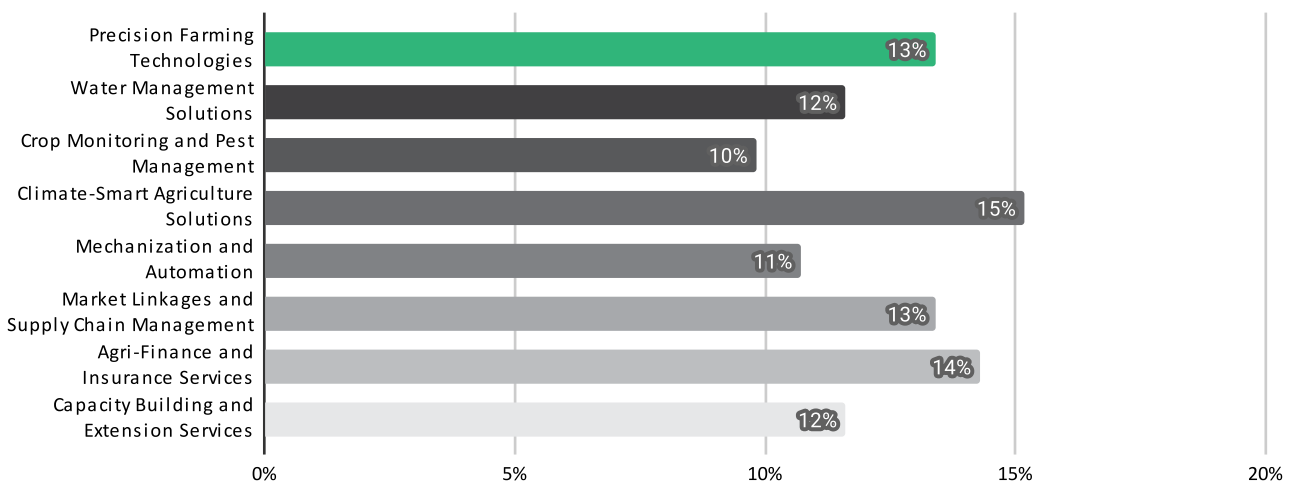
Finally, **agri-finance and insurance services** provided by firms like **Tagmu** and **Peepu** are meeting growing demand in KPK, where farmers seek financial resilience against climate risks. While urban areas show higher adoption, fintech solutions aimed at rural smallholders offer significant growth potential, reflecting a broader South Asian trend toward expanding financial access through micro-finance and insurance.

In general, solutions tailored to local agricultural conditions, focusing on cost-effectiveness and ease of use, have better adoption rates and resonate well with regional efforts across **South Asia** to enhance productivity, resilience, and market connectivity for farmers.

3. Market Demands



What are the Most Common Current Market Demand(s) for Agri-Tech Solutions in Pakistan?



Survey insights reveal a strong demand in Pakistan for **climate-smart agriculture solutions and agri-finance and insurance services**, driven by farmers' need to adapt to climate challenges and manage financial risks.

Precision farming technologies, market linkages, and supply chain management solutions are also highly sought, reflecting the priority placed on optimizing resources and ensuring market access.

- **Capacity building and extension services** are equally significant, highlighting the need for training and support to help farmers integrate new practices.
- Meanwhile, **water management and mechanization solutions** are critical as Pakistan faces severe water scarcity and requires productivity enhancements to meet growing agricultural demands.
- Improvements in **market infrastructure, logistics, and digital connectivity**, along with targeted educational campaigns, can further drive the adoption of these agri-tech solutions.

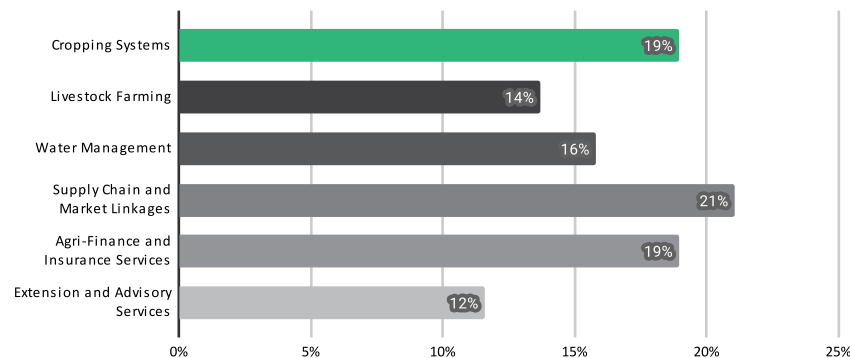
Regional Analysis of Agri-Tech Market Demand

- The demand trends in Pakistan align with those across **South Asia**, where **climate-smart agriculture, precision farming, and efficient supply chain solutions** are similarly prioritized.
- **India's** National Mission for Sustainable Agriculture and **Bangladesh's** microfinance options promote climate resilience by supporting drought-resistant crops and efficient irrigation, offering models for Pakistan's climate adaptation strategies.
- **India's** e-NAM and **Indonesia's** Tanihub platforms reduce intermediaries, ensuring fair prices for farmers—a need reflected in Pakistan's demand for market linkages.
- Water management remains critical across the region, with initiatives like **India's** Pradhan Mantri Krishi Sinchayee Yojana (PMKSY), which provides funds for water-efficient irrigation and machinery to smallholders; and **Bangladesh's** solar-powered pumps enhancing water efficiency.
- Extension services like **India's** Kisan Suvidha have proven effective in delivering digital advisories, illustrating how Pakistan can improve farmer training for broader technology adoption.
- Adopting such approaches can drive Pakistan's agri-tech sector toward enhanced **productivity, sustainability, and financial stability.**

4. Agri-Tech Sub-Segments with most Potential



What are the Key Segments or Sectors within the Agriculture Industry that Offer the most Potential for Agri-Tech companies?



Survey results indicate that **Supply Chain and Market Linkages** have the most potential, reflecting the urgent need to improve the efficiency, transparency, and reliability of Pakistan's agricultural supply chain. Enhancing these market linkages is essential to ensure that farmers can access broader markets and secure fair pricing for their produce.

Companies like **Mandi Express and Peepu** in Pakistan have already made strides in this area by connecting farmers directly with consumers, reducing intermediaries, and improving price transparency. Similarly, **India's Ninjacart** has transformed its supply chain by optimizing the farm-to-market timeline, reducing food spoilage, and ensuring fair returns to farmers.

Cropping Systems and Agri-Finance and Insurance Services are also viewed as promising. In Pakistan, companies like **Tazah Technologies** have developed precision farming and crop management solutions, helping farmers make data-driven decisions to enhance yield and resource use. Regionally, **India's Agrostar** offers real-time data analytics to optimize fertilizer and water use.

The demand for Agri-Finance and Insurance Services reflects the increasing need for tailored financial solutions for agriculture. Companies such as **Tagmu** and **Vital Green** in Pakistan, along with **Samunnati in India**, have successfully provided accessible credit and insurance services that cater to smallholder farmers, addressing the sector's unique risks.

Livestock Farming is another sector with significant potential. Pakistani firms like **Concave Agri** are developing technologies that enhance livestock health and productivity, while in **India, Stellapps** uses IoT and AI to optimize dairy farming operations, leading to better herd management and higher milk production.

In the areas of Water Management and Extension and Advisory Services, there is moderate potential, but the significance cannot be understated given Pakistan's water scarcity issues. Companies such as **RemoteWell** and **Khaiti Technologies** are addressing water conservation through smart irrigation solutions.

Similarly, **Jain Irrigation in India** has had considerable success with water-efficient drip irrigation systems, reducing water consumption while maintaining crop yields. Extension services that provide farmer education and capacity-building initiatives are equally critical for helping farmers adopt new technologies and practices effectively.

