

Sustaining Growth and Security

Agriculture, Rural Development, and
the Economy in the Face of
Global Challenges

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The #1 source for in-depth analyses, expert opinions, and cutting-edge research on topics such as sustainable farming practices, global food security, agricultural policies, market trends, and technological innovations.

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Agriculture at the Heart of Climate Change and Food Security Challenges

Explore how agriculture can drive climate action, food security, and rural development in an era of polycrisis. Policy, innovation, and resilience insights.

Muhammad Khalid Bashir

10/1/2025

As the world faces unprecedented challenges, agriculture stands at the forefront of solutions that can drive economic growth, combat hunger, alleviate poverty, and address the pressing issue of climate change. October brings with it a series of globally significant days that underscore the vital role agriculture plays in shaping our future. To celebrate these milestones, The Agricultural Economist invites submissions for a special edition exploring the interconnectedness of agriculture, rural development, and the economy in the context of these global challenges.

This month's theme, Sustaining Growth and Security: Agriculture, Rural Development, and the Economy in the Face of Global Challenges, aims to foster dialogue on how agricultural innovation can contribute to a sustainable and equitable world. The observances in October, such as World Food Day, International Day for Rural Women, and the International Day for the Eradication of Poverty, remind us of the far-reaching impact agriculture has on global development, from improving food security to empowering rural communities.

World Food Day (October 16): Achieving Zero Hunger

As global hunger persists, the need for sustainable food systems and agricultural innovation has never been greater. On World Food Day, we reflect on the importance of ensuring access to food for all. We invite articles that examine how technology can drive agricultural production, the role of smallholder farmers in achieving food security, and innovative policies that support sustainable practices. By focusing on these issues, we can envision a future where hunger is eradicated and food

systems are resilient in the face of climate challenges.

International Day for Rural Women (October 15): Empowering Rural Women

Rural women are the backbone of many agricultural economies, yet they face significant barriers to success. This day provides an opportunity to highlight the essential role women play in food production, rural enterprises, and community development. Articles that explore their contributions, as well as the obstacles they face in accessing land, finance, and technology, are crucial. Success stories of rural women transforming their communities can offer inspiration and demonstrate the importance of gender-inclusive policies for sustainable rural development.

International Day for the Eradication of Poverty (October 17): Farming as a Pathway out of Poverty

Agriculture has long been recognized as a powerful tool for poverty alleviation, particularly in rural areas where many of the world's poorest reside. Submissions focusing on how agricultural practices can raise incomes, create sustainable livelihoods, and reduce rural poverty are welcomed. Access to markets, finance, and supportive policies can make a substantial difference in the lives of smallholder farmers, helping them escape the cycle of poverty.

World Habitat Day (October 7): Rural-Urban Migration and Its Impact on Agriculture

As rural communities experience outmigration to urban areas, the landscape of agriculture is shifting. The effects of rural-urban migration on agricultural productivity and rural economies cannot be overlooked. On World Habitat Day, we

encourage articles that address strategies for improving rural living conditions to prevent migration and explore investments in rural infrastructure. How can rural areas retain labor, attract investments, and ensure agricultural productivity in the face of growing urbanization?

World Cotton Day (October 7): From Farm to Global Markets

The cotton industry plays a critical role in rural development and global trade, particularly in developing economies. Sustainability in cotton farming and overcoming market challenges for cotton farmers are essential topics for consideration. Articles focusing on the economic potential of cotton, its environmental impact, and the importance of fair trade in the cotton industry will help shed light on this vital crop.

World Day of Action on Climate Change (October 24): Climate-Smart Agriculture

Climate change poses one of the greatest threats to global food systems. As we face increasingly erratic weather patterns, agriculture must adapt to remain resilient. Articles on climate-smart agriculture, water and soil management innovations, and policies that support farmers in adapting to climate change are particularly timely. The role of agriculture in reducing greenhouse gas emissions is another critical area for exploration.

World Development Information Day (October 24): Technology and Data in Agriculture

In the digital age, information technology is transforming agriculture. From precision farming techniques to digital platforms for farmer education and market access, technology has the

potential to revolutionize the way we approach agricultural development. We seek articles that address the role of data in shaping agricultural policies and decision-making, and how bridging the digital divide in rural areas can enhance development and productivity.

Join the Global Conversation

The issues highlighted by these globally significant days underscore the intricate connections between agriculture, rural

development, and the economy. The Agricultural Economist invites contributions from a diverse range of voices agricultural economists, farmers, policymakers, rural development experts, and environmentalists to share insights, case studies, and policy recommendations that will help us navigate these challenges.

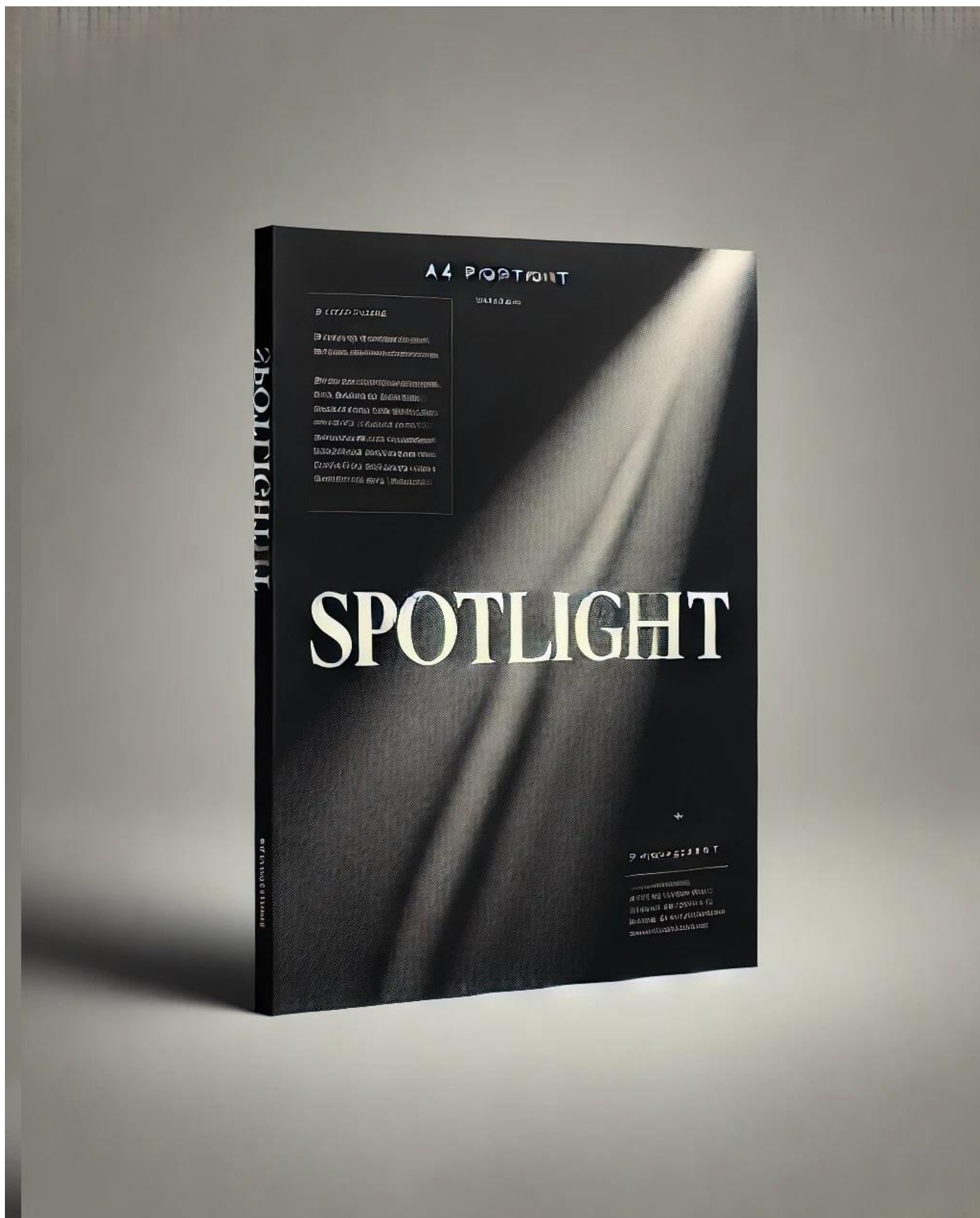
Together, we can create a sustainable and equitable future for agriculture and rural

communities. Submit your articles by October 20, 2025, and join us in shaping a global conversation that addresses some of the world's most pressing issues.

