

FROM VULNERABILITY TO VITALITY: **BUILDING** CLIMATE RESILIENCE IN AGRICULTURE

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Pakistan's agriculture is central to growth but remains highly exposed to climate shocks

Pakistan's agrarian economy plays a significant role in its growth. The agriculture sector employs over 40% of the labour force including two-thirds of women's labour force and contributes 23% to gross domestic product (GDP)¹, while also providing raw material to various industries in the country. It generates over 75% of export revenue through cotton-based textiles and agri-food products. Additionally, the sector still holds immense unrealised potential for growth owing to the potential for quick returns on investment which are unencumbered by high import-

dependent input costs. Moreover, an effective response to rising climate-induced challenges can contribute to building a robust and resilient agriculture sector, yielding substantial benefits for the broader economy.

However, despite the sector's importance, productivity is low, with significant yield gaps compared to other South Asian countries in major crops like wheat, rice and sugarcane². Pakistan's average wheat yield is about half that of China and approximately 15% lower than India. Similarly, China and Bangladesh's cotton

yields are 2.3 and 1.7 times higher than Pakistan, respectively. Moreover, between 1991-2019, Pakistan's agriculture output per worker increased at a rate of 0.7 in 2019 which is significantly lower than the South Asian average of 2.8 percent over the same time³. The sector faces a multitude of challenges that includes a rising demand for food due to increasing population, rapid urbanization that is taking over cultivable land as well as climate change that is making the entire sector extremely vulnerable to external shocks.

¹The World Bank Group. Country Climate and Development Report, 2022. <https://doi.org/10.1596/38277>

²Climate-Smart Agriculture in Pakistan. The World Bank Group, 2017. <https://hdl.handle.net/10568/83340>

³Unleashing the Agri-Food Sector Policy. Towards Productive and Climate-Resilient Agriculture. The World Bank Group, 2023. [Pakistan-Reforms-For-A-Brighter-Future-Policy-Note-4-Unleashing-the-Agri-Food-Sector.pdf](https://www.worldbank.org/publications/unleashing-the-agri-food-sector-policy-note-4)

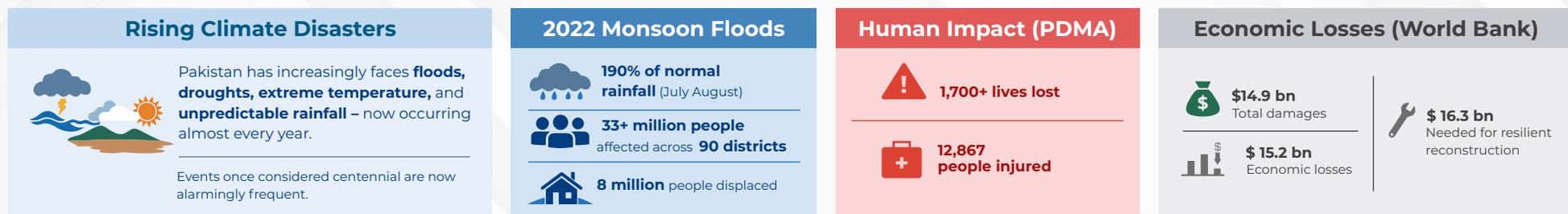
Escalating climate shocks

Over the last decade, Pakistan has increasingly witnessed climate induced disasters such as floods, droughts as well as extreme temperatures and unpredictable rains. These disasters now occur with an alarming frequency, often annually, as opposed to centennial events. In 2022 Pakistan received 190% of its normal rainfall between July and August, which impacted more than 33 million people across 90 districts, and displaced an estimated 8 million people. According to Pakistan National Disaster Management Authority (PDMA) over 1,700 people lost their lives and at least 12,867 people were injured⁴. The World Bank estimated that total damages exceeded USD 14.9 billion, and total economic losses amounted to about USD 15.2 billion. Moreover, an estimated USD 16.3 billion would be required for resilient rehabilitation and reconstruction⁵.

Pakistan has again found itself at the receiving end of the climate catastrophe as several parts of the country were devastated by heavy rainfall and mass flooding in 2025. Cloudbursts and heavier-than-usual monsoon impacted approximately 6 million people; resulting in the loss of more than a 1000 lives, damaged more than 12,500 houses, led to a loss of more than 6500 livestock and extensive destruction of crops⁶. On the other end of the spectrum severe droughts also adversely impact agriculture, food security and the economy. According to the Pakistan Meteorological Department (PMD), the winter of 2024-25 was one of the driest in Pakistan's history. The country experienced a staggering 67% less rainfall than usual. Sindh, the hardest-hit province, recorded a 90% deficit, while Punjab, the agricultural heartland, saw a 69% reduction⁷. Moreover, average temperatures in

Pakistan have been rising over the years with repeated annual heatwaves. This impacts crop yields particularly for crops that thrive in cooler conditions and increases the water requirement of crops⁸.

Unpredictable weather and precipitation patterns not only damage crops but have other spillover effects on the agricultural economy. Farmers face dual financial setbacks resulting from i) reduced income as a result of harvest losses and ii) increased expenditure on replanting and rehabilitation. Moreover, disruptions in production impact the supply chain, creating food shortages, hiking up prices and impacting national food security⁹. The impact of unpredictability in weather patterns is likely to increase manifold unless appropriate action is taken.



⁴British Red Cross. 2022. <https://www.redcross.org.uk/stories/disasters-and-emergencies/world/climate-change-and-pakistan-flooding-affecting-millions>

⁵The World Bank Group. Press Release. 2022. <https://www.worldbank.org/en/news/press-release/2022/10/28/pakistan-flood-damages-and-economic-losses-over-usd-30-billion-and-reconstruction-needs-over-usd-16-billion-new-assessme>

⁶Al Jazeera. 2025. <https://www.aljazeera.com/news/2025/9/19/impact-of-climate-change-a-harsh-reality-facing-pakistan>

⁷Concave Agri. Drought in Pakistan: What It Means for Farmers and the Future. <https://tinyurl.com/3sefjen5>

⁸Suncrop Group. Climate Change and its Impact on Agriculture in Pakistan. 2024. <https://tinyurl.com/3nknj2b7>

⁹Concave Agri. Floods Affecting Crops in Pakistan. 2025. <https://tinyurl.com/2pzd8xct>

Structural water stress

Most of Pakistan's territory is classified as arid to semi-arid. 75% of this land receives less than 250 mm of rainfall annually, while about 20% receives less than 120mm. This means Pakistan cannot rely on rainfall alone for agriculture.

Additional water is required either through irrigation or through water harvesting techniques. In terms of agricultural water productivity, Pakistan's existing use of water places it among the 10% of the worst

performing countries¹⁰. With increasing unpredictable rain patterns, especially long periods with no rain, the burden of utilizing ground water rises and water management becomes more challenging¹¹.

Climate impacts on yield and food security

Climate change negatively impacts agriculture in Pakistan in a number of ways; studies indicate that crop production in the country is highly sensitive to changes in temperature and water availability, although the magnitude of this impact varies across provinces. The effects of climate change have begun to impact crop yield and are projected to worsen in the absence of responsive adaptive and mitigative measures. Pakistan has already witnessed a decline of 14.7% of wheat and 20.5% of rice crop production in the past few years¹². The unpredictability of weather patterns i.e. precipitation and temperature of the earth

disturb the time and growth stages of the crop cycles. It is predicted that there will be a 3°C temperature rise by 2040 and by the end of the century temperatures will rise up to 5-6°C that will lead to a loss of up to 50% of wheat productivity in Asian countries. This loss will be greater for Pakistan due to its geographical position. It is expected that all major crops (Wheat, Rice, Maize, Cotton, and Sugarcane) in Pakistan will be significantly affected by climate change¹³. Moreover, labor productivity will be negatively impacted. With the combined impact of low crop yields and low labour productivity, there will be an increasing

pressure to import to meet the demands of the population.

Considering that nearly 4 in 10 Pakistanis experience moderate or severe food insecurity and about 20% of the population is currently undernourished, any reduction in production will have a far-reaching impact in terms of food security. Moreover, climate change will also affect the supply chain of food by altering storage conditions and disrupting transportation and access in times of catastrophes.

¹⁰Unleashing the Agri-Food Sector Policy. Towards Productive and Climate-Resilient Agriculture. The World Bank Group, 2023. Pakistan-Reforms-For-A-Brighter-Future-Policy-Note-4-Unleashing-the-Agri-Food-Sector.pdf

¹¹Climate-Smart Agriculture in Pakistan. The World Bank Group, 2017. <https://hdl.handle.net/10568/83340>

¹²Climate Impacts on the agricultural sector of Pakistan: Risks and solutions. 2022. <https://doi.org/10.1016/j.envc.2021.100433>

¹³The impact of climate change on major agricultural crops: evidence from Punjab, Pakistan. The Pakistan Development Review. 2012. <https://doi.org/10.30541/v51i41pp.261-276>.