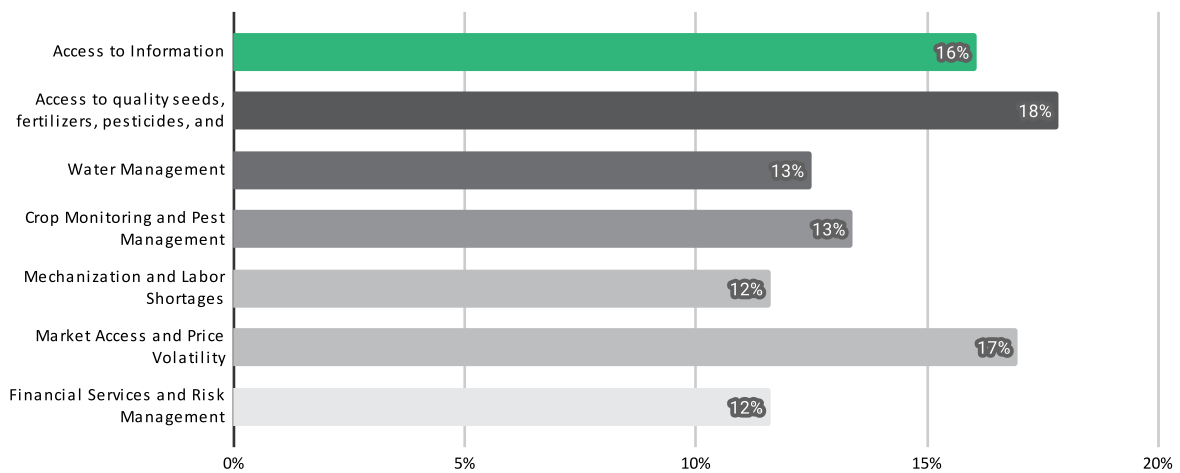
Sustainability Benefits:

- Across these sub-sectors, agri-tech innovations contribute significantly to **environmental sustainability**. Precision farming and water management technologies help conserve vital resources such as water and fertilizers, while enhancing crop productivity. Efficient supply chains like those implemented by **Mandi Express** and **Ninjacart** reduce food waste and cut emissions by streamlining logistics. Agri-finance solutions empower farmers to adopt climate-resilient technologies, improving their long-term sustainability. Overall, these innovations not only boost agricultural productivity but also support resource conservation, emission reduction, and climate resilience—key for building a sustainable future for Pakistan’s agriculture sector.

5. Farmers’ Critical Needs and Pain Points



What are the Primary Needs and Pain Points of Farmers that Agri-Tech Solutions could Address?



Survey insights reveal that the most significant pain points for farmers include **accessing markets, managing price fluctuations, and obtaining timely, relevant information**. These issues highlight a pressing need for improved market linkages, real-time data access, and better financial services. However, one of the main barriers to adopting Agri-Tech solutions is the limited technology access and digital literacy among farmers, particularly in rural Pakistan. Many farmers, especially smallholders, either lack access to smartphones and internet connectivity or do not have the technical skills to utilize digital platforms effectively.

Technology Access and Literacy Issues

- According to recent data, approximately **40% of Pakistan’s rural population lacks access to the internet**, limiting their ability to use Agri-Tech platforms. While smartphone penetration is growing, many farmers still use basic mobile phones, limiting their access to more advanced digital services.
- Even among farmers who own smartphones, many struggle with **navigating apps or interpreting the data provided by Agri-Tech solutions**. This low digital literacy hinders the effectiveness of technology adoption, as farmers are unable to fully exploit the benefits of these tools.

Policy Suggestions for Improving Adoption

Infrastructure Development

The government needs to prioritize **expanding internet access in rural areas**. Investment in rural broadband and mobile networks is crucial for enabling farmers to connect to digital platforms that provide **market, weather, and crop health information**.

Public-private partnerships (PPP) can play a significant role in financing and developing digital infrastructure, ensuring that Agri-Tech solutions are accessible even in remote farming communities.

Digital Literacy and Capacity Building Programs

Launching farmer education programs focused on digital skills is essential to ensure that farmers can effectively use **Agri-Tech tools**. These programs could include hands-on training sessions on how to use smartphones, mobile applications, and platforms offering **market linkages or crop management**.

Establishing farmer field schools could provide **localized, on-the-ground training, combining digital literacy** with agricultural extension services.

Mobile-First Solutions

Since a significant portion of farmers still use basic mobile phones, Agri-Tech solutions should prioritize **SMS-based services for disseminating information**. Simple, easy-to-understand SMS alerts for **weather, market prices, and pest control** can have an immediate impact.

Voice-based services in local languages could be another effective solution, ensuring inclusivity for those with lower literacy levels.

Subsidies for Technology Access

The government can introduce **subsidies or financing schemes** that make smartphones and data plans more affordable for smallholder farmers. This could be part of a broader rural digital inclusion policy.

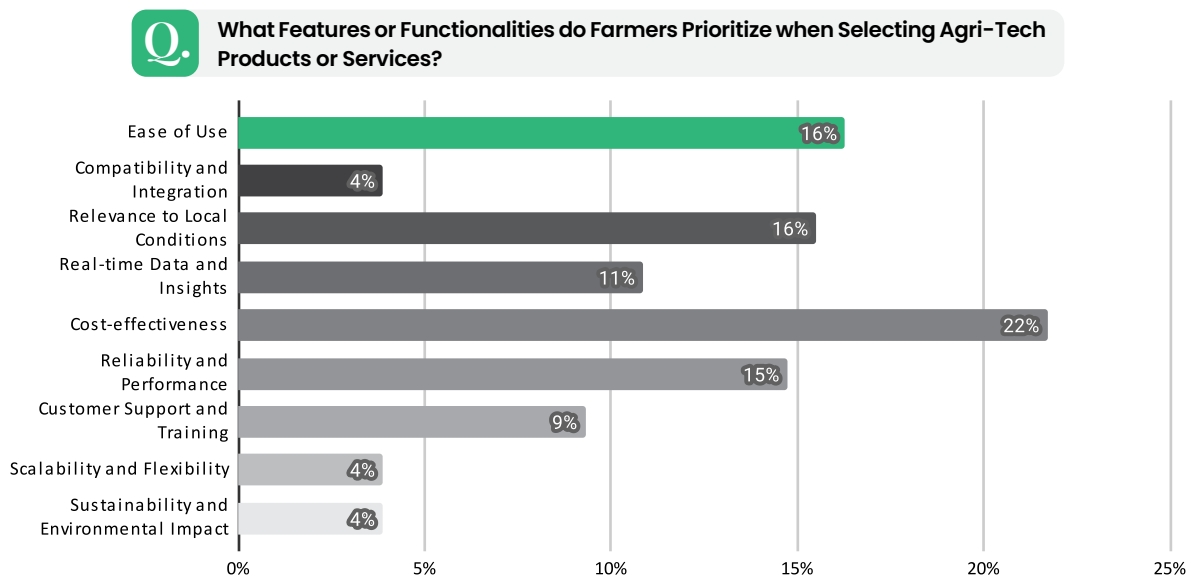
Special incentives could be provided to Agri-Tech companies that develop **affordable or low-tech solutions designed for smallholder farmers** in rural areas.

Successful Government Interventions from Other Countries

■ **India's eNAM (National Agriculture Market)** is a digital platform that has successfully connected over 1,000 wholesale markets across the country, enabling farmers to sell their produce online, bypassing intermediaries. This has improved price transparency and market access for farmers. Pakistan could replicate a similar system to address market linkage issues and price fluctuations faced by farmers.⁶

■ **Kenya's M-Pesa**, a mobile-based money transfer system, has been highly successful in offering financial services to rural farmers, allowing them to access credit and insurance through their mobile phones. Pakistan could introduce mobile-based financial products that provide easy access to credit and crop insurance to address farmers' financial needs.⁷

6. Features & Functionalities Farmers Prioritize



Farmers in Pakistan prioritize **affordability, ease of use, localization, and access to real-time data** when selecting agri-tech products and services.

Public and Private Sector Alignment

Currently, both public and private sectors have made efforts to address these priorities but face challenges. Public sector initiatives, such as subsidies and support programs, aim to make solutions more affordable, but many are still limited in scope. Private companies like **Mandi Express, Vital Green, ITROOS and Peepu** focus on localized solutions but often operate in silos, without adequate integration into broader farming ecosystems. While some private providers offer real-time data platforms, such as crop monitoring, there is still a gap in ensuring widespread adoption and ease of use for less tech-savvy farmers.

Strategies for Improvement

■ Regional best practices from India and Bangladesh show that public-private partnerships (PPPs) in microfinance and insurance schemes can enhance affordability. For example, India's Pradhan Mantri Fasal Bima Yojana (PMFBY) provides government-backed insurance for farmers. Pakistan can adopt similar PPP models to reduce financial risks for farmers.

⁶ https://enam.gov.in/NAMV2/home/about_nam.html

⁷ <https://www.vox.com/future-perfect/21420357/kenya-mobile-banking-unbanked-cellphone-money>

Sri Lanka has launched farmer training programs to increase technological literacy, a practice that Pakistan could replicate. Workshops and mobile-based tutorials could improve farmers' comfort with new technologies.⁸

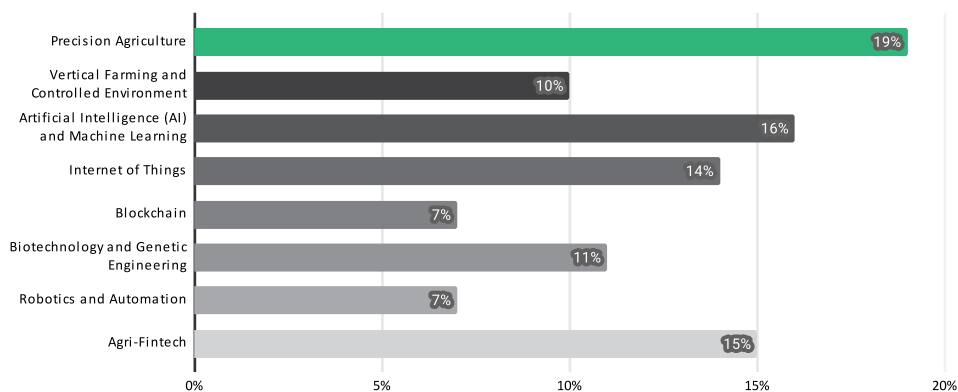
Rather than relying solely on foreign technology, Pakistan needs **localized agri-tech solutions** tailored to specific climatic and soil conditions. Private sector collaboration with universities and research institutions could foster innovation in this area.⁹

In **India**, apps like **IFFCO Kisan** provide real-time weather and crop information, which Pakistan could emulate to ensure farmers receive timely updates on crop conditions, market prices, and best practices.¹⁰

7. Emerging Technologies



What are the emerging technologies with the potential to revolutionize the Agri-Tech sector in Pakistan?