Send your submissions to: editor@agrieconomist.com

Muhammad Khalid Bahir, Managing Editor





Global Climate Crisis: Driving Resilience Through Innovation

Explore how the global climate crisis contributes to economic and social instability. Learn how bold policies, renewable energy, and innovative solutions can foster resilience in the face of these challenges.

Attaulah Veesar

10/16/2025

Climate change has moved beyond the realm of scientific projection and is now an undeniable reality shaping every dimension of human and ecological existence. It defines the Anthropocene epoch, a period where human activity has become the dominant force influencing Earth's systems. The overwhelming scientific consensus confirms that global warming is largely anthropogenic, driven primarily by the burning of fossil fuels, industrial agriculture, deforestation, and other unsustainable land-use practices that release vast quantities of greenhouse gases into the atmosphere (IPCC, 2023).

Recent years have underscored the severity of this crisis. According to the World Meteorological Organization (2024), the year 2023 was officially recognized as the warmest year on record, with global mean temperatures averaging 1.45°C above pre-industrial levels. This figure edges dangerously close to the 1.5°C threshold set by the Paris Agreement, beyond which climate-related risks to food security, water availability, and biodiversity are projected to escalate dramatically. The impacts are already evident through melting glaciers, extreme heatwaves, devastating floods, and erratic monsoon patterns that are reshaping livelihoods and ecosystems alike.

This paper presents a critical examination of the current climate scenario, analyzing not only the root causes but also the socio-economic and environmental repercussions that accompany them. It further evaluates the effectiveness of global and regional mitigation efforts, such as renewable energy transitions and carbon pricing mechanisms, alongside adaptation strategies including climate-smart agriculture and urban resilience

planning. Ultimately, the discussion emphasizes the indispensable role of policy coherence, international cooperation, and equitable governance in addressing what has become the defining challenge of the 21st century. Without decisive and coordinated global action, the window for limiting catastrophic climate change is rapidly closing.

The Escalating Climate Emergency: Evidence, Impacts, and the Global Implementation Gap

The Intergovernmental Panel on Climate Change (IPCC), in its Sixth Assessment Report (AR6), has delivered its most urgent message to date: human activity has warmed the planet at a rate unseen in at least the past 2,000 years (IPCC, 2023). The data are unequivocal: concentrations of the key greenhouse gases (GHGs) carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O) have surged to record highs not experienced in millions of years. CO₂ levels now exceed 420 parts per million (ppm), a direct result of relentless fossil fuel combustion. According to the Global Carbon Project (2023), fossil fuel emissions reached a new peak of 36.8 billion tonnes in 2023, rebounding sharply after the brief slowdown during the COVID-19 pandemic.

The consequences of this accelerated warming are no longer confined to scientific projections; they are unfolding before our eyes. The AR6 report attributes the rising frequency and intensity of extreme weather events directly to human-induced climate change. Pakistan's catastrophic 2022 floods, which submerged one-third of the country and displaced millions, Europe's record-breaking heatwaves, and widespread wildfires across North

America all exemplify the tangible costs of inaction. These disasters have compounded challenges to food security, freshwater access, and global health, while driving mass displacement and economic instability.

Biodiversity, too, is under unprecedented threat. The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES, 2019) warns that at 1.5°C of warming, up to 14% of species face a very high risk of extinction, a figure that doubles to 29% at 2°C.

While international frameworks such as the Paris Agreement aim to limit global warming to 1.5°C, current actions fall dangerously short. The United Nations Environment Program (UNEP, 2023) estimates that even if all Nationally Determined Contributions (NDCs) are fully implemented, global temperatures will still rise by 2.5–2.9°C by 2100. This stark “implementation gap” underscores the urgency for deeper emission cuts, stronger policy enforcement, and a just global transition toward sustainable development.

Global Climate Trends: Intensifying Drivers, Mounting Impacts, and Widening Inequities

A synthesis of contemporary climate data paints an alarming picture of accelerating environmental degradation and widening global disparities. Human-induced greenhouse gas (GHG) emissions remain the central force behind planetary warming. According to Climate Watch (2023), energy production contributes approximately 35% of total emissions, followed by agriculture at 22% and industry at 19%. Of particular concern is the growing release of methane, a gas with over 80 times the warming potential of carbon

dioxide over a 20-year period, originating from livestock, rice cultivation, and fossil fuel extraction. These emissions are significantly amplifying short-term climate feedback, accelerating warming trends beyond previous projections.

The physical and economic consequences of these emissions are increasingly severe and interlinked. The World Meteorological Organization (2024) reports that global mean sea level rise has reached an unprecedented 4.62 millimeters per year between 2013 and 2022, driven primarily by ice loss from Greenland and Antarctica. This rise threatens to submerge low-lying coastal areas, displace millions, and erode vital agricultural lands. Economically, the Swiss Re Institute (2021) estimates that without meaningful mitigation, climate change could reduce global GDP by 11–14% by 2050, with developing economies suffering the most profound losses.

Despite remarkable progress in renewable energy, the pace of decarbonization remains inadequate. The International Energy Agency (IEA, 2023) projects that fossil fuels will still supply 73% of the world's energy in 2030, only slightly lower than today's 79%. Carbon capture and storage technologies, essential for offsetting unavoidable emissions, remain vastly underutilized, further widening the mitigation gap.

The inequity of climate change is stark. Developing nations, responsible for a fraction of historical emissions, bear the brunt of the crisis. The World Bank (2022) warns that up to 132 million additional people could fall into poverty by 2030 due to climate-induced disruptions. These findings underscore an urgent moral and economic imperative: global cooperation must accelerate decarbonization while bolstering resilience where it is needed most.

From Crisis to Opportunity: Navigating the Global Climate Polycrisis

The world now faces a *climate polycrisis*, a complex convergence where environmental degradation fuels economic instability, political conflict, and deepening social inequities. This interconnected crisis underscores that climate change is no longer just an environmental issue but a defining global challenge that demands systemic transformation. The era of acknowledging the problem has passed; what is needed now is swift evaluation and implementation of feasible, large-scale solutions.

At the heart of the challenge lies the continued political and financial backing of fossil fuels. The International Monetary Fund (2023) estimates global fossil fuel subsidies both direct and indirect at a staggering \$7 trillion annually, effectively financing the very emissions driving planetary breakdown. Ending these subsidies is the most immediate and impactful step toward accelerating the global energy transition. Yet, mitigation alone is not enough. A certain level of warming is now inevitable, making adaptation equally critical. Investment in climate-resilient infrastructure, drought-tolerant crops, and advanced early-warning systems must become central pillars of national and global policy.

Despite these daunting realities, there are promising pathways forward. The International Energy Agency (2023) notes that renewable energy is now cheaper than fossil fuels in most markets, and electric vehicle adoption is rapidly outpacing expectations. Meanwhile, carbon pricing mechanisms covering 23% of global emissions are driving market-based decarbonization (World Bank, 2023). Coupled with growing climate litigation and civil society activism, these trends signal a shift toward accountability and action. The polycrisis, while perilous, may yet catalyze the most transformative era of climate governance in human history.