Scope of this brief

This brief examines how Pakistan can build resilience in its agriculture sector in the face of climate change. It outlines the concept of climate-smart and regenerative agriculture as a framework for adaptation and mitigation. It

then analyses four key constraint areas that include farm size and ownership and access to finance, poor soil nutrition and land degradation, water mismanagement, and stagnant technology and practices and weak

transport and market linkages. This is followed by targeted policy and institutional recommendations to strengthen productivity, sustainability, and food security.



Building resilience in agriculture

While there are many ways to tackle the impact of climate change and make agriculture more resilient and sustainable, one way to look at it in a holistic manner that is sensitive to climate change is through the lens of Climate Smart Agriculture (CSA). The concept of CSA was developed by the Food and Agriculture

Organization (FAO) in 2008 who defined it as agriculture that sustainably increases productivity, enhances resilience (adaptation), and reduces/ removes GHG emissions (mitigation). It is an approach that can incorporate technologies and processes that are sensitive to the local environment.

Currently efforts to adopt CSA are sporadic in Pakistan. Large scale farmers have taken the lead in adopting technologies and methods that are adaptive to climate change. They are using improved seed varieties, latest machinery equipped with drones to measure and monitor their inputs, water saving

technologies such as laser leveling and other such measures that improve productivity, while also ensuring their crops are resilient to climate change. Individual schemes by the government are also helpful in encouraging climate smart agriculture such as introducing happy seeders where farmers can sow wheat directly into heavy rice residue fields and avoid crop burning¹⁴. However, there is no coordinated effort to encourage climate smart agriculture methods in any of the provinces. That may be due to tradeoffs when trying to achieve the goals of CSA, specifically for small scale farmers. Whether it is adopting minimum tillage as a practice, diversifying crops, or investing in new technologies, these choices often carry significant opportunity costs for farmers. When soil health, water efficiency, or climate resilience becomes an economic issue for farmers, it needs to be matched with clear incentives. Without a clear economic rationale and some form of risk-sharing, farmers are unlikely to move away from familiar practices, even when long-term benefits are well understood.

Hence, the current policy framework will need to be amended with careful consideration to reform sequencing to address the structural challenges of small-scale farmers. Reforms will also be required to create incentives to attract private investment and improve access to markets, finance and innovations for CSA to work. Investments in public goods such as research and extension services, infrastructure and farmers organizations will also be essential¹⁵. Targeted education and training will be required to overcome behavioral barriers of farmers.

Another concept that has some similarities to CSA but focuses more on restoring ecosystems by focusing on soil health and biodiversity and returning it to its natural state is Regenerative Agriculture. This approach aims to maintain viable farming systems by eliminating manufactured inputs and solely utilizing ecosystem processes, such as cover cropping, manure-based fertilizer use, crop rotation, and integrated grazing¹⁶.

Regardless of which approach is used, the current impact of climate change has made it evident that farmers have to adapt using new methods and technology that can help them mitigate the effects of climate change. This would mean changing not only the kind of inputs that are being used but also the technique to utilize them.

Pakistan's farmers face multiple interconnected constraints that limit their ability to adapt to climate change: fragmented and unequal landholdings, degraded soils, mismanaged water, slow technology adoption, and weak storage and market access. The following key messages highlight where reforms can unlock resilience and productivity gains.

¹⁴The Dawn News. Happy Seeders to Help Tackle Smog. 2017. <https://www.dawn.com/news/1374300>

¹⁵Unleashing the Agri-Food Sector Policy. Towards Productive and Climate-Resilient Agriculture. The World Bank Group, 2023. [Pakistan-Reforms-For-A-Brighter-Future-Policy-Note-4-Unleashing-the-Agri-Food-Sector.pdf](https://www.worldbank.org/publications/poverty-reduction/2023/05/unleashing-the-agri-food-sector-policy-note-4)

¹⁶Climate Smart or Regenerative Agriculture: Defining climate policies based on soil health. 2018. <https://bpb-us-e1.wpmucdn.com/sites.tufts.edu/dist/0/5123/files/2019/10/ClimatePolicyBrief9.pdf>

Land size and ownership impacts small-scale farmers access to finance and capacity for climate adaptation

The Food and Agriculture Authority (FAO) defines small-holder farms as those that vary from less than one hectare to 10 hectares¹⁷. The majority of Pakistan's agriculture sector comprises mainly small-scale farmers¹⁸ who have minimal access to modern farming technologies, machinery, and weather tolerant inputs such as seeds. This access is limited through two channels; one due to limited resources as adaptive technology and processes are expensive while lack of collateral restricts farmers' access to credit markets¹⁹ and secondly due to sparse information on ways to combat climate shocks such as use of new seed varieties. Lack of support from the government in the face of high price of inputs and adaptive technology as well as in providing new information leaves farmers with no choice but to continue bearing productivity losses in the face of climate change. For a farmer to invest in techniques such as drip irrigation or happy seeders instead of burning crops, he/she will

have to take a loan to undertake the expense. Moreover, any return on investment will take time and even longer to pay off the loan. Hence, small farmers are generally risk averse and are unable to diversify to protect themselves from unpredictable weather patterns.

The overall public support system and specifically the current structure of subsidies in the sector is unable to help small farmers effectively as they do not always receive targeted support. Subsidies distort the market and create inefficiencies as they focus more on stimulating domestic staple crops²⁰. Large amounts of public finance are devoted to providing ill-targeted and ill-performing subsidies which have not reaped the desired benefits in terms of productivity gains and crop diversification. Domestic demand dictates crop choice, as exemplified by wheat (a dietary staple) absorbing the majority of agricultural spending and contributing to an approximate

US\$ 4.5 Billion outstanding debt²¹. This is counter-productive as it does not encourage crop diversification towards higher value, internationally competitive crops which could potentially help small farmers scale up.



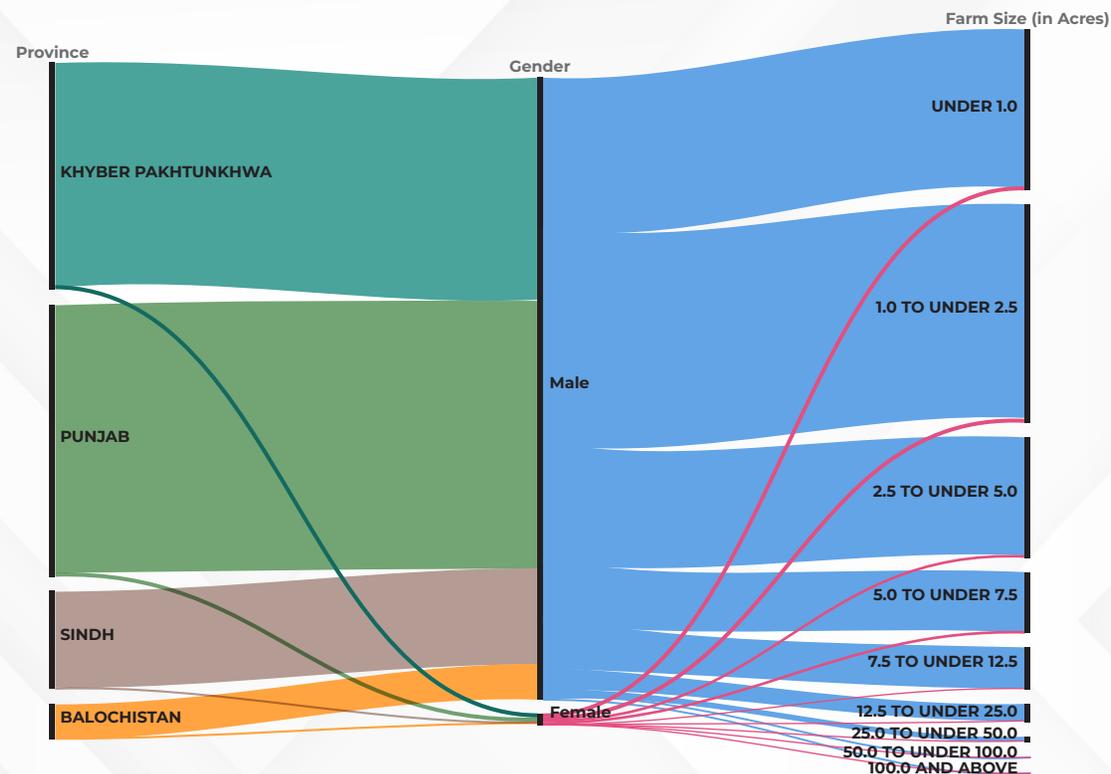
¹⁷Food and Agriculture Organisation of the United Nations. <https://openknowledge.fao.org/handle/20.500.14283/ar588e>