Survey insights highlight the potential of **emerging technologies** in transforming Pakistan's Agri-Tech sector. **Precision Agriculture** stands out, involving the use of data-driven technologies such as GPS-guided equipment, soil sensors, and satellite imagery to optimize farming practices, reduce waste, and increase yields. **Agri-Fintech** is also highly valued, offering access to credit, insurance, and payment systems to better manage financial risks and improve inclusion. The use of **AI and Machine Learning** helps analyze data for predicting yields, detecting diseases, and optimizing supply chains, while **IoT enables real-time monitoring** of crops, soil conditions, and weather for more efficient farm management. **Vertical Farming and Controlled Environment Agriculture** present solutions for growing crops in controlled environments, particularly beneficial in urban areas or regions with adverse climates, enabling year-round production and reduced water usage.

Renewable Energy Solutions

Solar-Powered Irrigation Systems have emerged as a sustainable solution, especially in rural areas with **limited access to electricity**. These systems use **solar panels** to power water pumps for irrigation, reducing dependence on grid electricity or diesel-powered pumps. **Solar irrigation** significantly lowers operational costs for small-scale farmers and helps mitigate water shortages, particularly in water-scarce regions like Balochistan and Sindh.

In **Punjab**, solar irrigation systems have been implemented under government-backed programs. For **small-scale farmers**, the initial installation cost of solar pumps can be recouped within 2-3 years due to savings in fuel and electricity costs. Studies show that farmers using solar pumps can reduce their irrigation expenses by up to **75%**, with increased crop yields leading to higher profitability. Additionally, **solar-powered systems** reduce carbon emissions, contributing to a cleaner, more sustainable agricultural sector.

⁸ <https://pmfby.gov.in/>

⁹ <https://www.themorning.lk/articles/FBCA2wOHgflqT4lw3qw>

¹⁰ <https://krishijagran.com/agripedia/top-10-agricultural-mobile-apps-for-farmers-in-2021/>

Post-Harvest Technologies

Post-harvest losses are a critical challenge in Pakistan, with up to **30–40%** of fruits and vegetables lost due to poor storage and handling. **Cold Chain Technology and Smart Storage Systems** are pivotal in reducing these losses. Cold storage facilities, integrated with IoT sensors, help monitor and maintain optimal storage conditions for perishable goods, while low-tech solutions like **solar-powered cold rooms** offer affordable options for smallholder farmers.

In **India**, smallholder farmers using low-cost solar-powered cold storage units have significantly reduced post-harvest losses. A typical small-scale unit can extend the shelf life of perishable produce by **3–4 days**, allowing farmers more time to find buyers at favorable prices. The cost of a solar cold storage unit can be offset in **1–2 harvest seasons** due to reduced wastage and improved market prices. These systems are especially beneficial for **remote areas** with limited access to conventional electricity.

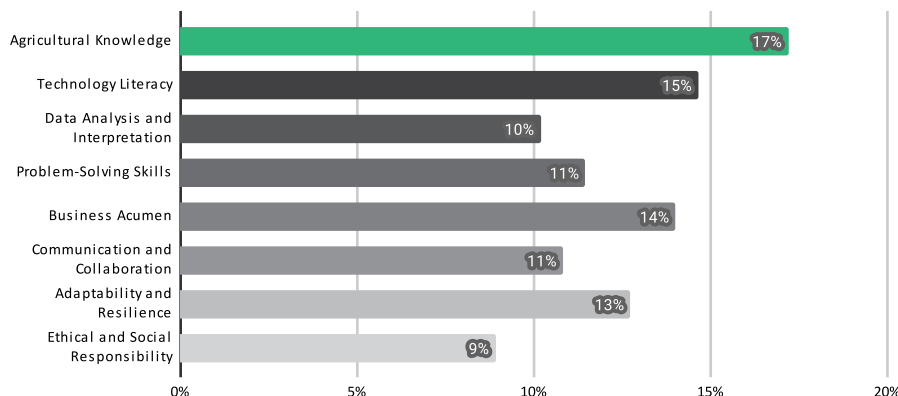
Cost-Benefit Analysis for Small-Scale Farmers

The average cost of installing a solar-powered irrigation system ranges from **\$3,000 to \$4,500** for a small-scale setup. Over five years, savings on fuel or electricity can amount to **\$2,000 to \$3,000**, with increased yields adding an additional **\$1,500 annually**. The environmental benefits, including **reduced carbon emissions** and more **efficient water use, make this a long-term, sustainable investment**.

A solar-powered cold storage unit costs **approximately \$2,000**. This investment can result in a **15–20% increase** in farmer revenue by **reducing post-harvest losses** and allowing for better market prices. Over two seasons, the investment can be fully recouped, while offering ongoing benefits for **storage efficiency and sustainability**.

8. Required Skills and Expertise

Q. What are the Key Skills and Expertise Required to Succeed in the Agri-Tech Sector?



Survey findings highlight the most critical skills for success in **Pakistan's agri-tech sector**. First, a deep understanding of agricultural practices is foundational for developing relevant **Agri-Tech solutions** that align with the country's unique farming conditions. Additionally, strong business skills, including market dynamics, financial management, and strategic planning, are highly valued for ensuring the commercialization and sustainability of **Agri-Tech innovations**. Proficiency in technology—such as digital tools, software, and emerging agricultural technologies—is also vital for leveraging advancements like **precision farming and IoT**. Furthermore, the ability to adapt to changing circumstances, learn from failures, and continuously evolve strategies is crucial for navigating the fast-evolving sector.

Current Capacity-Building Programs

Pakistan currently lacks a comprehensive national framework for Agri-Tech-specific training, although several institutions and programs offer agricultural and technical skills development. Major agricultural universities, such as the **University of Agriculture, Faisalabad** and **Sindh Agriculture University**, provide degree programs in agricultural sciences, which include components on modern technology use. The **Punjab Agricultural Research Board (PARB)** and **National Institute of Biotechnology and Genetic Engineering (NIBGE)** also play roles in fostering research and technology development in agriculture. However, these institutions primarily focus on traditional agriculture rather than the integration of cutting-edge digital technologies, business, and entrepreneurship skills needed for agri-tech solutions.

In the private sector, a few incubators and accelerators, such as **NIC Karachi** and **Telenor Velocity**, have started nurturing Agri-Tech startups, but these initiatives are limited and concentrated in urban areas, leaving rural regions underdeveloped.

Gaps and Opportunities

There is a pressing need to create specialized capacity-building programs that focus on developing both technological proficiency and entrepreneurial acumen among agricultural professionals. This includes offering hands-on training in **precision farming, digital tools, supply chain technologies**, and business development to empower individuals in rural areas where agriculture is most prevalent.

Suggested Training Modules and Programs

Establish dedicated innovation hubs in key agricultural regions such as Punjab, Sindh, and Khyber Pakhtunkhwa. These hubs would offer workshops on topics like **precision agriculture, IoT integration, and data analytics, in collaboration with local universities, businesses, and technology firms**. These centers could also serve as demonstration sites for emerging technologies, helping farmers understand how to implement them in their own operations.

To address the rural-urban gap in access to **technology training, mobile units** could be deployed to deliver short courses on digital literacy, business planning, and the use of specific technologies like **drones or solar-powered irrigation systems**. These units could partner with local agricultural extension officers to ensure tailored content delivery in local languages.

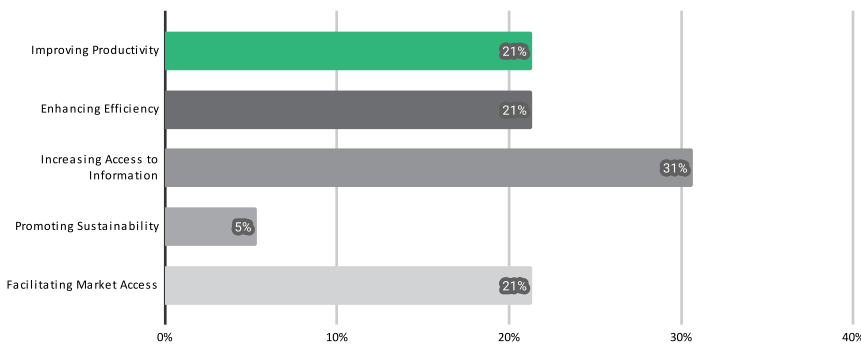
Focused programs aimed at developing **entrepreneurial skills in rural regions** should be established. These boot camps would help Agri-Tech entrepreneurs in business planning, accessing markets, and understanding regulatory requirements. They could also provide networking opportunities with investors and financial institutions.