Conclusion

The global climate polycrisis represents both a grave warning and an

extraordinary opportunity for transformative change. Humanity stands at a crossroads where incremental adjustments are no longer sufficient; only a comprehensive reorientation of economic, political, and social systems can prevent irreversible damage. The staggering \$7 trillion in fossil fuel subsidies illustrates the persistence of outdated priorities that continue to fund destruction rather than sustainability. Redirecting these resources toward renewable energy, reforestation, and climate-resilient infrastructure could yield immediate and long-term benefits for both people and the planet.

Equally important is the recognition that adaptation must advance alongside mitigation. As climate impacts intensify from megafires to floods investments in resilient cities, sustainable agriculture, and ecosystem restoration will define the success of future generations. Encouragingly, the rapid decline in renewable energy costs, expanding carbon markets, and rising global awareness suggest that a transition toward low-carbon prosperity is within reach.

Ultimately, overcoming climate polycrisis requires unprecedented collaboration between governments, industries, and civil society. The choices made in this decade will determine whether the 21st century is defined by collapse or renewal. If humanity acts decisively, the crisis can indeed become the catalyst for a more just, resilient, and sustainable global future.

References: Climate Watch; Global Carbon Project; IMF; IEA; IPBES; IPCC; Swiss Re Institute; UNEP; World Bank; WMO.

Please note that the views expressed in this article are of the author and do not necessarily reflect the views or policies of any organization.

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Dengue: A Public Health Emergency in Punjab

Dengue has become a persistent public health emergency in Punjab, exacerbated by climate changes and unplanned urbanization. As post-monsoon cycles intensify outbreaks, understanding the ecological and epidemiological trends is crucial for effective management and prevention.

Muhammad Hamid Bashir & Muhammad Huzaifa Jamil

10/23/2025

Dengue, a mosquito-borne viral illness, poses a recurrent and intensifying threat to public health in Pakistan, with Punjab repeatedly emerging as the epicenter of seasonal outbreaks. The dynamics of dengue transmission are tightly intertwined with environmental conditions, water management practices, and rapid urbanization. Each year, the post-monsoon period sets the stage for explosive disease spread. Torrential rains saturate cities and rural areas alike, leaving behind stagnant water in overhead tanks, flowerpots, discarded tyres, clogged drains, construction sites, and open water containers. These micro-habitats serve as ideal breeding grounds for *Aedes aegypti* and *Aedes albopictus*, the primary dengue vectors, whose life cycles accelerate in warm, humid climates.

High population density in urban centers such as Lahore, Rawalpindi, and Multan further fuels transmission. Unlike malaria mosquitoes, *Aedes* mosquitoes are daytime biters that thrive inside and around homes, making household water storage behaviors and sanitation practices critical determinants of risk. Climate change has amplified this challenge; increasingly erratic monsoon patterns, urban flooding, and unusually prolonged warm seasons have extended mosquito breeding periods and widened vector habitats. The WHO (2022) notes that climate variability is now directly tied to shifts in dengue incidence globally, and Pakistan is no exception.

Compounding these ecological and climatic factors are structural weaknesses in urban planning, waste management, and vector control. Informal settlements with poor drainage systems, unreliable piped water (prompting household storage), and unregulated construction

zones create persistent mosquito sanctuaries. Meanwhile, frequent movement of infected individuals between districts enables the virus to spread rapidly through dense population corridors.

As a result, dengue outbreaks in Punjab are no longer isolated health events, they are predictable seasonal crises. Without proactive ecosystem management and integrated vector control strategies, the province will continue to face escalating case numbers, mounting healthcare costs, and avoidable loss of life.

Ecological Drivers and Transmission Dynamics

The ecology of dengue transmission in Punjab is driven by a combination of climatic suitability, vector adaptability, and human-induced environmental change. The primary vector, *Aedes aegypti*, is a highly anthropophilic and day-biting mosquito that thrives near human settlements. Unlike other mosquito species that prefer natural wetlands, *Aedes* breeds in clean, stagnant water found in domestic environments overhead tanks, flowerpots, discarded plastic containers, tyres, and even bottle caps. Its eggs can withstand desiccation for months, allowing the species to survive between seasons and re-emerge explosively once water becomes available. Post-flood conditions amplify this breeding potential by multiplying water-holding containers and crippling drainage systems. In many urban and peri-urban areas of Punjab, disrupted water supply also compels households to store water in open containers, inadvertently creating ideal nursery sites for mosquito proliferation.

Temperature, humidity, and rainfall collectively shape transmission intensity.

A landmark study by Mordecai et al. (2017) demonstrated that dengue transmission peaks at temperatures around 29.3°C. Within the high-risk window of approximately 26–29°C, the virus's extrinsic incubation period (EIP), the time required for the virus to multiply inside the mosquito, shortens significantly, enabling the vector to transmit dengue more rapidly and efficiently. Punjab's post-monsoon climate consistently falls within this optimal range, aligning with findings by Liu et al. (2023), who emphasize that warm, humid conditions shorten mosquito breeding cycles and extend adult mosquito survival. Additionally, elevated nighttime temperatures, now more common due to climate change, allow *Aedes* populations to remain active for longer seasonal periods.

High human population density further accelerates virus circulation, as *Aedes aegypti* tends to bite multiple individuals during a single feeding cycle. This biological efficiency, combined with Punjab's climatic and ecological conditions, creates a self-reinforcing cycle of transmission, making dengue not just a seasonal event but a persistent public health threat.

The Epidemiological Burden: A Look at Recent Data

The province of Punjab has consistently borne the brunt of dengue outbreaks in Pakistan, highlighting the disease's entrenched presence and the urgent need for targeted public health action. In 2021, Punjab reported an alarming 24,146 confirmed cases and 127 deaths, representing nearly half of the national burden and the highest fatalities among provinces (WHO, 2022). That same year, the case-fatality rate and sheer volume signaled the scale of vulnerability in terms

of vector ecology, health infrastructure, and disease control.

The incursion of the catastrophic 2022 floods provided a stark example of how disaster and disease intersect. Flood-related disruptions to housing, water systems, and sanitation amplified mosquito breeding and human exposure. Between January and September 2022, Pakistan reported 25,932 confirmed dengue cases and 62 deaths with the majority concentrated in Punjab and other high-risk zones (WHO, 2022).

More recent figures show that dengue remains a persistent threat. As of November 10, 2024, Punjab's health department reported 6,838 confirmed cases in the province (Dawn, 2024). Early 2025 reports from high-burden districts such as Rawalpindi indicate that viral circulation continues at concerning levels, underscoring the need for heightened surveillance and rapid response (The Express Tribune, 2025). These numbers likely understate the true scale due to under-reporting, variance in diagnostic capacity, and differences in case definitions.

Collectively, the data illustrates that dengue in Punjab is more than just seasonal, it is endemic and escalating under changing climatic and infrastructural conditions. The convergence of extreme weather events, stagnant water habitats, dense urban populations, and overtaxed health systems means that outbreaks repeat with increasing frequency and severity. Strengthening epidemiological surveillance, ensuring accurate reporting, and prioritizing preventive control measures must be central to public-health strategy in Punjab—and by extension in Pakistan's broader fight against vector-borne disease.

Serotype Dynamics and the Narrow Window for Effective Intervention

The co-circulation of multiple dengue virus serotypes (DENV-1 to DENV-4) in Pakistan, particularly in high-burden provinces like Punjab remains one of the most consequential epidemiological challenges in dengue control. Unlike

many viral diseases where a single infection confers lasting immunity, dengue operates with a far more complex immunological profile. Infection with one serotype grants lifelong immunity only to that specific strain, while offering limited and temporary protection against others. When an individual is later exposed to a different serotype, the risk of severe illness such as dengue hemorrhagic fever or dengue shock syndrome rises significantly due to a process known as antibody-dependent enhancement (ADE). This makes shifts in serotype dominance a critical determinant of clinical outcomes and hospitalization surges.