¹⁸Agriculture Department. Government of Punjab. <https://www.agripunjab.gov.pk/overview>

¹⁹Climate-Smart Agriculture in Pakistan. The World Bank Group, 2017. <https://hdl.handle.net/10568/83340>

²⁰Unleashing the Agri-Food Sector Policy. Towards Productive and Climate-Resilient Agriculture. The World Bank Group, 2023. [Pakistan-Reforms-For-A-Brighter-Future-Policy-Note-4-Unleashing-the-Agri-Food-Sector.pdf](https://www.worldbank.org/publications/policy-note/4-unleashing-the-agri-food-sector)

²¹The World Bank Group. Country Climate and Development Report, 2022. <https://doi.org/10.1596/38277>



Gender inequality is another major dimension of landholding disparity. This alluvial diagram²² above illustrates: a striking gender imbalance in land tenure and a stark majority of smaller landholdings by acreage (<5 acres). The near absence of women in formal landownership is stark: they make up nearly 70% of the agricultural workforce yet own and control less

than 2% of farms²³. Lack of ownership can have implications on investment and spending patterns. Without ownership, women continue to work long, unpaid hours on their land while unable to access credit, loans or government subsidies. This can create cycles of poverty which are difficult to come out of. Similar issues are faced by tenants who have no security, and

find it difficult to invest back longterm in the farm and in addition face exploitation at the hand of owners which reduces their incomes. These dimensions impact investment on climate smart methods and make both women and tenants more susceptible to poverty post climate shocks.

²²A diagram that uses flows or streams that vary in width to represent the size of each group and to show how these groups change over time or stages.

²³Strengthening women's property rights in Pakistan brings opportunities – and new challenges. International Growth Centre . Blog. 2025. <https://www.theigc.org/blogs/gender-equality/strengthening-womens-property-rights-pakistan>

One way to mitigate risks for small scale farmers and vulnerable groups like women and tenants is through crop insurance. However, several factors influence the uptake of crop

insurance in the developing world, especially Pakistan. These include the household's vulnerability, its access to alternative income sources, confidence in weather predictions,

understanding the role of insurance, and trust that payouts will be received. Hence, any crop insurance products must take these factors into account for successful uptake²⁴.

Some possible solutions to aid small holding farmers are discussed below:

1. Revise existing subsidy system to support the small farmer.

Subsidies on inputs like water encourage waste and deepen scarcity without building resilience. A differentiated support structure is needed to not only promote equality but also prioritise sustainability and regenerative farming. While the political economic factors that support subsidizing inputs like water provide a challenging situation, the government must instead prioritize subsidizing inputs and technologies that can help small scale farmers invest in climate smart agriculture practices.

2. Leverage the private sector's ability to play a pivotal role in financing small farmers.

Although the State Bank mandates agriculture lending, small farmers continue to face difficulty in meeting the requirements of banks. The efficacy of models such as HBL Zarai needs to be assessed and scaled up if such commercial banks can support small- holders more effectively, by not only providing credit, but all kinds of agriculture services such as supplying inputs and purchasing their produce, helping farmers secure better prices and more stable incomes²⁵.

3. Secure land rights for tenants

to encourage long-term investments in climate-smart agriculture and water management practices²⁶.

4. Climate linked financial products.

These include 'green loans' where the funds are used for green or climate friendly investments such as solar powered irrigation systems²⁷. In Pakistan, the Zarai Tarqati Bank Limited issues such loans. More recently, HBL Microfinance Bank has initiated Pakistan's first climate-smart agriculture loans using satellite data in partnership with SUPARCO. This makes use of satellites to analyze and monitor crop production, which can on one hand guide lending decisions and on the other guide farmers when facing volatile weather conditions.

²⁴Demand for Crop Insurance: Evidence from Pakistan. Baylis and Naeem, 2025.

²⁵The State of Pakistan's Agriculture 2024. How the Corporate Sector in Developing Agriculture. The Pakistan Business Council, 2024. <https://www.pbc.org.pk/wp-content/uploads/The-State-of-Pakistans-Agriculture-2024.pdf>

²⁶Unleashing the Agri-Food Sector Policy. Towards Productive and Climate-Resilient Agriculture. The World Bank Group, 2023. [Pakistan-Reforms-For-A-Brighter-Future-Policy-Note-4-Unleashing-the-Agri-Food-Sector.pdf](https://www.worldbank.org/en/publication/pakistan-reforms-for-a-brighter-future-policy-note-4-unleashing-the-agri-food-sector)

²⁷What is Green and Sustainable Financing? 2021. <https://tinyurl.com/8k5rcy3y>

5. Crop insurance can help small farmers manage climate risks.

Area Yield Index-based Insurance (AYII) is linked to the average yield of the area and the payout is not affected by major disasters like floods. It protects against multiple risks that may affect crops such as heat waves, pest attack, diseases. This is more advantageous for small farmers compared to conventional crop loan insurance²⁸.

6. Learn from regional successes. Experience from other countries show that weather indexed insurance has positive effects for farmers as seen in Bangladesh. It can provide both insurance and liquidity, by guaranteeing access to credit in the event of a flood. Evidence shows that even in Pakistan, provision of weather information suggests to farmers that payouts are more likely, thereby increasing

demand for crop insurance. Hence, uptake can be improved by designing affordable, bundled products in partnership with the private sector and financial institutions²⁹.



²⁸Area Yield Index Insurance: Pakistan Agricultural Coalition's climate resilience solution for Pakistan's smallholder farmers. https://pac.com.pk/wp-content/uploads/2025/01/Area-Yield-Index-Insurance_-Pakistan-Agricultural-Coalitions-climate-resilience-solution-for-Pakistans-smallholder-farmers.pdf

²⁹Climate Adaptation. Namrata Kala, Clare Balboni, Shweta Bhogale, 2023. <https://voxdev.org/voxdevlit/climate-adaptation/adaptation-responses>

Degraded soils and poor land management undermine resilience to floods and droughts

Unsustainable agricultural and land management practices, along with unpredictable climate events such as frequent floods, droughts, heatwaves and cold waves have accelerated land degradation in Pakistan. Rising temperatures and reduced soil moisture are decreasing growing seasons and crop development, leading to losses in yield³⁰. Over time recurrent climate shocks have intensified soil erosion, water logging and salinity, loss of soil biodiversity, and diminishing organic matter in the soil.

To promote climate adaptation and mitigation, a mix of conservation and regenerative agricultural practices is essential. Conservation practices is a more achievable first step towards sustainability that aims to maintain soil health through minimal soil disturbance, permanent soil cover, and crop diversification. Regenerative practices focus on 'holistic land management'³¹ and seek to actively restore soil health and revitalize ecosystems by reversing degradation and sequestering carbon back

into the soil³². Good-quality soils with high organic matter increase microbial activity, which not only raises yields but also improves plant vigor, making them less susceptible to pest and disease attacks. Increasing soil organic matter also significantly improves water retention. A 1% increase in organic matter in the top six inches of soil enables an additional 27,000 gallons of water storage per acre. Such natural reservoirs can substantially improve drought and flood resilience across Pakistan's farmlands³³. However, Pakistan's soils have an average organic matter content of around 0.3%, whereas ideally this should be around 2% or higher.

A common practice meant to increase soil organic matter is the reintegration of crop residues such as straw and cotton sticks back into the soil. Practices like mulching with straw and other farm byproducts not only improve soil structure and fertility but also enhance moisture retention and lower soil temperatures (sometimes creating a difference of almost 10

degrees Celsius), particularly in the root zone, thus helping crops combat increasingly frequent and severe heatwaves.

However, these practices impose a clear opportunity cost on farmers who often sell crop residues for additional income or use them as fuel and household energy sources. Without a compensating economic return, farmers are unlikely to adopt such soil-improving practices.

To overcome these structural frictions, effective pull factors must be created, particularly from processors, to incentivize investment in soil health. Farmers will not invest in long-term soil improvement without clear economic incentives and risk-sharing mechanisms. Processors can play a stronger role by creating a pull-factor for regeneratively grown products and complementing it by providing agronomic support not only for their crop-of-interest but also for other crops grown on the farm.