In order to scale capacity-building efforts, training programs for agricultural extension officers and other local influencers could be established. These programs would equip local trainers with the skills necessary to teach farmers about new technologies, sustainable practices, and digital solutions.

9. Strengths and Weaknesses of existing Agri-Tech Solutions



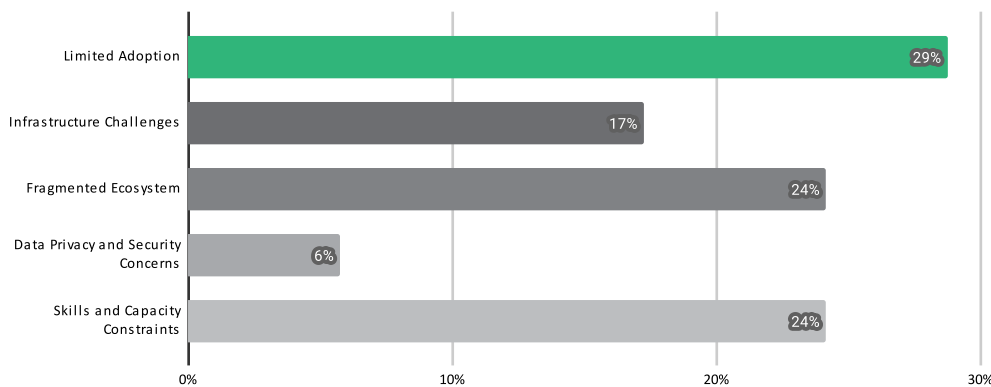
What are the Strengths of Existing Agri-Tech Solutions in the Market?



Survey insights highlight the strengths of current Agri-Tech solutions, particularly their ability to provide farmers with **critical data on weather, market prices, and best practices**, empowering them to make more informed decisions.



What are the Weaknesses of Existing Agri-Tech Solutions in the Market?



There are several weaknesses to address, such as **limited adoption due to lack of awareness, affordability issues, and a reluctance to adopt new technologies**. A fragmented ecosystem and infrastructure challenges—like poor internet connectivity and electricity in rural areas—also hinder the scalability of these technologies.

Scaling Successful Agri-Tech Solutions Across Farm Sizes and Regions: Adaptability to Farm Sizes

Small-scale farms often have lower investment capacities and may require more affordable, user-friendly technologies compared to larger commercial farms. Successful scaling would involve offering tiered solutions—basic tools for smallholders (such as mobile-based platforms for market access or simple weather data) and advanced solutions (such as precision farming systems) for larger farms. For instance, **Kenya's M-Pesa** platform has successfully scaled to small farmers by offering mobile-based financial services tailored to their needs.

Regional Customization

- Different regions in Pakistan face unique challenges—ranging from water scarcity in Sindh to infrastructure gaps in Balochistan. Technologies must be tailored to local conditions. In regions with scarce water resources, scaling **solar-powered irrigation technologies** like those used in **India's Gujarat state** could be beneficial. Likewise, areas with poor internet connectivity could benefit from **offline-compatible Agri-Tech** tools that sync data when a connection becomes available.

Government Role in Encouraging Adoption

- The government can play a key role in incentivizing the use of Agri-Tech solutions. Examples like **India's PM-Kisan scheme**, which provides direct income support to farmers, could be paired with conditional grants for adopting technology, ensuring that farmers receive financial incentives to use modern tools. Additionally, **public-private partnerships (PPPs)** could be established to provide farmers with subsidized access to these technologies.

Infrastructure Development

- Improving rural infrastructure—particularly in terms of internet access, electricity, and transportation networks—is essential for the wide-scale deployment of **Agri-Tech solutions**. Using renewable energy like solar power to run off-grid systems for irrigation, cold storage, and other essential operations would enable farmers to overcome power shortages. In **India**, **solar-powered irrigation pumps** have been successfully scaled, reducing reliance on erratic electricity supplies.

Building Skills and Capacity

- For successful scaling, it is crucial to **train farmers and other stakeholders** on how to effectively use these solutions. Localized training programs should be established, potentially modeled on the **Farmer Field Schools approach** used in Southeast Asia, where practical, community-based training sessions are conducted to help farmers adopt new practices. In conjunction with Agri-Tech companies, government agencies can create extension programs that focus on **teaching farmers** how to use mobile applications, sensors, and other tech tools.

Comparison with Global Best Practices

- **Drip irrigation, invented in Israel**, has been globally adopted due to its efficiency in water usage, particularly in arid regions. Scaling this technology across Pakistan's water-scarce regions could greatly conserve resources while improving crop yields.¹¹
- **India's** success with mobile platforms like **AgroStar** and **DeHaat**, which provide farmers with real-time advice, input supplies, and access to buyers, shows how digital platforms can be tailored to smallholders. These models could be adapted for Pakistan, where a significant percentage of farms are small-scale and would benefit from accessible digital services.¹²
- The **M-Pesa mobile money platform in Kenya** has revolutionized access to finance for smallholder farmers, enabling them to make payments, save money, and access credit for purchasing agricultural inputs. This could serve as a model for developing mobile financial solutions for Pakistani farmers who lack access to traditional banking services.¹³

¹¹ <https://blogs.worldbank.org/en/climatechange/innovation-water-part-1-drip-irrigation>

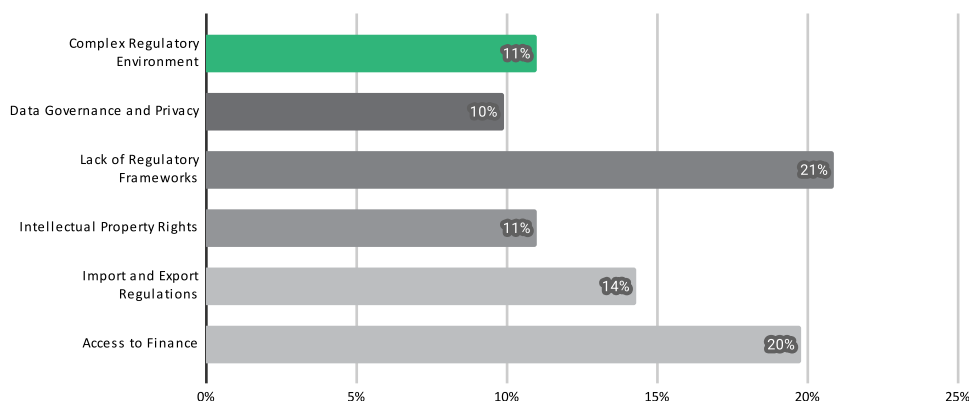
¹² <https://www.mckinsey.com/industries/agriculture/our-insights/how-agtech-is-poised-to-transform-india-into-a-farming-powerhouse>

¹³ <https://documents.worldbank.org/en/publication/documents-reports/documentdetail/638851468048259219/mobile-payments-go-viral-m-pesa-in-kenya>

10. Policy and Regulatory Challenges for Agri-Tech Companies



What Policy and Regulatory Challenges or Barriers do Agri-Tech Companies Face in Pakistan?



Survey findings highlight several regulatory and policy barriers faced by Agri-Tech companies in Pakistan. These challenges include **complex approval processes, lack of standardized regulations across provinces, and difficulties in accessing finance**. Additionally, farmers face uncertainty about using Agri-Tech solutions due to a fragmented legal framework that varies by region,¹⁴ which creates inefficiencies and inhibits nationwide scalability.

Data Privacy and Governance

The protection of farm data is a growing concern as agri-tech companies increasingly rely on data-driven technologies like precision farming, real-time monitoring, and digital marketplaces. A robust data privacy framework is crucial to build trust among farmers and ensure ethical use of their data. Drawing inspiration from international models such as the **General Data Protection Regulation (GDPR)** in Europe, Pakistan needs to adopt clear guidelines that:

- a. Establish Ownership of Farm Data:** Just as GDPR ensures personal data rights, Pakistan's framework should clearly define farm data as owned by the farmers, giving them control over how it is used and shared.
- b. Consent and Transparency:** Companies must obtain explicit consent from farmers for data collection and ensure full transparency about how the data is utilized, protecting them from exploitation.
- c. Data Sharing and Portability:** In alignment with GDPR's data portability principles, there should be policies to allow farmers to transfer their data to different platforms, fostering competition and innovation in the agri-tech ecosystem.
- d. Security Measures:** Guidelines for securing sensitive agricultural data should be established, incorporating regular audits, encryption standards, and penalties for breaches, similar to international standards.