Genomic surveillance following the 2022 outbreak identified DENV-2 as the dominant circulating serotype (Umair et al., 2023). However, more recent surveillance from 2024–2025 indicates a changing landscape, with DENV-1 gaining ground in major urban hubs such as Karachi, while DENV-2 continues widespread circulation in Punjab and Khyber Pakhtunkhwa (Tariq et al., 2025; Ali et al., 2024). Such heterogeneous serotype distribution increases the likelihood of sequential infections at the population level, amplifying the risk of severe disease clusters. This reality underscores the urgency of strengthening genomic monitoring, data-sharing, and hospital preparedness.

Against this backdrop, the post-flood and post-monsoon phase presents a narrow but powerful 4–6 week intervention window. Because *Aedes* mosquitoes can complete their life cycle in 7–10 days, stagnant floodwater creates synchronized “waves” of emerging adult mosquitoes. The World Health Organization (WHO, 2022) stresses that aggressive source reduction, removing standing water, larviciding priority sites, and deploying targeted vector control, during this early window can decisively blunt transmission before mosquito densities peak. Missing this intervention window allows exponential vector growth, dramatically increasing human infection rates and overwhelming health systems. For Punjab, timely, data-driven action during this critical period may spell the

difference between containment and crisis.

Recommended Public Health Response and Mitigation Strategies

Effective dengue control in Punjab requires a coordinated, multi-dimensional response that simultaneously targets the mosquito vector, strengthens clinical systems, and mobilizes communities. The cornerstone of prevention is robust entomological surveillance paired with sustained vector control. Urban administrations and district health authorities must conduct routine monitoring of larval habitats, using entomological indicators such as the Breteau Index and Container Index to prioritize hotspots. Weekly elimination of stagnant water through emptying, scrubbing, drying, and covering household storage vessels remains the most powerful preventive measure. Equally important is the proper disposal of discarded tyres, plastic containers, and construction waste, which serve as high-yield *Aedes* breeding sites. Where necessary, targeted larviciding and indoor residual spraying should be deployed based on surveillance data rather than blanket operations.

Clinical preparedness forms the second pillar of an effective response. Hospitals and primary care centers must be equipped with rapid triage, hematocrit assessment, platelet monitoring, and fluid management, following standardized national guidelines such as the Dengue Expert Advisory Group (DEAG) protocols. Because most mortality results from delayed detection and inappropriate fluid therapy, training frontline clinicians in early recognition of warning signs such as abdominal pain, persistent vomiting, mucosal bleeding, and fluid accumulation is essential for reducing fatalities, especially during peak transmission weeks.

Community engagement is the third and most sustainable component. Public awareness campaigns must be practical, repetitive, and culturally tailored, promoting the “Empty, Cover, Clean, and Dispose” approach for water containers. Encouraging the use of mosquito

repellents containing DEET or picaridin, installing window screens, and wearing full-sleeved clothing during peak biting times (dawn and dusk) can significantly reduce exposure. Schools, mosques, and local councils can serve as critical partners in mobilizing neighborhoods. When vector control, clinical readiness, and community participation advance together, Punjab can substantially reduce disease transmission and avert seasonal epidemics.

Conclusion

Dengue is no longer a seasonal inconvenience for Punjab it is an entrenched, climate-sensitive public health emergency that resurfaces with greater intensity each post-monsoon cycle. The convergence of ecological suitability, unplanned urbanization, inadequate waste management, and shifting serotype dynamics has created a persistent environment in which Aedes

mosquitoes thrive and outbreaks repeat with alarming regularity. Recent epidemiological trends and post-flood surges underscore that the province now faces *predictable crises*, not unpredictable shocks.

Yet, the path forward is clear. Dengue control is entirely achievable with timely, science-based interventions. Success demands an integrated strategy that attacks the problem at its source: eliminating breeding sites, strengthening entomological surveillance, and investing in rapid, protocol-driven clinical care. Equally crucial is community participation no amount of spraying or hospital preparedness can substitute for household-level action in controlling a mosquito that lives and breeds in domestic spaces.

The next decade will determine whether Punjab learns to live safely with dengue or continues to absorb preventable human

and economic losses each year. With political will, data-driven public health planning, and sustained societal engagement, the province can break the cycle of outbreaks and transform its response from reactive crisis management to proactive prevention. Dengue is beatable if we act before the next wave, not after it.

References: Ali et al; Dawn; Liu et al; Mordecai et al; NIH; Tariq et al; The Express Tribune; Umair et al; WHO.

Please note that the views expressed in this article are of the author and do not necessarily reflect the views or policies of any organization.

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2025 Monsoon Floods: Impact on Pakistan's Economy

The 2025 monsoon floods in Pakistan highlight the country's vulnerability to climate change, revealing weaknesses in its economy. Learn how these floods affect GDP growth, inflation, and food security.

Muhammad Ashir & Maha Nisar

10/31/2025

Pakistan, ranked consistently among the top ten countries most vulnerable to climate change (Global Climate Risk Index, 2024), has once again found itself at the epicenter of a climate-induced catastrophe. The 2025 monsoon floods, triggered by unprecedented rainfall patterns across South Asia, have become the most devastating natural disaster to strike the country since the historic deluge of 2022. Overwhelmed river systems, glacial meltwater, and saturated catchments converged to inundate vast areas across Punjab, Sindh, and Khyber Pakhtunkhwa (KPK), where the combined loss of lives, livelihoods, and infrastructure has been staggering.

Preliminary assessments by the National Disaster Management Authority (NDMA, 2025) indicate that more than 18 million people have been affected, with large-scale displacement and destruction of critical assets including homes, roads, schools, and health facilities. The agricultural sector, which remains the backbone of rural livelihoods and contributes nearly 24% to national GDP, has been particularly hard-hit. Standing crops of cotton, rice, and sugarcane were destroyed across millions of hectares, while livestock mortality and the loss of stored grain reserves have deepened food insecurity in already fragile rural economies. Simultaneously, the infrastructure damage, including washed-out bridges, power installations, and irrigation networks, has disrupted supply chains, curtailed trade flows, and imposed severe fiscal pressure on reconstruction budgets.

At the macroeconomic level, the floods are projected to shave at least 1.5–2% off Pakistan's GDP growth for 2025–26 (State Bank of Pakistan, 2025). Inflationary pressures are expected to intensify as food prices surge, while debt-financed recovery efforts further strain public finances. Beyond immediate losses, the 2025 floods

underscore a deeper structural vulnerability: the absence of climate-resilient planning, inadequate early warning systems, and fragile social protection mechanisms. Understanding these cascading impacts is crucial for guiding evidence-based policy, mobilizing international climate finance, and embedding resilience at the heart of Pakistan's development agenda.

The Immediate Toll: Human and Physical Impact

The 2025 monsoon floods left a trail of devastation across Pakistan, inflicting one of the gravest humanitarian and economic crises in recent years. According to the National Disaster Management Authority (NDMA, 2025), the disaster claimed 1,037 lives and injured 1,067 people, while over 229,000 houses were damaged, of which nearly 59,000 were destroyed. The loss of 22,841 livestock animals has further eroded the livelihood base of rural households, particularly in farming and pastoral communities already struggling from the 2022 floods. Infrastructure damage has been extensive, with 2,811 kilometers of roads and 79 bridges either washed away or rendered impassable, severing vital transport and supply routes across multiple provinces.