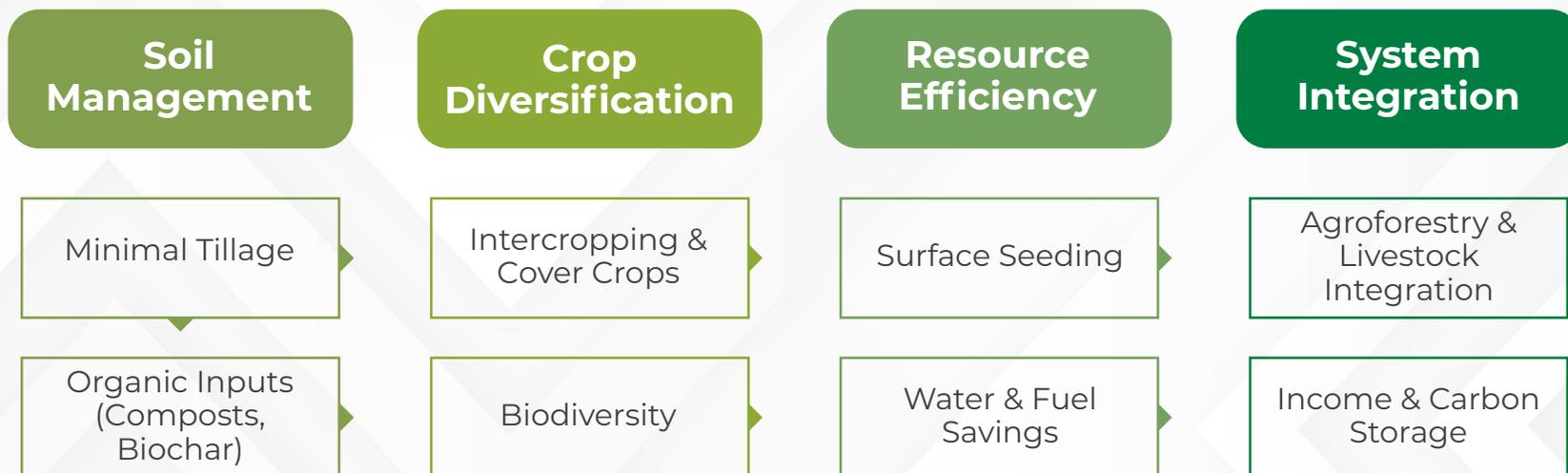
³⁰Shifts in Irrigation Water Demand and Supply Pattern During Sensitive Crop Growth Phases in South Asia. <http://dx.doi.org/10.2139/ssrn.3969074>

³¹Technological Approaches for Climate Smart Agriculture. 2024. <https://link.springer.com/book/10.1007/978-3-031-52708-1>

³²Conservation Agriculture vs. Regenerative Agriculture: What's the Difference? <https://tinyurl.com/56havpbw>

³³The State of Pakistan's Agriculture 2024. How the Corporate Sector in Developing Agriculture. The Pakistan Business Council, 2024. <https://www.pbc.org.pk/wp-content/uploads/The-State-of-Pakistans-Agriculture-2024.pdf>

Some regenerative agriculture practices that build resilience are discussed below



BOOSTING SUNFLOWER OIL Production in Pakistan



50%
of Sugarcane Crops Intercropped with Sunflower

↓

Average Yield
25 Maunds Per Acre

POTENTIAL OUTPUT
525,000 Tons
of Sunflower Oil



ECONOMIC IMPACT
Reducing Edible Oil Imports

\$3.6 Billion
Imported in 2023³⁴



INTERCROPPING STRATEGY

Carefully manage spacing and resources to ensure crops do not compete, but supplement each other.

³⁴The State of Pakistan's Agriculture 2024. How the Corporate Sector in Developing Agriculture. The Pakistan Business Council, 2024. <https://www.pbc.org.pk/wp-content/uploads/The-State-of-Pakistans-Agriculture-2024.pdf>

Despite the availability of innovative regenerative practices, adoption levels of such techniques remain low due to lack of access to information and finance. To accelerate uptake, the following measures are critical for soil health:

1. Strengthen extension and advisory services:

Educating farmers on optimal practices and new technologies is essential to shift from familiar but inefficient methods³⁵. A lack of reliable information reinforces risk-averse behavior, discouraging adoption of regenerative techniques. Strengthening agricultural advisory systems—supported by digital tools for timely, practical guidance—can make extension services more efficient, accessible, and impactful. Providing information regarding sources and acquisition methods for agricultural implements such as

organic inputs will support uptake of regenerative practices.

2. Unlock finance: Improving access to finance to allow the shift to regenerative practices such as through government offering financial incentives in the form of subsidies or low-interest credit schemes, to encourage regenerative farming³⁶.

3. Leverage Public-Private Partnerships (PPPs) to access regenerative technologies, by allowing collaborations between government

bodies and private sector PPPs leverage the strength of the government's mandate and ability to deliver public services while shifting the responsibility of financing, R&D and distribution systems to the private sector.



³⁵A framework for productivity and export led growth in Pakistan, IGC. 2025.

<https://www.theigc.org/publications/framework-productivity-and-export-led-growth-pakistan>

³⁶Agroforestry: Sustainable Solution for Pakistan. <https://www.agrieconomist.com/agroforestry-sustainable-solution-for-pakistan>

Poorly governed and wrongly priced water use accelerates scarcity and climate vulnerability

Water is a fundamental input for agriculture and its importance is rising as Pakistan faces increased intensity and unpredictability of both drought and flooding events and impact of glaciers melting. Pakistan's use of water in agriculture puts it among the 10 percent worst performing countries on agricultural water productivity³⁷. Rainfall has never been sufficient for agricultural purposes, but growing uncertainty in the timing, volume and distribution of precipitation, makes provision of supplemental water via irrigation or water harvesting more critical³⁸. Unreliable irrigation makes it difficult for farmers to plan and discourages investment in water-efficient technologies such as drip systems³⁹.

Climate uncertainty also leads to misallocated irrigation as farmers are unable to predict

rainfall accurately. Farmers often overuse irrigation during wetter conditions and underuse it in drier conditions. Better forecasting would improve adoption of subsurface water technologies (SWTs),⁴⁰ demonstrating the importance of accurate weather forecasts at a more localized level⁴¹.

A major barrier to better water management is water pricing. The current Abiana system is outdated and through under-collected charges, brings in a fraction of the potential revenue; potential revenue could be as high as Rs. 32.66 billion, but less than Rs. 3 billion is collected⁴². The current flat rate system does not encourage conservation of water. A fair pricing model would involve charging farmers based on their actual water consumption, which would encourage more equitable and

efficient water use, so that those who consume more, pay accordingly. It would also encourage farmers to use water-saving technologies, such as drip or sprinkler irrigation. However, devising the water pricing policy needs to be aligned to the costs of operations and maintenance of the water system, tariff structures, environmental considerations and incentives for efficient use of water⁴³. Revenue generated could potentially be used to invest in water saving R&D or capital costs for new irrigation infrastructure. However, while developing the strategy, it is important to take into account the political economy of water and the voices that will resist any changes to the fee structures, making it critical to ensure effective stakeholder engagement.

³⁷Unleashing the Agri-Food Sector Policy. Towards Productive and Climate-Resilient Agriculture. The World Bank Group, 2023. [Pakistan-Reforms-For-A-Brighter-Future-Policy-Note-4-Unleashing-the-Agri-Food-Sector.pdf](#)

³⁸Climate-Smart Agriculture in Pakistan. The World Bank Group, 2017. <https://hdl.handle.net/10568/83340>

³⁹Adapting to Climate Change in Vulnerable Areas: Farmers' Perceptions in the Punjab, Pakistan. Nadeem, F.; Jacobs, B.; Cordell, D. 2024. <https://doi.org/10.3390/cli12050058>

⁴⁰Subsurface water technology involves methods to capture, store, and manage water below the ground's surface, such as installing underground barriers like polyethylene membranes to retain water in the root zone or constructing subsurface dams to store large quantities of water.

⁴¹Adapting to climate change accounting for individual beliefs. Guglielmo Zappalà. 2024. <https://doi.org/10.1016/j.jdevec.2024.103289>

⁴²The Agricultural Economist. Reforming Water Pricing in Pakistan for Sustainability. 2024. <https://www.agriconomist.com/reforming-water-pricing-in-pakistan-for-sustainability>

⁴³Irrigation Water Pricing & its Sustainability in Pakistan. Pakistan Engineering Congress. <https://tinyurl.com/rhwhufuf>

To improve water management and reduce climate vulnerability, following actions are key:

1. Strategic water pricing reform: Water pricing policy should ensure that the rapid increase in Abiana and water fee does not affect the users adversely. Moreover, the pricing system should also analyze the cost and pricing in various sectors. Global experience demonstrates that raising water tariffs can significantly improve economic efficiency and environmental sustainability of water use⁴⁴.

2. Improved irrigation infrastructure and governance: Maintenance of the existing structures particularly ensuring there is no water leakage through the canals is important for preventing waterlogging. Conjunctive management⁴⁵ of canal and ground water is also important for ensuring reliable access of

water for farmers. Percolation tanks⁴⁶ can be deployed at village-level to capture surface runoff and recharge ground water supply⁴⁷.