Harmonizing Provincial Regulations

The fragmented regulatory environment in Pakistan, where each province operates under different agricultural laws, complicates scaling agri-tech solutions nationally. A unified framework is essential to create a coherent agri-tech market across the country. Strategies could include:

- a. National Agri-Tech Regulatory Body:** Establishing a **National Agri-Tech Regulatory Authority** that works across provincial lines to harmonize policies, certifications, and standards can ensure consistency for

¹⁴ <https://gdpr-info.eu/>

companies operating in multiple regions. This body could streamline the registration of agri-tech products, synchronize taxation policies, and ensure uniform regulatory requirements across provinces.

b. Inter-Provincial Agreements: Learning from India's model of **Agricultural Produce Market Committees (APMCs)**, Pakistan could initiate **inter-provincial agreements** to standardize market linkages and input supplies. This would enable agri-tech companies to operate seamlessly across provinces, ensuring that products and services remain accessible nationwide.¹⁵

c. Digital Platforms for Unified Market Access: Creating government-backed **digital platforms** that allow agri-tech companies to list their products and services for all provinces can help address provincial disparities in regulatory approaches, ensuring companies face fewer obstacles in expanding across regions.

Examples of Global Best Practices

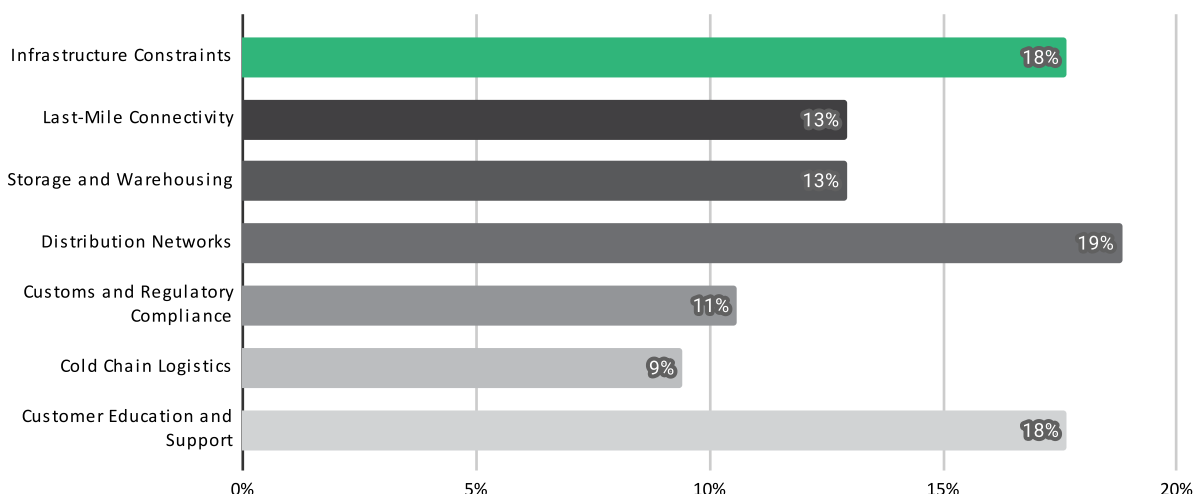
India's National Agriculture Market (eNAM) has effectively harmonized market regulations across states by creating a unified digital marketplace for agricultural goods. Pakistan could adopt a similar system to bring provincial markets under a single, national platform, making it easier for agri-tech companies to scale.

Kenya successfully harmonized agricultural policies across its counties, particularly with respect to agri-tech services, through a **national framework for digital agriculture**, which has accelerated the adoption of innovations across the country. Pakistan could follow suit to remove regulatory bottlenecks between provinces.¹⁶

11. Logistical Challenges



What Logistical Challenges do Agri-Tech Companies Encounter in Delivering their Products or Services to customers?



Key logistical challenges for Agri-Tech companies include **inefficient distribution networks, high transportation costs, and limited rural reach**. Inadequate infrastructure, such as **roads, power, and communication networks**, hampers service delivery, particularly in remote areas. Storage and warehousing issues complicate the handling of perishables, while last-mile connectivity is hindered by difficult terrain and regulatory hurdles.

¹⁵ <https://enam.gov.in/web/stakeholders-Involved/Apmcs>

¹⁶ https://www.iwmi.cgiar.org/Publications/Other/PDF/kenya_agricultural_policy_profile.pdf

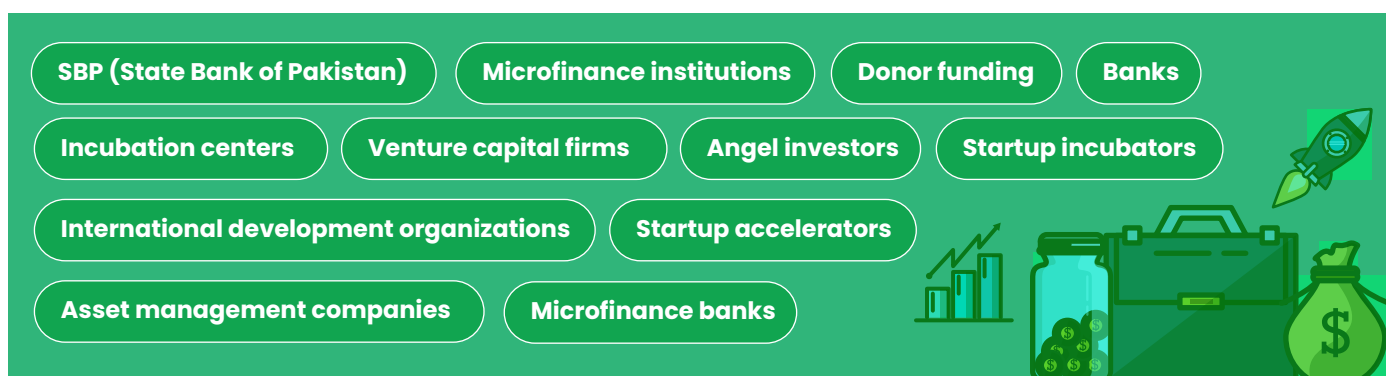
- Rural infrastructure challenges—such as **poor roads and unreliable electricity**—are especially severe in Sindh, Balochistan, and KP, compared to Punjab, which benefits from better transportation and agricultural support services. A lack of inter-provincial coordination and inconsistent policies also limits market access. The Ministry of Inter Provincial Coordination can help harmonize efforts to improve logistics and streamline agri-tech services across provinces.

Regional Best Practices to Overcome Logistical Challenges

- **Bangladesh's Cold Storage Expansion:** Bangladesh has expanded cold storage facilities for perishable goods like potatoes, ensuring they are preserved during transportation and storage. The government's involvement in building decentralized cold storage infrastructure closer to farming regions has drastically reduced post-harvest losses. A similar public-private partnership in Pakistan could focus on cold chain development, especially for crops like fruits, vegetables, and dairy.
- **Thailand's Integrated Logistics Hub:** Thailand has developed regional agri-logistics hubs equipped with modern cold storage and sorting facilities.¹⁷ These hubs serve as collection and distribution points, reducing transportation time and costs while preserving the quality of produce. Pakistan can replicate this by setting up regional hubs in agriculturally rich areas (like Punjab and Sindh) to streamline storage and distribution across provinces.
- **Sri Lanka's Rural Road Improvement Project:** Through the Rural Roads and Connectivity Improvement Program, Sri Lanka has improved rural road networks, significantly enhancing last-mile connectivity for farmers.¹⁸ This has reduced transport costs and time, while facilitating easier access to markets. Pakistan can benefit from a similar initiative, focusing on rural road development to improve agri-tech product and service distribution across provinces.