The agricultural toll has been particularly severe. More than 2.23 million acres of cropland were submerged or destroyed, wiping out standing crops of rice, maize, cotton, and sugarcane, staples that underpin both domestic food security and export earnings (FAO, 2025). Punjab, the country's agricultural powerhouse, suffered the most extensive damage, followed closely by Sindh and Khyber Pakhtunkhwa (KPK). In many districts, entire harvests were lost within days, and thousands of tenant farmers and laborers were displaced, with little means to recover in the short term.

The floods' physical destruction has also led to cascading humanitarian consequences, displacement of millions, contamination of drinking water sources, and the outbreak of waterborne diseases. Relief efforts have struggled to keep pace with the magnitude of need, highlighting deep structural weaknesses in Pakistan's disaster preparedness and early warning systems. Beyond the immediate loss of life and property, the floods have disrupted local economies, fractured community resilience, and intensified the urgency for climate-adaptive infrastructure and proactive governance to prevent a recurrence of such large-scale devastation.

Quantifying Economic Losses

The 2025 monsoon floods have inflicted staggering economic losses on Pakistan, surpassing the damage caused by the catastrophic floods of 2022. The Planning Commission of Pakistan (2025) initially placed the total damage estimate at approximately PKR 744 billion, encompassing destruction across housing, agriculture, infrastructure, and livestock. This figure was later refined to represent only verified and measurable losses, excluding secondary impacts such as long-term productivity declines and health-related costs, which could push the total even higher. The scale of destruction has stretched public finances, forcing the government to divert development allocations toward emergency relief and reconstruction efforts, thereby slowing progress in other sectors.

International institutions have echoed these concerns. The World Bank (2025) revised Pakistan's GDP growth forecast for FY2025–26 downward from 3.8% to 2.6%, citing severe agricultural disruptions and widespread infrastructure damage. In Punjab, agricultural output is projected to contract by nearly 10%, driven by the destruction of key crops such as maize,

cotton, and rice. The United Nations Office for the Coordination of Humanitarian Affairs (UN OCHA, 2025) reported that over 6 million people were affected, with 2.5 million displaced, underscoring the magnitude of the humanitarian and economic fallout.

The macroeconomic consequences have been immediate and far-reaching. The dual shocks to agriculture and public finances have derailed Pakistan's FY2025–26 growth target of 4.2%. Both the State Bank of Pakistan (SBP) and the World Bank project growth between 2.4% and 2.7%, depending on the speed of recovery and external financing inflows. Inflation is projected to rise by 1.5–2 percentage points in the second half of 2025, driven by supply disruptions and food shortages. Meanwhile, damage to export-oriented crops and rising food import bills could widen the trade deficit by \$1.2 billion, amplifying pressures on Pakistan's fragile external balance.

Sectoral Analysis and Humanitarian Fallout

The 2025 floods have left a profound and multidimensional impact on Pakistan's economy, with agriculture, infrastructure, and industry bearing the brunt of the destruction. Agriculture contributed nearly 19% to GDP and employing 37.4% of the national workforce (GoP, 2024) was the hardest-hit sector. The confirmed loss of 2.23 million acres of cropland (NDMA, 2025; FAO, 2025) has devastated the production of cotton, rice, sugarcane, and maize, with ripple effects throughout the agro-industrial value chain. Cotton losses have severely constrained raw material availability for the textile sector, which underpins Pakistan's export earnings. Beyond crop destruction, the loss of over 22,000 livestock has worsened rural household incomes and food insecurity, particularly among smallholders who rely on mixed farming systems.

Infrastructure damage has compounded these challenges. The destruction of 2,811 km of roads and 79 bridges has paralyzed regional trade and logistics, isolated rural communities and disrupting agricultural supply chains. The Planning Commission (2025) estimates direct infrastructure

losses at PKR 112 billion, but the secondary economic effects such as transport delays, supply shortages, and increased fuel costs are likely to double that figure in real terms. Damage to energy and irrigation systems has further constrained both industrial and agricultural productivity, slowing post-flood recovery.

Industrial output has been particularly affected in the textile sector, which faces an estimated 8% decline in export orders for cotton yarn and garments between August and September 2025 (PBS, 2025). Energy distribution failures in Sindh, Punjab, and Balochistan have led to factory shutdowns and reduced working hours, undermining employment stability.

The humanitarian crisis is equally dire. Over 6 million people have been affected, with 2.5 million displaced (OCHA, 2025). Rural communities in Punjab and Sindh are confronting acute food shortages, unsafe water, and collapsed health and education infrastructure. In response, the government alongside NDMA, UNDP, and the World Bank launched the National Flood Response Plan 2025, disbursing PKR 15 billion in emergency cash assistance through the Benazir Income Support Program (BISP) by October 2025. Despite these efforts, recovery remains slow, underscoring the urgent need for climate-resilient rebuilding and sustainable livelihood restoration.

Policy Response and Pathways to Resilience

The 2025 floods have prompted one of the most comprehensive disaster response efforts in Pakistan's recent history. The government's multi-pronged approach, as outlined by the Planning Commission (2025), reflects both immediate humanitarian priorities and the need for long-term structural reform. In the early phase, armed forces and provincial administrations were mobilized for extensive search, rescue, and relief operations, ensuring rapid evacuation from inundated districts and the provision of food, shelter, and medical aid. Concurrently, a Post-Disaster Needs Assessment (PDNA) was launched in collaboration with the World Bank and UNDP, providing a data-driven framework

to quantify total rehabilitation costs and guide funding allocations.

To meet urgent fiscal demands, the federal government reallocated PKR 120 billion toward emergency expenditures, redirecting resources from development projects to support humanitarian operations and infrastructure repair. In the agricultural sector, rehabilitation programs were rolled out to subsidize seeds, fertilizers, and irrigation repairs, aiming to restore livelihoods and prevent long-term food insecurity (FAO, 2025). On the international front, Pakistan engaged with the IMF to seek fiscal flexibility under the Extended Fund Facility (EFF), ensuring that post-flood reconstruction did not derail macroeconomic stability (IMF, 2025).

However, beyond these immediate measures, the floods have underscored Pakistan's deep-seated structural vulnerabilities its overreliance on climate-sensitive agriculture, inadequate water management, and underinvestment in resilient infrastructure (World Bank, 2025). Both the World Bank and Planning Commission have emphasized the necessity of a paradigm shift from reactive disaster response to proactive resilience-building. Key priorities include large-scale investment in climate-resilient infrastructure, modernization of irrigation and drainage systems, and the expansion of climate-smart agriculture and crop insurance schemes. Equally crucial is the mainstreaming of climate adaptation into national development planning to ensure that economic growth aligns with environmental sustainability.

Ultimately, the 2025 floods represent both a warning and an opportunity a chance for Pakistan to rebuild not just what was lost, but to construct a more resilient, inclusive, and climate-adaptive economy capable of withstanding the shocks of an increasingly volatile future.

Conclusion

The 2025 monsoon floods have once again underscored Pakistan's profound vulnerability to the escalating impacts of climate change. Beyond the staggering human and physical losses, the floods have

exposed deep structural weaknesses in the country's economy, particularly its dependence on climate-sensitive agriculture, fragile infrastructure, and inadequate disaster preparedness. The economic shock has rippled through multiple sectors, shaving nearly two percentage points off projected GDP growth, intensifying inflation, and widening the trade deficit. With millions displaced and agricultural production sharply reduced, the floods have not only disrupted livelihoods but also heightened food insecurity and fiscal strain.

Yet, within this crisis lies an opportunity for transformation. The floods serve as a

wake-up call for Pakistan to reorient its development model toward climate resilience and sustainable growth. Investing in modern water management, climate-smart agriculture, resilient infrastructure, and robust early warning systems are no longer essential for survival. The government's collaboration with international partners, including the IMF, World Bank, and UNDP, provides a pathway for rebuilding smarter and stronger.