3. Mobilize local farming communities: Innovative measures and incentives can be used to raise awareness amongst and mobilize local farming communities. An example of such an initiative is seen in India where the Paani Foundation⁴⁸ organizes the Satyamev Jayate Water Cup, an annual competition among villages to implement watershed management and rainwater harvesting structures like percolation tanks, check dams, contour trenches, and other recharge works before the monsoon. Winners receive both cash prizes and accolades and recognition.

4. Promote climate-smart water practices on farms: It is also important for farmers to rationalize the use of water in agricultural practices by using techniques like laser leveling to ensure water is distributed for crops evenly. A laser beam is used to level the land evenly and prepare it uniformly which allows for crops to grow consistently. Some parts of Pakistan are already using this technique. However, the cost discourages high take-up⁴⁹. Another practice unique to rice, which uses the highest amount of water compared to other crops, is alternate wet and drying (AWD) of paddies. This technique does not flood the rice crop constantly but alternates between submergence during critical growing periods like flowering and surface flooding or flooding

⁴⁴ibid.

⁴⁵A strategy that coordinates the use of surface water from canals and groundwater to meet demands

⁴⁶Percolation tanks are artificially constructed water storage bodies designed to facilitate groundwater recharge. These tanks are typically built in areas with permeable soil and fractured rock formations, which allow water to percolate or seep down into the groundwater table. The primary purpose of percolation tanks is to capture surface runoff during the rainy season and store it, enabling it to gradually seep into the ground and recharge the aquifers.

⁴⁷Agriculture Institute. Using Percolation Tanks for Groundwater Recharge. 2023. <https://agriculture.institute/water-harvesting-conservation-utilisation/using-percolation-tanks-groundwater-recharge/>

⁴⁸Pani Foundation. Satyamev Jayate Water Cup. <https://www.paanifoundation.in/satyamev-jayate-water-cup/>

⁴⁹Climate-Smart Agriculture in Pakistan. The World Bank Group, 2017. <https://hdl.handle.net/10568/83340>

⁵⁰System of Rice Intensification is a management technique that promotes reduced plant density, improved soil conditions through enrichment with organic matter and reduced and controlled water application.

up to 15cm above the soil surface. AWD is currently moderately adopted in Punjab and Sindh provinces, but can be promoted by the government to help manage water for the most water hungry crop. System of Rice Intensification (SRI)⁵⁰ is another technique which has been a game changer for Southeast

Asian countries and is slowly gaining traction in Pakistan and has the potential to be scaled up⁵¹.

5. Accessible and localized weather information: This can help farmers plan better the usage of rainwater so that the burden on

the irrigation system is lower. Weather information must be timely, reliable, and easy for farmers to interpret for crop decisions⁵². Yet forecasts alone have limited impact unless paired with broader adaptation measures, given the rising uncertainty from climate change⁵³.



⁵¹Cornell University. College of Agriculture and Life Sciences. SRI-RICE. <https://sri.ciifad.cornell.edu/countries/pakistan/index.html#:~:text=According%20to%20a%20February%205,seasonal%20fungal%20and%20pest%20attacks>.

⁵²Adapting to Climate Change in Vulnerable Areas: Farmers' Perceptions in the Punjab, Pakistan. Faisal Nadeem, Brent Jacobs and Dana Cordell. 2024. <https://doi.org/10.3390/clj12050058>

⁵³Learning, Adaptation, and Climate Uncertainty: Evidence from Indian Agriculture. Namrata Kalay. 2017. https://cepr.mit.edu/wp-content/uploads/2021/09/2017_023.pdf

Slow uptake of climate-smart technologies and mechanization keeps yields low and costs high

Climate-smart practices can help farmers protect their crops, improve productivity, and reduce environmental damage. Pakistan is moving in this direction; however, adoption of

Research and development of resilient seed varieties:

Seeds are a core agricultural input that not only impact the quality and productivity of crop output but also determine the crop's ability to withstand changes in temperatures and water availability due to climate change. Hence research into new resilient seed varieties is imperative. Adoption of better seed varieties can help farmers diversify and improve their productivity in addition to providing some protection in case of unpredictable weather patterns affecting one crop. For instance drought-resistant and high-yield seed varieties, if used appropriately, can increase crop yields and overcome crop failure caused by droughts and dry spells⁵⁴.

However, in Pakistan the process of seed innovation is fraught with a plethora of challenges; there are poor standards for quality control and limited regulatory capacity.

modern practices and technology remains uneven particularly amongst small farmers. To push this forward, investments in better seeds, smarter use of fertilizers and pesticides,

While the Federal Seed Certification and Registration Department, Punjab Seed Council (PSC) and the National Biosafety Committee look after seed quality, the Research and Development of seeds needs to be supported with a thorough evaluation and approval process, bringing in more diligence and transparency.

With the use of better wheat crop seeds in Pakistan, wheat production which stands at an average of 32 maunds per acre can increase to 55 maunds per acre, resulting in an increase of approximately 20 million tonnes of wheat given that about 22 million acres of land are currently under wheat production.

diversified cropping systems, improved mechanization, and access to modern data-driven tools is needed. These are discussed below:



⁵⁴Diversification of agriculture practices as a response to climate change impacts among farmers in low-income countries: A systematic literature review. Hayrol Azril et al., 2024. <https://doi.org/10.1016/j.cliser.2024.100508>.

Farmers in Eastern India, for example, are successfully using flood resistant rice varieties that yield output even under flood conditions and also do well under normal conditions. Similarly, in Sierra Leone the use of short-duration, high-yielding rice variety has allowed farmers to harvest during the wet season⁵⁵.

In Pakistan, certain private sector players have been active in experimenting with better seed varieties of cotton and wheat⁵⁶. These seeds offer a range of benefits including heat tolerance, pest tolerance and early maturing varieties. Moreover, early maturing seed varieties of wheat allows for the simultaneous planting of canola, a competing seasonal crop. If farmers are able to move up the time of canola plantation it would allow for earlier varieties of other crops such as cotton to be grown following canola harvest, hence increasing overall crop yield while protecting the cotton crop from monsoon⁵⁷.

Moreover, continuous research and development on seeds, as well as other agricultural inputs and practices, is essential to enable timely and effective responses to both anticipated and unforeseen challenges.

Integrated Pest Management (IPM): In addition to seeds, the use of fertilizers and pesticides needs to be managed. Under CSA, use of organic matter and fewer chemicals is encouraged in order to ensure that the land is not depleted of its nutrients. Hence the practice of Integrated Pest Management (IPM) is used which utilizes natural predators and beneficial insects for pest control, reducing dependence on chemical pesticides that cause damage to non-target species and adversely impact biodiversity⁵⁸. While farmers in Pakistan have adopted IPM since its emergence, they are stuck using traditional and outdated techniques due to lack of information⁵⁹.

Crop diversification is a critical technique that is being used globally and that can work for both small- and large-scale farmers. There are two different approaches to crop diversification: i) the horizontal crop intensification method is beneficial for small farmers as production increases due to increased cropping intensities and ii) the vertical approach whereby the farmer adds value and goes beyond just the production of crops by including post-harvest activities such as processing, grading, packaging, and transporting to domestic as well as foreign markets. Large scale farmers may find this method easier as it requires more investment but has the potential to provide higher returns⁶⁰.

Precision farming & real time data: Real time data often through GPS can help make important resource management decisions with accuracy and precision by observing, measuring, and responding to variables within

⁵⁵Climate Adaptation. Namrata Kala, Clare Balboni, Shweta Bhogale, 2023.

⁵⁶The State of Pakistan's Agriculture. 2024. Producing More with Less: Fatima Group in Wheat and Cotton. https://pac.com.pk/wp-content/uploads/2025/01/SOPAR_24-2.-Producing-more-with-less-Fatima-Group-in-wheat-and-cotton.pdf

⁵⁷The State of Pakistan's Agriculture 2024. How the Corporate Sector in Developing Agriculture. The Pakistan Business Council, 2024. <https://www.pbc.org.pk/wp-content/uploads/The-State-of-Pakistans-Agriculture-2024.pdf>

⁵⁸Institute of Sustainability Studies. 2024. How regenerative farming practices are revolutionising biodiversity in agriculture. <https://instituteofsustainabilitystudies.com/insights/lexicon/how-regenerative-farming-practices-are-revolutionising-biodiversity/>

⁵⁹Integrated Pest Management and Controlling Strategies in Pakistan. 2025. 10.70749/ijbr.v3i6.1605

⁶⁰Technological Approaches for Climate Smart Agriculture. 2024. <https://link.springer.com/book/10.1007/978-3-031-52708-1>

the field. Autoseers (tractor guidance) and variable rate technology are efficient methods which use GPS when planting, spraying herbicide, or applying fertilizer to ensure accuracy and reduce wastage⁶¹. Moreover, sensors, drones and satellite data can be used to provide high-resolution imagery to monitor crop health and variability across a field to allow more efficient and targeted resource usage.