12. Access to Finance and the Current Landscape

Sources of Funding Available to Agri-Tech Start-ups & Companies



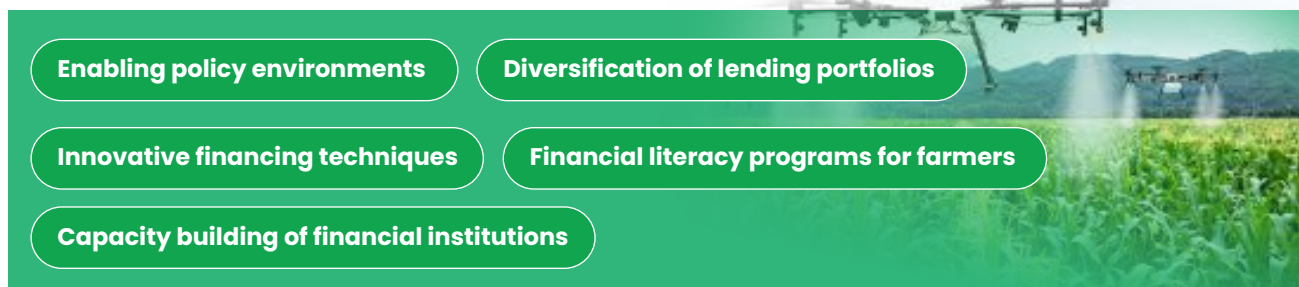
The State Bank of Pakistan has been instrumental in promoting agricultural finance since its inception in 1956, initially through the Zarai Taraqati Bank Limited (ZTBL). To increase agricultural credit outreach, SBP has introduced modern financing methodologies such as warehouse receipt financing, value chain financing, and concessional financing schemes. These efforts have led to a substantial increase in agricultural credit, growing from Rs. 109 billion in FY 2004–05 to Rs. 704.5 billion in FY 2016–17.¹⁹

¹⁷ <https://www.techsciresearch.com/report/thailand-cold-chain-logistics-market/14655.html>

¹⁸ <https://www.adb.org/news/adb-continues-support-rural-road-connectivity-sri-lanka>

¹⁹ <https://www.sbp.org.pk/70/sup-14.asp>

- For FY 2017-18, SBP set an ambitious target of Rs. 1,001 billion, with Rs. 849 billion disbursed by May 2018, achieving 85% of the target and covering approximately 75% of the agricultural credit demand. Currently, 52 financial institutions, including major banks, specialized banks, microfinance banks, Islamic banks, and microfinance institutions, are actively providing agricultural financing in Pakistan. SBP's strategy for agricultural finance focuses on five pillars:



Attracting investment for Agri-Tech startups in Pakistan is currently challenging due to limited investor awareness and interest, compounded by a recent investment drought largely caused by political and economic uncertainty. However, the growing recognition of agriculture's potential and government incentives offer some hope. To revitalize the economy and attract investment, the government must create a more conducive and investor-friendly environment, drawing inspiration from successful regional practices.

Government-Led Innovation Funds

- **India** has established the Agriculture Infrastructure Fund, which provides long-term, low-interest loans to Agri-Tech startups and other agricultural enterprises.²⁰ Pakistan can introduce a similar fund to encourage private sector investment in agri-tech, with the government offering subsidies or guarantees for early-stage financing to reduce risk for investors.
- The **Philippines** launched the **Agricultural Guarantee Fund Pool (AGFP)**, which offers credit guarantees to banks and financial institutions lending to small farmers and agritech startups.²¹ A comparable credit guarantee scheme in Pakistan could enhance investor confidence and promote lending to the agri-tech sector by mitigating the risk of default.

Public-Private Partnerships (PPPs) for Agri-Incubators

- In Malaysia, Agrobank collaborates with the government to support agri-startups through financing and incubation programs. Pakistan can establish similar agri-tech incubators in collaboration with private banks and industry bodies. These centers can provide mentorship, technical support, and funding opportunities to Agri-Tech innovators, helping them scale their businesses.²²

Tax Incentives and Regulatory Simplification

- **Vietnam** offers tax exemptions and reductions for **agri-tech firms** in their early years of operation, spurring sector growth.²³ Pakistan could introduce tax holidays for startups in Agri-Tech, particularly those working in innovative fields like precision agriculture, AI, or IoT in farming, to attract investment and facilitate growth.
- The complex regulatory environment often discourages investment in Pakistan. Streamlining business registration, reducing bureaucratic red tape, and providing fast-track approval for Agri-Tech startups can create a more business-friendly atmosphere.

²⁰ <https://pib.gov.in/PressNoteDetails.aspx?NotelId=152061&ModuleId=3®=3&lang=1>

²¹ https://www.apraca.org/wp-content/uploads/2021/05/TS-2.2_Brief-Paper-NABARDAPRACA.pdf

²² <https://www.bernama.com/en/news.php?id=2013508>

²³ <https://thuenhanuoc.vn/tapchien/categories/pace-of-life-in-tax-administration/tax-incentive-policies-and-support-effects-to-sustainable-development-of-enterprises>

Attracting Foreign Investment and Venture Capital

- **India** has seen rapid growth in **venture capital for agri-tech**, with funds like Omnivore dedicated to investing in this sector. Pakistan can follow suit by promoting agri-tech-specific venture capital funds, offering co-investment opportunities with international VCs, and engaging in global investor outreach to showcase the potential of its agricultural sector.²⁴
- **Singapore** has launched a global agri-food tech accelerator, bringing international investors to its agri-tech scene. Pakistan can initiate similar programs, creating platforms to connect local startups with international investors and showcasing innovation at global tech conferences.²⁵



²⁴ https://www.omnivore.vc/wp-content/uploads/2024/04/AGF_India_2024_F.pdf

²⁵ <https://agfundernews.com/12730-singapores-first-agri-foodtech-accelerator>

Key Insights from Expert Consultations

1. Key Trends & Current State of Agri-Tech Entrepreneurs

- Many Agri-tech entrepreneurs in Pakistan lack a deep understanding of farming, leading to poorly designed products that don't meet farmers' needs.
- While a few startups have found some success, most struggle due to insufficient R&D and failure to address critical pain points.
- Unlike Kenya and India, which have seen successful Agri-tech companies and higher agricultural digitization, Pakistan's impact on the ground remains limited.
- Challenges such as securing land, accessing quality inputs, and post-harvest inefficiencies, coupled with climate change, further complicate farming.
- While the Agri-tech sector is growing, scaling up remains essential to tackle Pakistan's low agricultural yield and supply chain inefficiencies.

2. Role of Technology

- Technology plays a vital role in solving agricultural challenges, especially in areas like precision farming, drones, and IoT tools. However, there is a lack of testing tools for seed quality, soil assessment, and water use, leading to inefficiencies.
- Smart equipment, such as moisture sensors and diagnostic tools, can optimize input usage and improve productivity.
- Technology can also aid in post-harvest processes like dehydration and cold storage, where other countries have made significant progress.
- AI, IoT, and solar energy present further opportunities, though challenges remain in scaling these technologies for smallholder farmers. Groundwater management is a growing concern, and technologies to monitor water use are essential for sustainability.

3. Viability of Agri-Tech Solutions for Smallholder Farmers

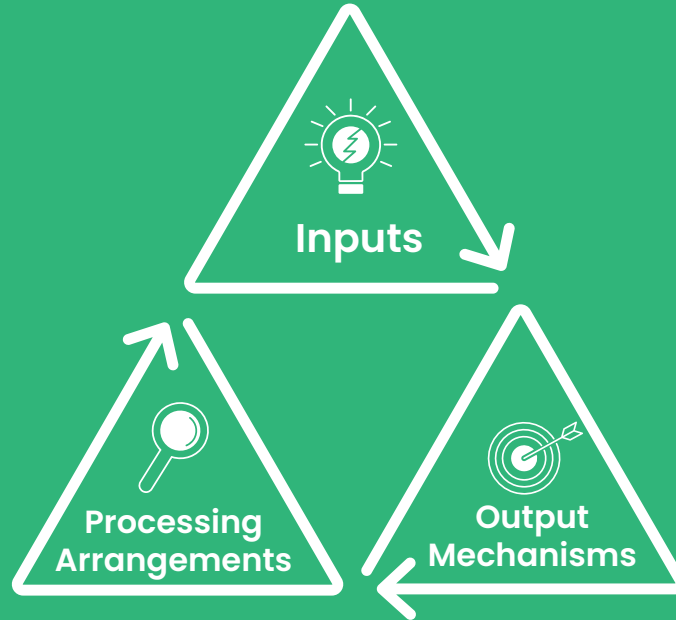
- Smallholder farmers, who own 75% of Pakistan's farmland, face significant challenges such as poor inputs, lack of credit, and inadequate facilities.
- Access to crop insurance, quality inputs, expert advice, and affordable machinery is critical.
- Government-led rental models or credit schemes could provide smallholders with access to expensive machinery.
- Additionally, formal training programs are essential to help small farmers make informed decisions about technology.
- Though technology adoption has been slow among small farmers, success stories from larger farms can encourage gradual uptake as costs decrease and proven solutions emerge.

²⁴ https://www.omnivore.vc/wp-content/uploads/2024/04/AGF_India_2024_F.pdf

²⁵ <https://agfundernews.com/12730-singapores-first-agri-foodtech-accelerator>

Policy Recommendations

This section is tailored in order to categorically understand the needs and requirements of the entire agriculture ecosystem that encompass a set of inputs, processing arrangements and output mechanisms.



1. Inputs

These policy recommendations aim to improve the availability, accessibility, and efficiency of agricultural inputs in Pakistan's agri-tech ecosystem, fostering a more sustainable and productive agricultural sector. They also provide a foundation for a comprehensive policy framework tailored to the needs of Pakistan's farmers and agri-tech companies.