If Pakistan can translate this tragedy into a catalyst for reform, it may yet emerge from the disaster more resilient, equitable, and future-ready turning climate vulnerability

into an engine of adaptive strength and sustainable progress.

References: FAO; GoP; IMF; NDMA; PBS; Planning Commission of Pakistan; SBP; OCHA; World Bank.

Please note that the views expressed in this article are of the author and do not necessarily reflect the views or policies of any organization.

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Change and Transformation in Agricultural Production in Türkiye

Discover how Türkiye's agriculture is evolving through sustainability, precision farming, and policy reforms. Explore challenges like land fragmentation, water scarcity, and climate change, and the innovations shaping the future of food security.

Mithat Direk

10/3/2025

Agriculture stands as a cornerstone of Türkiye's economy, history, and culture, shaping livelihoods for millions and sustaining its role as one of the world's few self-sufficient countries in food production. Contributing around 6.5% to the national GDP and employing nearly 18% of the workforce (TurkStat, 2023), the sector is central not only to rural development but also to national food security and export competitiveness. Beyond economics, agriculture remains a cultural anchor, with traditional farming practices, cuisine, and rural heritage deeply tied to Türkiye's identity.

Yet, Turkish agriculture now faces a pivotal transformation. On one hand, it benefits from technological progress precision farming, greenhouse cultivation, and digital platforms that connect farmers to markets. On the other hand, profound structural challenges persist. Land fragmentation limits economies of scale, with many farmers operating on small, inefficient plots. An aging farming population adds another layer of concern, as youth migration toward urban areas threatens generational continuity in rural livelihoods.

Water scarcity further complicates the picture, as climate change exacerbates drought frequency and alters rainfall patterns. Türkiye, already located in a semi-arid region, faces mounting pressure to balance agricultural productivity with sustainable resource use. These issues are compounded by global economic pressures, volatile input prices, and the growing demand for climate-resilient food systems.

Looking ahead, the path for Turkish agriculture lies in embracing sustainable intensification boosting yields while conserving natural resources. Policy reforms to consolidate land, incentives for

youth participation, and wider adoption of climate-smart technologies will be critical. Türkiye's agricultural evolution thus reflects both a national necessity and a global responsibility: ensuring resilient food systems in an era of uncertainty while safeguarding the sector's cultural and historical legacy.

Historical Transformation and the Current Structural Landscape

Türkiye's agricultural journey is deeply rooted in history, with its fertile soils forming part of the ancient Fertile Crescent, often described as the cradle of agriculture. From the Anatolian plateau to the coastal plains, farming has long been at the heart of livelihoods, shaping the country's culture, economy, and identity. The Republican era brought significant state intervention, with agricultural cooperatives and state-owned enterprises established to modernize production, improve food security, and stabilize rural incomes. These policies laid the foundation for Türkiye's early agricultural self-sufficiency.

The decades after 1950 marked a turning point. The introduction of mechanization tractors, harvesters, and chemical fertilizers revolutionized productivity, enabling larger harvests and reducing dependence on manual labor. However, this transformation also fueled massive rural-to-urban migration, as surplus labor shifted into cities to support industrialization. While productivity improved, rural depopulation began to erode traditional farming knowledge and weakened rural community structures.

Today, the structural issues that emerged during this transformation are increasingly evident. Employment in agriculture has fallen sharply, dropping from 48% in 2000 to just 17.3% in 2023

(TÜİK, 2024). Compounding this decline, the farming population is aging, with the average farmer now over 55 years old (Ministry of Agriculture and Forestry, 2023), signaling a looming crisis of succession and innovation. Land fragmentation remains another critical barrier: small, scattered plots prevent farmers from achieving economies of scale, investing in advanced technologies, or efficiently managing scarce resources like water.

These demographic and structural constraints threaten the resilience and long-term viability of Türkiye's agricultural system. Without generational renewal, land consolidation, and stronger policy support, the sector risks stagnation, undermining both national food security and rural development goals.

The Double-Edged Sword of Inputs and Environmental Pressures

The widespread adoption of chemical fertilizers, pesticides, and mechanized farming during the Green Revolution was a turning point for Türkiye's agriculture. These inputs significantly increased yields of staple crops such as wheat, maize, and cotton, allowing the country to strengthen its food security and reduce dependence on imports. For decades, higher productivity was seen as the main indicator of progress. However, this intensive input-dependent model has revealed its darker side over time, exposing serious environmental and economic vulnerabilities.

According to the Turkish Foundation for Combating Soil Erosion (TEMA, 2023), nearly 73% of Türkiye's soils are now degraded, with alarming declines in organic matter content. In many regions, soils have fallen below the critical 2% threshold of organic matter, undermining

fertility and crop resilience. Heavy reliance on synthetic nitrogen fertilizers has further reduced nutrient-use efficiency, leading to both wasted resources and widespread soil acidification. Pesticide overuse has also disturbed ecological balances, contributing to biodiversity loss and threatening pollinator populations essential for fruit and vegetable production.

Water resources face similar strain. Agriculture accounts for over 70% of Türkiye's freshwater withdrawals, and water-intensive crops such as cotton, rice, and maize have accelerated over-extraction. This has led to falling groundwater levels, salinization in coastal regions, and growing conflicts over water allocation. The World Resources Institute (2023) categorizes Türkiye as experiencing "high" water stress, a condition that jeopardizes irrigated agriculture in the fertile basins of Central Anatolia and the Southeast.

Compounding these pressures is the accelerating impact of climate change. Rising temperatures, erratic rainfall, and more frequent droughts have already disrupted planting calendars and reduced yields in vulnerable provinces. Together, these challenges underscore the urgent need for a paradigm shift—away from input-intensive models toward regenerative, climate-smart practices that restore soil health, conserve water, and safeguard long-term productivity.

Buy vitamins and supplements

The Rise of Organic and Sustainable Agriculture

In Türkiye, growing environmental concerns and consumer demand for healthier food have created strong momentum for organic and sustainable agriculture. Over the last decade, the sector has witnessed remarkable growth, positioning Türkiye as one of the leading exporters of organic products to European Union markets. According to TÜİK (2024), the total organic agricultural area expanded to 1.1 million hectares by 2023, marking a significant increase from earlier years. This expansion reflects both

market opportunities abroad and rising domestic awareness of food safety and environmental protection. At the same time, the Ministry of Agriculture and Forestry has promoted "Good Agricultural Practices" (GAP), which encourage reduced chemical use, better resource management, and traceability throughout supply chains.

Sustainable agriculture in Türkiye also draws on deep cultural roots, with increasing efforts to revive indigenous seed varieties and traditional knowledge systems. These local practices often prove more resilient to pests, droughts, and shifting climate conditions than imported high-input seeds. Initiatives like the *National Biodiversity Inventory and Sustainable Land Management Project* (2022) are working to protect genetic resources and ensure that traditional varieties remain available for future generations.

Consumer behavior is an equally important driver of this shift. Urban populations are showing greater preference for organic, traceable, and ethically produced food. However, challenges remain. Production costs for organic farming are generally higher, supply chains are fragmented, and consumer awareness still needs strengthening at the national level. Despite these obstacles, sustainable agriculture is increasingly recognized as a pathway to balance environmental stewardship, economic resilience, and rural development.

Ultimately, Türkiye's organic and sustainable agriculture movement reflects both an economic opportunity and a societal response to global pressures. By combining modern certification systems with traditional resilience, the sector has the potential to redefine food production in a way that safeguards both public health and environmental stability.