Similarly, integrated real-time sensors can be used to measure soil moisture, temperature, and humidity monitoring with Arduino-based automation⁶² ⁶³. However, these are all big investments which small farmers might not have resources for.

Leverage Artificial Intelligence: There is a crucial need to move beyond diagnostics

towards a clearly outlined innovative strategy, that addresses gaps and challenges, by leveraging modern technology and artificial intelligence (AI). Effective use of AI powered flood and weather intelligence systems allow farmers to pre-empt climate-change induced disruptions and enable early intervention before vulnerabilities result in breaches⁶⁴.

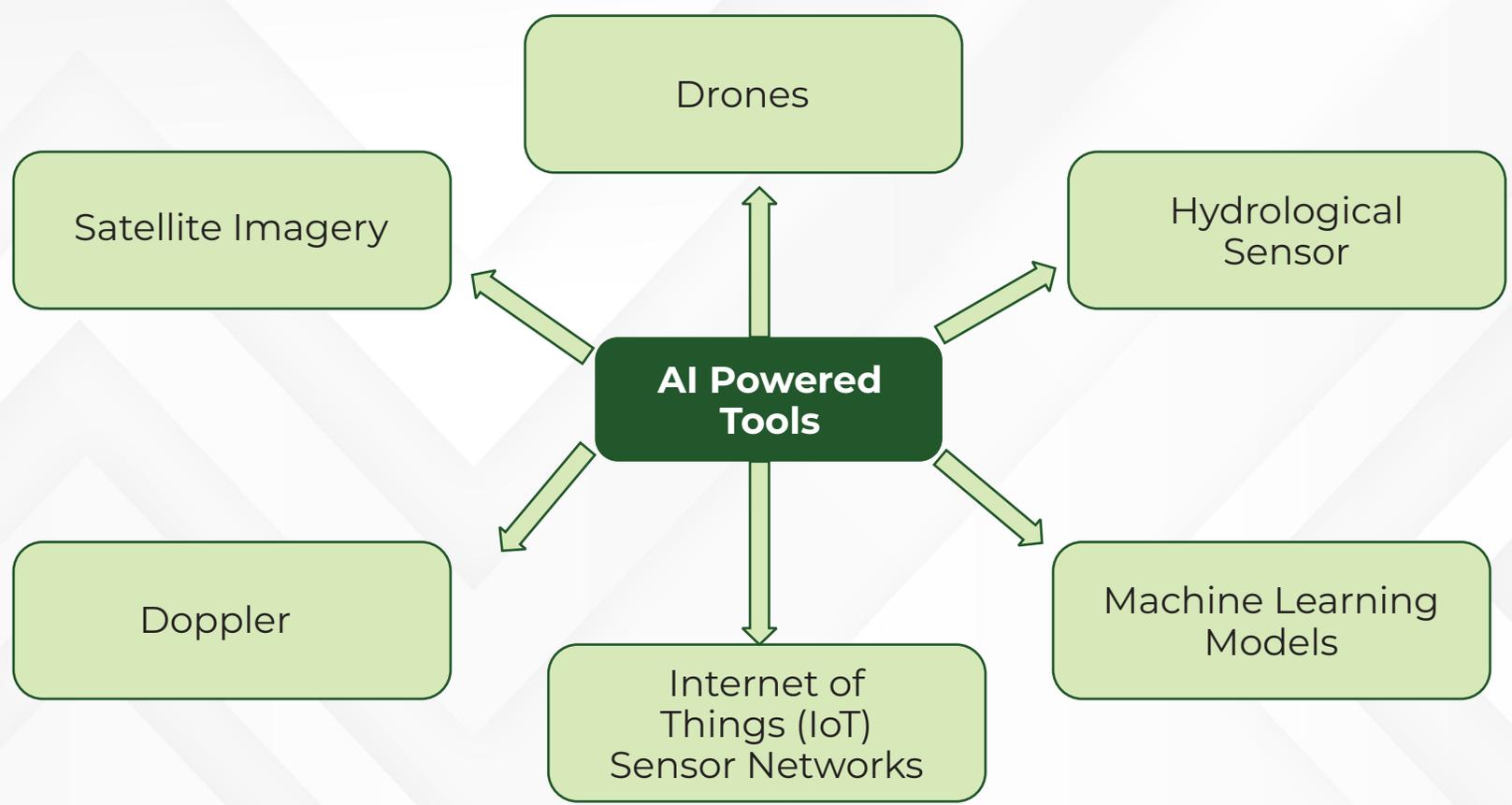


⁶¹USDA. Benefits and Evolution of Precision Agriculture. 2025. <https://www.ars.usda.gov/oc/utm/benefits-and-evolution-of-precision-agriculture/>

⁶²Arduino is an open-source electronics platform that is based on microcontroller technology. It consists of a series of microcontroller boards that can be programmed using a simple, easy-to-use software development environment. <https://stemready.acads.iiserpune.ac.in/modules/technology/arduino-automation>.

⁶³Smart agriculture using IoT for automated irrigation, water and energy efficiency. 2025. <https://doi.org/10.1016/j.atech.2025.101081>

⁶⁴T-Magazine. The New Agriculture Frontier. 2025. <https://tribune.com.pk/story/2583291/the-new-agriculture-frontier>



Modern Machinery: Modern machinery can be used to facilitate CSA techniques and methods by making them more efficient, reducing labour costs and improving crop quality and yields.



(i) Crop-residue management machinery reduces both labour costs and limits time investment between crop cycles. **Rice Straw Shredders** and **Happy Seeders** can be used to reduce dependence on crop burning and to prepare fields in time for planting of the next crop. Research indicates that the use of such machinery has yielded positive results in India where GHG emissions per hectare were reduced by more than 78% relative to

Unfortunately, Pakistan's overall farm mechanization remains low (an estimated 35% mechanization rate), but informal rental markets are bridging the gap. In provinces like

burning⁶⁵. Minimum tillage implements such as **no-till drills** or **direct seed drills** can also be used to prepare land for planting without altering soil integrity. Similarly, **balers** and **straw choppers** can be used for collecting, transporting, and storing loose hay or straw.

(ii) Solar powered or renewable energy driven equipment such as solar-powered pesticide sprayers reduce the input costs of

Punjab, most wheat cultivation steps are now mechanized, from land preparation to seeding and harvesting⁶⁶. Smallholders who do not have the resources to purchase latest

energy and have a significantly lower environmental impact.



equipment can rent it from others on a short-term basis, allowing them to benefit from the modern technology without bearing the upfront costs⁶⁷.



⁶⁵Can subsidising green agricultural technology reduce smog? An experimental study. 2023. <https://www.theigc.org/sites/default/files/2023-11/Naeem%20et%20al%20Policy%20brief%20February%202023.pdf>

⁶⁶FAO. Agricultural mechanization for smallholder farmers in Pakistan: Results of a multistakeholder policy dialogue. 2024. <https://doi.org/10.4060/cd1865en>

⁶⁷Informal Farm Machinery Rental Market in Pakistan. 2025. <https://amarrazzaq.com/insights/farm-machinery-rental-pakistan.html>

Following are a few recommendations to support adoption of modern techniques and technology by farmers:

1. Prioritise continuous and responsive research and development:

Cutting-edge research is required to ensure effective and timely response to anticipated and unforeseen challenges. This can be done by enriching existing research wings in provincial agricultural departments through collaborations with both local institutions and international research centres.

2. Improve regulatory capacity and efficiency:

Reevaluate the existing seed certification and quality control mechanisms to make them more modern and aligned with international standards. Moreover, regulatory processes need to be made more efficient and user-friendly. A holistic approach to monitor seed production practices (i.e. processing, treatment, storage and transport) is required.

3. Safeguard intellectual property:

A robust mechanism to protect intellectual property

rights needs to be put in place, especially during the seed certification interim period to prevent information leaks resulting in the premature sale of the product before the certification is granted.

4. Integration of modern seed varieties:

Incentivize and promote the development and distribution of high-yield, pest resistant, and climate-resilient seed varieties to help farmers mitigate the adverse impacts of climate change⁶⁸. Educate and train farmers to use the right varieties through extension services.

5. Improve access to information:

Improve agricultural extension systems to make them more effective allowing for a responsive seed delivery system to enable farmers to access quality seeds and planting materials of resilient crop varieties at affordable prices and in a timely manner⁶⁹.