Financial Support and Access to Inputs

- **Government-backed programs:** Establish partnerships with local financial institutions and cooperatives to facilitate bulk purchasing of certified seeds and fertilizers at lower costs. Use local extension services to oversee distribution and monitor quality.
- **Low-interest loans:** Collaborate with banks to design special loan packages for smallholder farmers. Implement digital payment options and simplified loan applications through mobile banking, ensuring easy access and flexibility for farmers.
- **Microfinance and crowd-lending:** Develop online platforms for peer-to-peer lending, supported by government guarantees. These platforms can match investors with farmers, reducing the financial risks for input purchases.
- **Targeted subsidies for agri-tech tools:** Create an incentive mechanism that provides discounts on AI tools, IoT systems, and advanced irrigation through public-private partnerships. Provide mobile-based tutorials and training centers to ensure farmers can use these tools effectively.

Capacity Building and Knowledge Dissemination

- **Training programs:** Leverage agricultural extension services and local universities to deliver practical workshops on precision farming, irrigation, and drone usage. Use digital platforms like WhatsApp or SMS to send reminders and training videos to farmers.
- **Local knowledge hubs:** Establish public-private knowledge hubs at provincial and district levels. Collaborate with agri-tech companies and NGOs to host on-site demonstrations, ensuring accessibility for smallholder farmers.

Research, Innovation, and Sustainability

- **Organic inputs promotion:** Initiate pilot projects in key farming regions that demonstrate the benefits of organic fertilizers and bio-pesticides. Encourage farmers through training and subsidies for eco-friendly farming techniques.
- **Climate-resilient seeds:** Fund research programs in collaboration with agricultural universities and global seed companies. Run trials in different regions of Pakistan to promote varieties tailored to local climate challenges.
- **R&D and collaboration:** Establish government-funded grants for innovation in seed technology, fertilizers, and soil health tools. Form research clusters bringing together government, private, and academic stakeholders to accelerate the commercialization of new technologies.

Infrastructure and Regulatory Support

- **Rural infrastructure development:** Collaborate with provincial and local governments to improve transportation networks, focusing on farm-to-market roads. Develop public-private logistics companies to ensure timely distribution of inputs.
- **Cold storage investment:** Incentivize the private sector to build cold storage facilities near farming hubs through tax breaks and low-interest loans. Support cooperatives in managing these facilities to ensure cost-effective access for small farmers.
- **Stricter quality controls:** Establish regional seed and fertilizer testing centers. These centers can be co-managed by local agricultural boards and private firms, ensuring the quality of inputs and certifying products before they reach the market.

2. Processing Arrangements

The following set of suggestions aim to strengthen Pakistan's agri-processing ecosystem, driving efficiency, sustainability, and market competitiveness while laying the groundwork for a robust policy framework.

Infrastructure and Equipment Modernization

- **Agro-processing zones:** Partner with provincial governments to identify strategic locations for agro-processing zones near key agricultural hubs. Provide tax incentives and public-private partnership models to attract investment in building these facilities.
- **Incentives for modern machinery:** Create a subsidy program to offset the cost of modern equipment (e.g., automated systems) for farmers and processors. Collaborate with equipment manufacturers to offer leasing options and after-sales support for maintenance.

- **Cold storage and transport:** Establish public-private partnerships to build cold storage facilities at key points along the supply chain. Provide low-interest loans for refrigerated transport companies and create a regulatory framework that ensures cost-efficient cold chain operations.
- **Government-private sector partnerships:** Launch a co-investment fund where the government matches private investments in infrastructure development projects. Prioritize regions with the highest post-harvest losses for immediate investment in cold chains and processing hubs.

Value Addition and Product Innovation

- **Secondary processing industries:** Introduce fiscal incentives, such as tax holidays, for companies establishing secondary processing units in rural areas. Provide technical assistance and R&D support to enable product diversification like canning and oil extraction.
- **Product innovation:** Set up a public-private innovation fund that grants resources to companies and startups developing plant-based, functional, or bio-based products. Collaborate with universities and research centers to facilitate product testing and market trials.
- **R&D investment:** Partner with academic institutions and international food tech companies to establish R&D labs. Focus on food preservation, sustainable processing methods, and bio-processing to introduce new technologies. Offer grants for small firms that engage in innovative research.

Financial Support and Policy Incentives

- **Financing schemes for SMEs:** Develop government-backed loan programs or grants specifically for SMEs in the agro-processing sector. Collaborate with banks to streamline loan applications and provide preferential interest rates for technology upgrades.
- **Tax holidays and import duty reductions:** Implement tax relief programs and reduce import duties on modern processing equipment. Promote these incentives through agro-processing cooperatives and chambers of commerce to encourage uptake.

Capacity Building and Skill Development

- **Training workshops:** Partner with industry associations and technical institutes to organize hands-on training programs on quality control, food safety, and advanced packaging techniques. Use online learning platforms for wider reach, especially in rural areas.
- **Technical support for SMEs:** Establish mentorship programs where large processors and export companies provide technical advice to SMEs. Offer government-backed certification programs that help SMEs meet international quality standards and connect them to export markets.

Sustainability and Resource Efficiency

- **Eco-friendly processing techniques:** Develop pilot projects to demonstrate the benefits of solar drying and energy-efficient machinery. Collaborate with NGOs and international donors to subsidize the initial setup costs for eco-friendly technologies.
- **Waste-to-value strategies:** Work with local universities and research centers to develop small-scale bioenergy and composting facilities using agricultural by-products. Provide tax breaks and financial incentives for processors who adopt waste-to-value initiatives.
- **Renewable energy in processing:** Launch a grant or rebate program for processors who invest in renewable energy systems like solar panels or biogas. Work with energy providers to offer technical support and affordable financing options.

Supply Chain and Market Linkages

- **Digital platforms for supply chains:** Partner with tech companies and telecom providers to develop and deploy mobile platforms that connect farmers, processors, and markets. Incorporate features like real-time tracking and digital payments to streamline operations.
- **Traceability systems:** Collaborate with food safety authorities and technology providers to develop affordable traceability systems, using QR codes or blockchain technology, to ensure product quality. Offer subsidies to help small processors implement these systems.
- **International partnerships:** Initiate partnerships with multinational food processing companies to facilitate knowledge transfer and technology sharing. Organize exchange programs or joint ventures with leading international companies to introduce best practices in processing.

3. Output Mechanisms

Below policy recommendations are intended to improve output mechanisms by focusing on product quality, market access, sustainable practices, and financial support. By implementing these strategies, Pakistan's agri-tech ecosystem can enhance productivity and the competitiveness of its agricultural outputs.

Technology Adoption and Digital Innovation

- **Precision agriculture technologies:** Provide government-backed grants or subsidies to farmers for adopting drones, satellite imagery, and IoT sensors. Partner with tech startups to create affordable leasing options and on-site training for farmers on using these tools.
- **Digital farm management systems:** Collaborate with local software companies to develop user-friendly farm management apps tailored to Pakistan's agriculture. Offer training through extension services and farmer cooperatives to ensure widespread adoption.
- **Digital selling platforms:** Launch a government-endorsed e-marketplace for agricultural products, supported by partnerships with e-commerce platforms. Ensure the platform includes logistics services for last-mile delivery and digital payment systems to ensure seamless transactions.
- **Blockchain for traceability:** Develop pilot programs in collaboration with blockchain developers and agri-tech companies to test and implement traceability systems. Focus on export-oriented crops first, providing incentives for early adopters of this technology.

Quality Standards and Market Access

- **Good Agricultural Practices (GAP):** Implement a national GAP certification program. Offer subsidies or free certifications for small farmers to meet food safety standards. Collaborate with international food safety bodies for global recognition.
- **Post-harvest handling:** Establish training centers in rural areas to demonstrate best practices in sorting, grading, and packaging. Provide micro-loans or subsidies for the procurement of essential post-harvest equipment.
- **Export-oriented strategies:** Work with export agencies to organize workshops on international quality standards, focusing on high-value crops. Offer government-backed incentives for certified farms to access global markets.
- **Quality and safety standards:** Enforce stronger inspection regimes by establishing mobile testing units for quality control at the farm level. Partner with agricultural cooperatives to ensure farmers meet both local and international market standards.

Market Diversification and Linkages

- **Product and market diversification:** Provide financial and technical support to farmers for cultivating high-value crops, organic produce, and specialty products. Organize farmer fairs and export promotion events to connect farmers with niche buyers.
- **Domestic market linkages:** Develop cooperatives or farmer producer organizations (FPOs) to aggregate outputs and negotiate better prices with retailers and processors. Offer government-backed platforms where farmers can easily connect with domestic buyers.
- **Collaboration with research institutions:** Create public-private partnerships that fund research into new crop varieties and farming technologies. Establish demonstration farms where farmers can learn about innovative practices through hands-on training.