Technological Innovations and the Future of Agriculture in Türkiye

The future of agriculture in Türkiye is being reshaped by the rapid adoption of Agriculture 4.0, a framework that integrates digital technologies into

farming practices. Precision agriculture is at the forefront, with GPS-guided machinery, drones for aerial field monitoring, and sensor-based irrigation systems increasingly used to optimize input application. These technologies not only save water and reduce reliance on fertilizers and pesticides but also help improve yields and profitability. To accelerate adoption, the Turkish government has introduced grants, credit schemes, and training programs designed to promote the uptake of smart farming solutions.

At the same time, advances in biotechnology are providing pathways for resilience against climate change. Research institutions are working on drought- and salt-tolerant crop varieties that can withstand the challenges of water scarcity and soil salinity, which are pressing issues in many regions. Digital platforms are also emerging as vital tools, connecting farmers with markets, offering real-time price updates, and minimizing the role of intermediaries that often reduce farmers' margins.

Yet, the benefits of these innovations remain unevenly distributed. High costs limit access for smallholders, who form the majority of Türkiye's farmers. Bridging this gap through cooperative ownership models, targeted subsidies, and farmer education is essential to ensure inclusive agricultural modernization.

Conclusion

Türkiye's agricultural sector stands at a decisive turning point where history, culture, and modern challenges intersect. Once the anchor of rural life and national self-sufficiency, agriculture now grapples with structural, environmental, and demographic pressures that demand urgent reform. The legacy of land fragmentation, soil degradation, and water scarcity, coupled with an aging farmer population, underscores the fragility of the system. At the same time, global economic volatility and climate change have amplified vulnerabilities, making business-as-usual approaches untenable.

Yet, within these challenges lies a clear opportunity. The rise of organic farming, sustainable practices, and the growing integration of Agriculture 4.0 technologies provide a roadmap for renewal. By leveraging precision farming, biotechnology, and digital platforms, Türkiye can align productivity goals with environmental stewardship. Equally critical is ensuring inclusivity: smallholders, who remain the backbone of rural livelihoods, must be empowered through land consolidation, cooperative

models, credit access, and targeted policy support.

Ultimately, the transformation of Türkiye's agriculture is not merely about securing higher yields; it is about sustaining rural communities, preserving cultural heritage, and ensuring food sovereignty in an era of uncertainty. With strategic reforms and inclusive innovation, Türkiye has the potential to lead as a model of resilient, sustainable agriculture.

References: Ministry of Agriculture and Forestry, Republic of Türkiye; TEMA Foundation; TÜİK; WRI.

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From Fields to Cities: Climate Change, Migration, and Food Security in Pakistan

Explore how climate change, migration, and agriculture intersect in Pakistan shaping food security, rural resilience, and urban growth.

Shahan Aziz & Kiran Hameed

10/6/2025

The narrative of agriculture in Pakistan transcends the mere cycle of sowing and reaping, it mirrors the nation's ongoing story of social, demographic, and economic transformation. Pakistan today stands at the crossroads of one of South Asia's fastest urban transitions, with nearly 43.7% of its population now living in cities (World Bank, 2023). By 2050, this figure is projected to exceed 50% (UN DESA, 2022), signaling a profound shift in the country's spatial and economic landscape. Behind this rapid urbanization lies the deep structural evolution of Pakistan's agrarian system.

The spread of agricultural mechanization has reduced the need for manual labor, while continuous land fragmentation has made small-scale farming increasingly unviable. Simultaneously, erratic rainfall, water scarcity, and rising temperatures, hallmarks of climate change, have further eroded rural livelihoods, compelling millions to seek security in urban centers. Yet, this migration is not solely a symptom of rural distress; it also represents untapped potential. When strategically managed, rural-urban migration can act as a dynamic force for national development. Agriculture, if revitalized through technology, policy reform, and value-chain integration, can serve as the anchor for balanced economic growth. Strengthening rural infrastructure, supporting agro-based industries, and promoting rural entrepreneurship can transform migration into a circular process where resources, skills, and remittances flow back into the countryside.

Ultimately, Pakistan's future urbanization cannot be sustained without strong rural foundations. By positioning agriculture as both a source of livelihood and

innovation, the country can bridge the rural-urban divide, ensuring that growth in cities does not come at the expense of rural decline. The transformation of Pakistan's agricultural sector, therefore, is not only vital for food security but central to achieving inclusive, sustainable, and equitable national development.

The Climate-Migration Nexus: A Pressing Driver of Change

Climate change has emerged as one of the most powerful forces reshaping Pakistan's demographic and economic landscape. The country, despite contributing less than 1% to global greenhouse gas emissions, remains among the ten most climate-vulnerable nations in the world (Germanwatch, 2021). Its geography ranging from arid deserts to glacial mountain systems—makes it uniquely exposed to both slow-onset and sudden climate shocks. The devastating floods of 2022 serve as a stark reminder: nearly one-third of Pakistan was submerged, causing over \$30 billion in damages and losses, destroying 4.4 million acres of cropland, and displacing nearly 33 million people (World Bank, 2022; Government of Pakistan, 2022). For many, the floods were not just a temporary disruption but a permanent rupture in their way of life, forcing millions to migrate from submerged villages to overcrowded cities.

Beyond such catastrophic events, slow-onset processes continue to silently erode the country's agrarian stability. Rising temperatures, irregular monsoon patterns, soil salinization, and the overexploitation of groundwater are progressively undermining rural productivity. Scientific projections are grim: studies suggest that wheat yields in Punjab, Pakistan's primary grain-producing region, could

drop by 15–20% by 2050 if adaptive measures are not taken (Hussain et al., 2023). Such gradual degradation pushes rural households into a state of chronic vulnerability, where migration becomes not a choice, but a survival strategy.

The climate-migration nexus thus represents more than environmental displacement it is a socio-economic transformation in motion. Unplanned migration strains urban infrastructure amplifies poverty in informal settlements, and fuels social tensions. Addressing this requires integrated climate resilience policies that link rural adaptation through climate-smart agriculture, water management, and disaster preparedness with sustainable urban planning. Only through this holistic approach can Pakistan break the cycle of climate vulnerability and forced migration.

Food Security and Migration: A Vicious Cycle

Food security lies at the heart of Pakistan's development challenge, intricately tied to both rural livelihoods and patterns of migration. With the population surpassing 241 million (Pakistan Bureau of Statistics, 2023), the country faces a mounting struggle to ensure consistent access to nutritious and affordable food for all citizens. The Food and Agriculture Organization (FAO, 2023) estimates that 36.9% of Pakistanis experience moderate or severe food insecurity a figure that highlights both the depth and the persistence of this crisis. Rural-urban migration, while often seen as a response to poverty and environmental stress, can paradoxically deepen food insecurity across regions.

As increasing numbers of rural workers migrate to cities in search of better income

opportunities, the agricultural labor force thins out, particularly in smallholder and subsistence farming systems. This labor shortage can reduce agricultural productivity, disrupt planting cycles, and limit the capacity for local food production. Simultaneously, urban areas already struggling with inadequate infrastructure face rising demand for food, inflating prices and straining supply chains. Without efficient logistics and storage systems, food waste increases, compounding shortages and driving further economic stress among low-income households.

A 2022 study published in *Food Policy* underscores this dangerous feedback loop: migration, unless accompanied by agricultural modernization and supply chain resilience, can worsen food insecurity in both sending and receiving regions (Mughal & Fontan, 2022). The result is a self-reinforcing cycle food insecurity compels people to migrate, and migration further weakens food systems.

Breaking this cycle requires a two-pronged approach. First, investment in rural innovation mechanization, value chain development, and water-efficient farming must strengthen productivity. Second, urban food policies must enhance distribution efficiency and affordability. Only by linking food systems with migration management can Pakistan

secure its nutritional future and build resilience against future shocks.