6. Investment in enabling digital infrastructure and digital literacy:

Technology, AI and social media can be used to augment human capital development by providing agricultural training programs that inform, train and produce skilled farmers who can use and maintain the latest technology, machinery and techniques. This can be done through a collaborative effort between public and private sectors. This will reduce the burden on an already capacity-constrained extension services system.

7. Develop a unified futuristic policy:

Formulate an exclusive and comprehensive national policy on agricultural mechanization and related digital transformation. The policy should encompass how advanced technology will be acquired⁷⁰, and how it will be made accessible to the most vulnerable farmers, delineating clear architecture for data, governance and delivery⁷¹.

⁶⁸A framework for productivity and export led growth in Pakistan, IGC. 2025. <https://www.theigc.org/publications/framework-productivity-and-export-led-growth-pakistan>

⁶⁹FAO. Climate Smart Crop Production. <https://www.fao.org/climate-smart-agriculture-sourcebook/production-resources/module-b1-crops/chapter-b1-2/fr/>

⁷⁰FAO. Agricultural Mechanisation for Small-holder Farmers in Pakistan.

<https://openknowledge.fao.org/server/api/core/bitstreams/0369bd1a-11de-4d1c-9838-ae9f6eda312a/content>

⁷¹T-Magazine. The New Agriculture Frontier. 2025. <https://tribune.com.pk/story/2583291/the-new-agriculture-frontier>

8. Evaluate existing support programs to assess visibility, reach and efficacy:

An assessment of the performance of government agricultural support schemes such as the Green Tractor Scheme⁷², Punjab Wheat Support Scheme⁷³, Kissan Card Scheme⁷⁴, Benazir Hari Card⁷⁵, and the Sindh Water and Agriculture Transformation Project⁷⁶ at provincial levels and the Prime Minister's Youth Business and Agriculture Loan Schemes⁷⁷ at the Federal Level needs to be conducted. Key metrics to be measured could include awareness of/visibility, efficiency, accountability, and ease of opting-in of such programs to determine reasons for low uptake. Such an assessment can feed into how policies and programs can be redesigned to remove barriers to uptake.

9. Leverage Public-private partnerships:

Foster innovation in agricultural technology by creating an enabling environment for local manufacturing, through targeted subsidies and rebates on taxes and duties, particularly

on the import of raw materials⁷⁸. PPPs can also be leveraged to create international partnerships to acquire intellectual and technological expertise such as biotechnology. Additionally, PPPs can be leveraged to provide specialised one-stop-shop agricultural services such as Habib Bank Limited (HBL)'s 'Zarai Deras' which aim to support and promote agricultural investments through state-of-the-art centers that offer expert agronomic guidance, high-quality farm inputs, advanced mechanization solutions, efficient logistics support and crop procurement⁷⁹.

10. Leverage China-Pakistan Economic Corridor (CPEC):

Agriculture has been formally included as a priority area under CPEC^{2,9}. The government should leverage this partnership to support and invest in innovative and regenerative agricultural practices, techniques and technologies.

11. Leverage rental arrangements: Access to expensive technology and machinery can be

made available through rental services. Public-Private partnerships should be established to provide commercially sustainable rental services for equipment; this would reduce farmers' need to make large capital investments⁸⁰.



⁷²Punjab Portal. CM Green Tractor Scheme. <https://punjab.gov.pk/cm-green-tractors-scheme>

⁷³Punjab Portal. CM Punjab Wheat Support Program. <https://punjab.gov.pk/node/6427>

⁷⁴Punjab Portal. CM Kissan Card Scheme. <https://punjab.gov.pk/cm-kissan-card-scheme>

⁷⁵Government of Sindh. Benazir Hari Card. <https://www.benazirharicard.gos.pk/>

⁷⁶Sindh Water and Agriculture Transformation Project. <https://swatagriculture.gos.pk/>

⁷⁷State Bank of Pakistan. Prime Minister's Youth Business and Agriculture Loan Scheme (PMYB&ALS) <https://www.sbp.org.pk/Incen-others/PMYBALS.asp>

⁷⁸FAO. Agricultural mechanization for smallholder farmers in Pakistan: Results of a multistakeholder policy dialogue. 2024. <https://doi.org/10.4060/cd1865en>

⁷⁹Habib Bank Limited. Zarai Services. <https://hblzarai.com/services/>

⁸⁰FAO. Agricultural mechanization for smallholder farmers in Pakistan: Results of a multistakeholder policy dialogue. 2024. <https://doi.org/10.4060/cd1865en>

Weak storage, transport, and market linkages amplify climate-induced food losses and price spikes

The Last Mile Problem: A critical component of the agricultural process is the last mile challenge that goes far beyond physical distance. The last mile challenge reflects the difficulty and high costs of reliably, timely and scalably providing the requisite services, inputs and market access, in particular, to small-scale farmers⁸¹. Only about 15% of farmers have direct linkages to markets⁸². It indicates deeper structural gaps such as fragmented input supply chains, limited extension services, poor market connectivity, poor logistics, processing and storage inefficiencies and and low financial inclusion preventing farmers from accessing the right inputs timely or selling their produce efficiently⁸³. As temperatures rise and rainfall becomes more unpredictable, these weaknesses become even more costly.

Globally, post-harvest losses account for the loss of one-third of of all food produced, with grains faring better than perishable crops⁸⁴. Consistent with this trend, in Pakistan 35-40% of total production of vegetables and fruits is estimated to be wasted post-harvest⁸⁵. These losses are exacerbated in the wake of climate shocks such as floods that disrupt the supply chain. Storage facilities get compromised. The inundation of roads affects transport of crops. Perishable crops are impacted the most as they cannot be transported in time to markets. Moreover, price volatility impacts both farmers and consumers as prices surge and retailer margins increase. As a result of the 2022 floods supply went down by 50-65% while prices surged by 49% at auction time and 65% at the retail level contributing significantly to food inflation⁸⁶. Poor farmers bear the worst burden

of such shocks as they lack the savings and access to credit required to absorb losses.

Remote regions face even steeper barriers. Transport costs are high, markets are not well connected to each other, and farmers may be isolated or marginalized, unable to interact with markets either as sellers or buyers. To overcome climate induced supply chain challenges, farmers require access to markets both to purchase climate-smart agricultural inputs (such as fertilizers, seeds, credit, and insurance) and to sell their goods. Small-scale farmers in particular are susceptible to losses in profitability as they face many barriers to accessing markets, especially at the right time⁸⁷.

⁸¹KCL Global. Bridging the Last Mile: Private Sector Solutions for Farmer Service Delivery. <https://tinyurl.com/3wh5nvaf>

⁸²The Agricultural Economist. Impact of Middlemen of Pakistan's Agriculture. 2025.

<https://www.agrieconomist.com/impact-of-middlemen-on-pakistans-agriculture>

⁸³KCL Global. Bridging the Last Mile: Private Sector Solutions for Farmer Service Delivery.

<https://tinyurl.com/3wh5nvaf>

⁸⁴FAO. Policy Support and Governance Gateway.

<https://www.fao.org/policy-support/policy-themes/food-loss-and-food-waste/-Food-Loss-and-Food-Waste-Database/en>

⁸⁵AgriTech: Crafting Pakistan's Journey to Impact. <https://tabadlab.com/wp-content/uploads/2022/07/AgriTech-Report-07-07-22.pdf>

⁸⁶Vulnerable Markets: Impact of Extreme Flooding on Agricultural Supply Networks in Punjab. Asad, Gondal & Said, 2025. SSRN Working Paper.

<https://dx.doi.org/10.2139/ssrn.5040333>

Addressing last-mile constraints is essential for sustainable agricultural growth. Global experience shows how improvements in

storage, logistics, and market connectivity/transport can reduce losses from 20-30% to under 2%⁸⁸.



Empower farmers through agribusiness sector linkages

A strong and effective communication channel between farmers and the agribusiness sector offers the opportunity for productivity gains by creating the right pull-factors. Processors can drive adoption of productivity enhancing and climate resilient practices by setting quality standards, providing agronomic guidance, and facilitating access to machinery and services. Establishing such a collaborative relationship

presents as a mutually beneficial arrangement whereby processors benefit from additional value as a result of standardized, higher-quality produce and farmers benefit financially from price premiums, assured offtake, or more stable demand. Such alignment between farm-level practices and downstream value creation and value sharing is critical to unlocking meaningful change. Moreover, the

push to forge such relationships typically comes from the agribusiness side as opposed to the farmers' side, due to their limited capacity and capability to explore new market opportunities, and hence an environment conducive to the establishment and growth of the agribusiness sector will be essential to achieving such linkages⁸⁹.

⁸⁷J-PAL. Increasing small-scale farmers' access to agricultural markets. 2025.