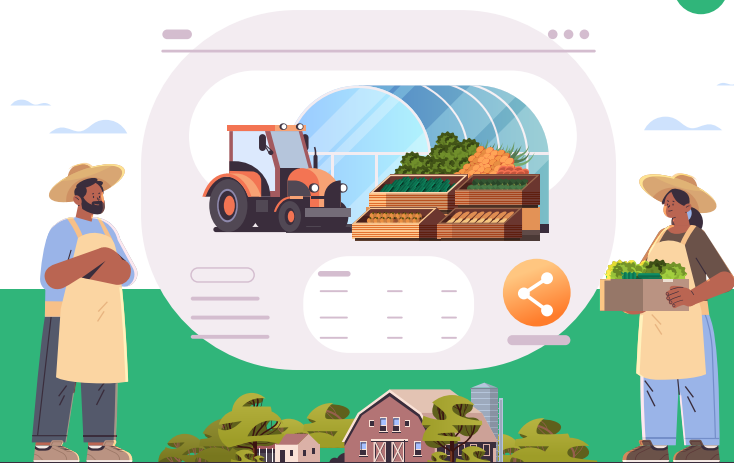
Financial Support and Incentives

- **Output-linked credit and insurance:** Collaborate with financial institutions to create credit lines based on projected outputs. Implement crop insurance schemes tied to production targets and offer premium subsidies to make them affordable.
- **Warehouse receipt financing:** Work with the banking sector to expand warehouse receipt financing. Build certified warehouses near major agricultural hubs and provide awareness programs on how farmers can use stored crops as collateral.
- **Minimum support prices (MSP):** Implement MSP schemes for key crops and create a transparent pricing mechanism that reflects real-time market data. Use digital platforms to make these prices available to farmers and eliminate intermediaries.

Sustainability and Climate-Resilience

- **Climate-resilient crop varieties:** Partner with agricultural universities and international research organizations to develop and distribute drought-resistant, flood-tolerant, and climate-resilient crop seeds. Launch seed distribution programs in vulnerable regions.
- **Sustainable farming practices:** Promote agroforestry and regenerative agriculture through government-supported demonstration plots. Provide incentives for farmers adopting these practices, such as access to eco-friendly inputs or direct financial support.
- **Training for output optimization:** Organize training programs through local extension services or public-private partnerships. Focus on pest management, efficient water use, and crop rotation. Provide field-based mentorship to ensure farmers can implement what they learn.

Conclusion and Analysis



The adoption of technological solutions to enhance agricultural productivity in Pakistan has seen gradual progress, particularly among large and medium-scale farmers who have begun incorporating climate-smart agriculture, agri-finance, and insurance services. The demand for precision farming tools, supply chain management systems, and advanced technologies like AI, machine learning, and IoT is also growing. Agri-tech start-ups are increasingly offering innovative solutions tailored to local conditions, especially in areas like crop monitoring, pest management, and market access. These technologies hold great potential for reducing price volatility, improving input quality, and offering cost-effective solutions aimed at increasing productivity and sustainability.

However, Pakistan's agri-tech landscape still faces significant challenges. Despite the promise of these advancements, adoption rates remain low due to a fragmented ecosystem and limited digital literacy among farmers and technology providers. Key barriers include a lack of financial inclusion, insufficient access to credit, and a regulatory environment that has yet to fully accommodate the growing needs of the agri-tech sector. Logistical constraints, such as inefficient distribution networks, inadequate infrastructure for cold storage and warehousing, and limited customer education on the benefits of modern technologies, further compound the problem.

To unlock the full potential of agri-tech in Pakistan, it is imperative to address these challenges through a holistic approach that involves all stakeholders—government, private sector, farmers, and international organizations. Public-private partnerships, inspired by successful models from other regions, can help bridge gaps in infrastructure, financing, and service delivery. The government must play a crucial role as an enabler, offering both financial and non-financial incentives, such as low-interest loans, subsidies, and tax breaks, to spur the adoption of agri-tech solutions.

A comprehensive agri-tech ecosystem should be built around key pillars: improving access to quality inputs, such as certified seeds and cutting-edge technologies; promoting digital marketplaces and IoT solutions to enhance resource management and market transparency; and focusing on capacity building through farmer training and local knowledge hubs. These steps would equip farmers with the skills and tools necessary for modern, sustainable agriculture.

In addition, fostering research and innovation—particularly in developing climate-resilient crops, cost-effective fertilizers, and eco-friendly pest control technologies—will be critical. Enhancing rural infrastructure and logistics, such as cold chains and transportation networks, is also essential for reducing post-harvest losses and ensuring that agricultural outputs reach markets efficiently. Moreover, developing a clear, supportive regulatory framework is vital to ensure the long-term sustainability and scalability of agri-tech solutions across Pakistan.

A multifaceted approach is required, demanding coordinated efforts from all sectors to accelerate the creation of a sustainable agri-tech ecosystem. Given the current challenges and opportunities in the sector, the formulation of a well-defined policy framework is essential. This framework should clarify the roles and responsibilities of all stakeholders, outline strategies to address existing barriers, and lay the groundwork for a future-oriented, resilient agricultural sector. With the right policies and collaborative efforts, Pakistan can capitalize on the promise of agri-tech to achieve a more sustainable and productive agricultural future.

Annex: List of Participating Companies & Experts

Participating Company	Agri-tech Category	Location
1. AgreCir	Biological Crop Inputs; Supply Chain Management Solutions	TandoJam
2. AirNex	Precision Farming Solutions; Farm Management Software; Crop Monitoring Systems; Robotics and Automation; Supply Chain Management Solutions	Karachi
3. Bakhabar kissan	Crop Monitoring Systems	Islamabad
4. BGrowTech	Vertical Farming Equipment	Gujranwala
5. Buraq Integrated Solutions (Pvt) Ltd	Precision Farming Solutions; Farm Management Software; Smart Irrigation Systems; Robotics and Automation	Rawalpindi
6. Clearlife Technologies	Solar powered wastewater treatment	Faisalabad
7. Concave Agri Services (Pvt) Ltd	Precision Farming Solutions; Farm Management Software; Crop Monitoring Systems; Smart Irrigation Systems; Biological Crop Inputs; Agri-Finance and Insurance Services	Islamabad; Lahore; Karachi
8. CREECO (PVT) LTD	Smart Irrigation Systems	Rawalpindi
9. Digital Dera (Pvt) Ltd	Precision Farming Solutions; Farm Management Software; Crop Monitoring Systems; Smart Irrigation Systems; Biological Crop Inputs	Lahore & Pakpattan
10. Farming & Agriculture	Supply Chain Management Solutions	Mardan
11. GrowTech Services	Precision Farming Solutions; Farm Management Software; Crop Monitoring Systems; Biological Crop Inputs; Supply Chain Management Solutions; Agri-Finance and Insurance Services	Islamabad
12. Horizon Tech	Precision Farming Solutions; Farm Management Software; Biological Crop Inputs; Supply Chain Management Solutions	Faisalabad
13. Indus Acres	Precision Farming Solutions	Tando Allahyar & Karachi
14. Integrated Agritech - Mandi Express	Precision Farming Solutions; Supply Chain Management Solutions	Karachi
15. ITROOS (Pvt) Ltd	Farm Management Software; Crop Monitoring Systems; Supply Chain Management Solutions	Islamabad
16. Khaity Technologies (Pvt) Ltd	Precision Farming Solutions; Crop Monitoring Systems; Smart Irrigation Systems; Vertical Farming Equipment; Biological Crop Inputs	Karachi , Islamabad , Peshawar , quetta, AJK , Gilgit, Okara
17. Kissan Energy & Chemicals	Vertical Farming Equipment	Bahawalpur & Houston (USA)
18. Machvista Engineering (Pvt) Ltd	Precision Farming Solutions	Wah Cantt

Participating Company	Agri-tech Category	Location
19. Metagood Research & Industries	Biological Crop Inputs	Lahore
20. Mezan Group	Dairy Farming	Karachi
21. Pakistan Agriculture Research (PAR)	Crop Monitoring Systems; Supply Chain Management Solutions	Karachi
22. Peepu	Livestock Monitoring Systems; Supply Chain Management Solutions; Agri-Finance and Insurance Service	USA
23. Plantlife Biotech	Biological Crop Inputs	Karachi
24. RemoteWell	Smart Irrigation Systems	Faisalabad
25. Sulit Agro (Pvt) Ltd	Vertical Farming Equipment	Hyderabad
26. Spurt International	Precision Farming Solutions; Farm Management Software; Vertical Farming Equipment	Faisalabad
27. Tagmu	Livestock Monitoring Systems; Agri-Finance and Insurance Services	Lahore
28. Vital Agri Nutrients (Pvt) Ltd	R&D on production of specialty fertilizers, micronutrient & soil amendments	Lahore
29. Vital Green Ltd	Farm Management Software; Crop Monitoring Systems; Supply Chain Management Solutions; Agri-Finance and Insurance Services	Lahore

Focused Group Discussion

Consulting Experts

Expert	Entity
Yusuf Hussain	Ex head Venture Capital, HBL
Mohammad Asif Siddiqui	CEO Integrated Agritech- Mandiexpress
Ahmed Umair	CEO, Vital Green Ltd & VAN
Anas Shaikh	COO & Co-Founder of Peepu & The Farms
Ghasharib Shoukat	Co-Founder, Zarai Mandi
Zeeshan Shahid	Development Manager GrowTech

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