<https://www.povertyactionlab.org/policy-insight/increasing-small-scale-farmers-access-agricultural-markets>

⁸⁸Agriculture Institute. The Importance of Transport and Storage in Agricultural Logistics. 2024.

<https://agriculture.institute/marketing-management-for-agribusiness/importance-transport-storage-agricultural-logistics/>

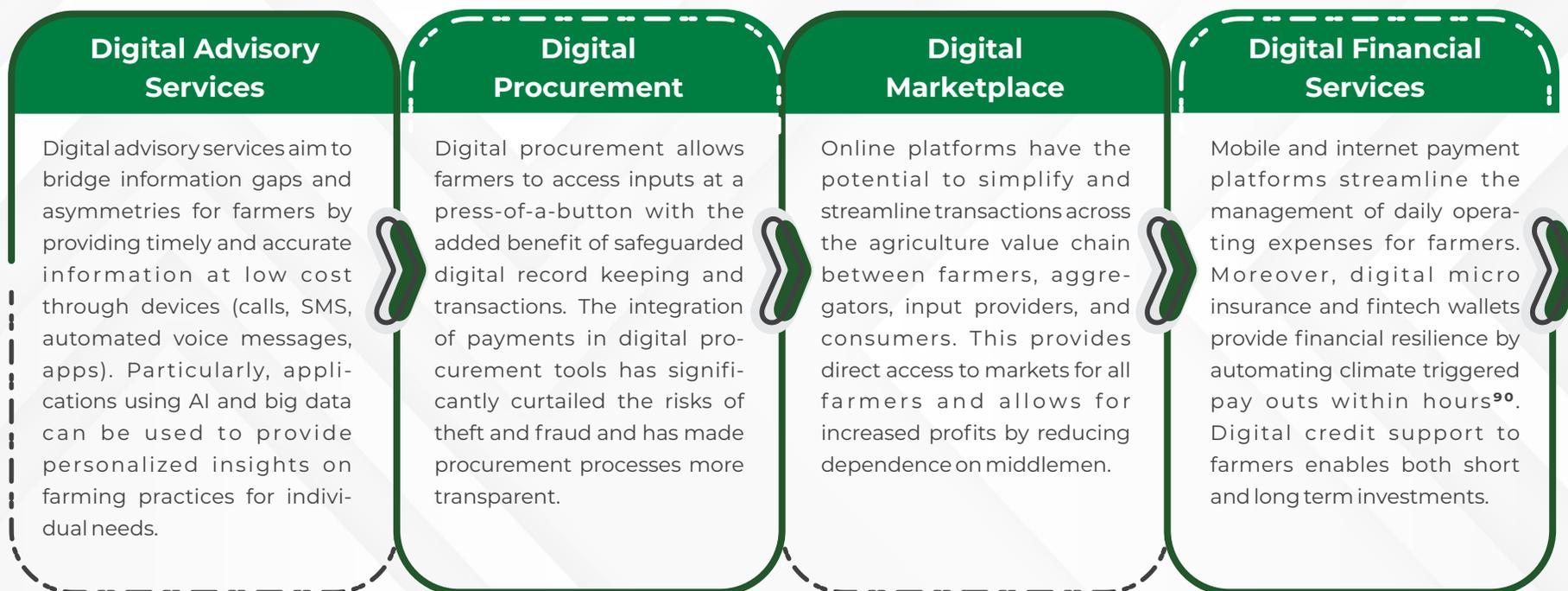
⁸⁹Promoting farm/non-farm linkages in developing countries. <https://www.fao.org/4/y4383e/y4383e04.htm>

Embrace digital transformation to unlock agricultural growth

Digitising the agriculture value chain can help overcome challenges pertaining to both financial inclusion and market access. Creating

digital profiles for farmers has a catalytic impact on their access to a variety of digital services like advisory, e-commerce, and digital

financial services.



Source of above infographic: AgriTech - Crafting Pakistan's Journey to Impact. Tabadlab⁹¹.

⁹⁰T-Magazine. The New Agriculture Frontier. 2025. <https://tribune.com.pk/story/2583291/the-new-agriculture-frontier>

⁹¹AgriTech: Crafting Pakistan's Journey to Impact. <https://tabadlab.com/wp-content/uploads/2022/07/AgriTech-Report-07-07-22.pdf>

Following are some recommendations for overcoming last mile challenges:

1. Develop adequate storage facilities:

Properly sealed hermetic storage facilities are essential to reduce storage losses and preserve seed viability and quality for a long time. Similar facilities are required for storage of produce⁹².

2. Curtail losses incurred in transit:

Development of appropriate post-harvest handling system including cold-chain maintenance, for the transportation of food from the time and location of harvest to the consumer⁹³.

3. Leverage Public-Private partnerships:

Establish PPPs and utilise private incubators to encourage innovation and develop proper forecasting systems to initiate quick response from farmers at times of climate events and shorten recovery times and lower recovery costs⁹⁴.

4. Establish linkages between farmers and the agribusiness sector

to unlock downstream value creation and value sharing, which supports and incentivises farmers to boost productivity and build resilience. The government must create an environment conducive to investing in agribusiness as that is the catalyst to the establishment of such linkages.

5. Leverage digital tools for information sharing and early response mechanisms:

Widespread mobile and smartphone penetrations can be leveraged to communicate important weather-related and sectoral information to farmers working even in the most remote areas in the country. Advisory scripts and early warning messages can be sent to farmers' phones in local languages to maximise outreach.

6. Leverage digital ecosystems to create marketplaces:

Connect farmers to markets through existing rural transportation systems or digital platforms⁹⁵. Digital platforms, such as SMS services, community radio, or other easily accessible online platforms, can offer a marketplace, connecting farmers to potential buyers allowing for contact farming, reducing information asymmetries and traditional transaction costs⁹⁶.

7. Invest in digital literacy: To boost uptake AgriTech services investments into digital literacy and skill upgradation is required to ensure meaningful engagement with digital interfaces and services.

8. Invest in infrastructure: In the long-term it is imperative that road networks and associated infrastructure be developed to facilitate market access.

⁹²AgriTech: Crafting Pakistan's Journey to Impact. <https://tabadlab.com/wp-content/uploads/2022/07/AgriTech-Report-07-07-22.pdf>

⁹³ibid.

⁹⁴Synthesis of evidence from Pakistan and global research: Asad et al. (2021–25); Cisse et al. (2024); Christian et al. (2025); Cunha, De Giorgi & Jayachandran (2019); Lawlor et al. (2017); Filmer et al. (2023).

⁹⁵J-PAL. Increasing small-scale farmers' access to agricultural markets. 2025. <https://www.povertyactionlab.org/policy-insight/increasing-small-scale-farmers-access-agricultural-markets>

⁹⁶Agriculture Institute. Challenges Facing the Agribusiness Sector in India. 2024. <https://agriculture.institute/agribusiness-mgt-policies/challenges-facing-agribusiness-in-india/>

Key policy messages

Climate resilience should be a core goal of agricultural policy and shift focus from short-term production and price support towards policies that protect long-term yields, farmer incomes, and food security against climate events like floods, droughts, and heatwaves.

Government policies should target small and vulnerable farmers. Subsidy reform and support schemes should prioritise smallholders, redirecting resources towards regenerative practices rather than reinforcing wheat-centric incentives.

The foundations of agriculture, such as soil health and water governance, need to be strengthened via regenerative and conservation practices (such as intercropping, minimal tillage, organic inputs, agroforestry) alongside fairer water pricing and improved irrigation governance.

Unlock productivity through seeds, modern technology, artificial intelligence, digitisation and mechanisation by investing in resilient seed varieties, integrated pest management, precision agriculture, and modern machinery, while ensuring small farmers can access these through rental markets, extension services, and targeted incentives.

Fix the last mile in storage, transport, and market linkage by reducing climate-induced food losses and volatility by improving hermetic and cold storage, rural roads, and expanding use of digital platforms linking farmers to inputs, buyers and information.

Use finance and public-private partnerships to scale adaptation by expanding specialised agricultural finance, weather/yield-indexed insurance, and PPPs for mechanisation, storage, and advisory services to crowd in private investment.

Strengthen information and extension systems by modernising agricultural extension services via digital tools and locally relevant climate and market data to support behaviour change and better on-farm decision-making by farmers.

Digitize the agriculture value chain—starting with universal digital farmer profiles— to foster financial inclusion, market access, and resilience. The governments can integrate digital advisory, procurement, marketplaces, and financial services into a single ecosystem to reduce information asymmetries, lower transaction costs, improve transparency, and empower farmers to make informed decisions, access markets directly, and invest confidently in productivity and climate resilience



FROM VULNERABILITY TO VITALITY:

BUILDING

**CLIMATE RESILIENCE IN
AGRICULTURE**