A Policy Roadmap: From Global Frameworks to Local Action

The interconnected challenges of climate change, food insecurity, and migration are no longer isolated national concerns they are part of a shared global agenda. The United Nations Global Compact for Safe, Orderly, and Regular Migration (GCM), adopted in 2018, formally acknowledges environmental degradation and climate change as key drivers of human displacement (United Nations, 2018). For Pakistan, which endorsed the Compact, this international framework provides both guidance and legitimacy for designing migration policies that are preventive, inclusive, and development oriented. Complementing this, the UNFCCC COP27 summit (2022) introduced the “Sharm el-Sheikh Joint Work on Agriculture and Food Security,” integrating agricultural resilience into global climate negotiations (UNFCCC, 2022). Aligning Pakistan’s National Climate Change Policy (2021) and National Adaptation Plan with these frameworks can transform reactive disaster responses into proactive, climate-resilient planning.

Pakistan, which has consistently championed climate justice on the international stage, can now leverage

these global commitments to access climate finance and technology transfer. International support, combined with domestic reforms, can fund large-scale adaptation measures drought-tolerant crops, efficient irrigation, and resilient rural infrastructure that reduce the drivers of forced migration.

However, global alignment must translate into localized action. Pakistan’s strategy should integrate agricultural modernization with urban preparedness. The development of agro-based industries in peri-urban zones particularly through Special Economic Zones (SEZs) under CPEC can generate non-farm employment while maintaining links to agriculture. Establishing value-added industries, cold storage, and processing units can reduce post-harvest losses, estimated at 25–40% for perishables (FAO, 2021), while curbing distress migration. Programs like the Ten Billion Tree Tsunami and the Benazir Income Support Program (BISP) can be expanded within this integrated framework to enhance livelihoods, environmental resilience, and social protection. In doing so, Pakistan can transform migration from a crisis response into a cornerstone of sustainable development.

Key Indicators of Rural–Urban Transitions, Food Security, and Climate Challenges in Pakistan

Indicator	Statistic	Date / Period	Source
Rural population (% of total population)	~ 61.2% rural, ~ 38.8% urban	2023 Census	Pakistan Bureau of Statistics (Wikipedia)
Undernourishment rate (percentage of population)	~ 20.7% undernourished	~2024	World Food Programme / FAO (World Food Programme)
Percent of children under 5 stunted	~ 40%	2024	WFP country brief for Pakistan (World Food Programme)
People at risk of acute food insecurity	~ 10 million	FY2025 forecast	World Bank (The Express Tribune)
Acute food insecurity in flood-affected rural districts	~ 11 million people (22% of analysed population)	Nov 2024– Mar 2025 lean period	FAO / Global Report on Food Crises (The Economic Times)
Portion of youth in agrifood systems vs decline	In 2005 ~54% of working youth in agrifood systems; now lower (declined)	2005 vs 2021–23 period	FAO warning on labor shortage in agrifood systems (Profit by Pakistan Today)
Project financing for climate-smart growth & social protection	US\$535 million	June 2024	World Bank approved for CRISP & LIVAQUA projects (World Bank)

Conclusion

Pakistan's agricultural transformation stands at the nexus of climate resilience, economic reform, and social justice. The pressures of rapid urbanization, climate-induced displacement, and food insecurity are deeply interconnected, reinforcing the other in a cycle that threatens long-term national stability. Yet within this complexity lies opportunity. If Pakistan reimagines agriculture not as a declining sector but as the foundation of sustainable growth, it can turn migration into a managed process that fuels both rural and urban development.

The country's commitment to international frameworks such as the Global Compact for Migration and the

UNFCCC's agricultural resilience agenda must now translate into action at home. Strengthening rural infrastructure, promoting climate-smart agriculture, and building agro-based industries near urban centers can reduce rural distress while creating jobs that bridge the countryside and the city. Ensuring food security through efficient supply chains, empowering smallholders with technology and credit access, and expanding social protection programs will further anchor resilience.

Ultimately, the path forward demands integration not separation of rural and urban priorities. A climate-smart, inclusive, and innovative agricultural system can serve as Pakistan's most

powerful tool for equitable growth, turning the pressures of migration and environmental change into drivers of national renewal and shared prosperity.

References: FAO; Germanwatch; GoP; Hussain et al; Mughal & Fontan; Pakistan Bureau of Statistics; UN DESA; UNFCCC; United Nations; World Bank

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Boost Wheat Yields in Pakistan Sustainably

Explore research-based strategies to enhance wheat yields in Pakistan through sustainable land, water, and fertilizer management, ensuring food security and crop yield improvement.

Nazar Gul & Hafiz Abdul Salam

10/14/2025

Wheat (*Triticum aestivum* L.) stands as the backbone of Pakistan's food security and rural economy, forming the dietary foundation for over 200 million people. Beyond human consumption, wheat straw serves as a critical resource for livestock feed, paper manufacturing, and other agro-based industries, reinforcing its centrality to both the agricultural and industrial sectors. However, despite its pivotal role, Pakistan's wheat productivity continues to underperform compared to its potential. During the 2022–23 cropping season, wheat was cultivated across approximately 9.0 million hectares, producing 28.0 million tonnes with an average yield of 3,111 kg/ha (GoP, 2023). While this represents modest progress, the figure remains significantly below the potential yield of major wheat varieties estimated between 5,000 to 8,000 kg/ha (API, 2022).

This persistent yield gap underscores the need for urgent intervention in both policy and practice. The main contributing factors include inefficient irrigation systems leading to water wastage, imbalanced fertilizer use that depletes soil fertility, delayed sowing caused by poor crop rotation planning, and limited adoption of climate-smart technologies. Additionally, post-harvest losses, seed quality issues, and lack of farmer training further constrain productivity.

Addressing these challenges requires an integrated approach. The adoption of precision agriculture, balanced nutrient management, laser land leveling, and zero-tillage practices can improve input efficiency and yields. Strengthening extension services, improving certified seed availability, and promoting mechanization will enhance farmers' capacity to implement best practices. Policy alignment with research-based recommendations, including incentives

for water-efficient irrigation and soil health management, can further accelerate productivity gains.

Bridging Pakistan's wheat yield gap is not merely an agricultural goal, it is a national necessity for ensuring food security, economic resilience, and rural prosperity in the face of climate and resource pressures.

Optimizing Land Preparation and Sowing Techniques for Enhanced Wheat Yields in Pakistan

Land preparation forms the foundation of successful wheat cultivation, influencing every subsequent stage of crop growth from germination to root establishment and nutrient uptake. Properly prepared soil ensures optimal seed-to-soil contact, moisture conservation, and aeration, all of which are prerequisites for achieving high yields. Research shows that optimized tillage practices can boost wheat yields by 13–30% (Rizwan et al., 2017), emphasizing the need for precision and discipline in pre-sowing operations.

An ideal sequence of tillage involves one pass with a Mould Board Plough immediately after the preceding crop's harvest to invert the soil and incorporate residues. This should be followed by two passes of a Disc Harrow or Rotavator to crush clods and refine the seedbed, and finally, one pass with a Cultivator to ensure fine tilth and proper leveling. Smooth level land facilitates uniform irrigation and reduces nutrient runoff, setting the stage for efficient crop management throughout the growing season.

Laser Land Leveling (LLL) has become indispensable for modern wheat production. By ensuring a precise and even field surface, it enables uniform water distribution, improves fertilizer efficiency, and enhances germination. A

study conducted in Sargodha demonstrated that LLL maintains a field level variance of just ± 2 cm, compared to ± 3 – 6 cm in traditionally leveled fields after three years (Ashraf et al., 2017). Economically, LLL reduces irrigation water use by up to 51%, increases yields by 6–10%, and raises net annual income by about 32%. Farmers are encouraged to conduct accurate land surveys using Eye Level Detectors before leveling to ensure precision and long-term benefits.

Transitioning to advanced sowing methods is equally crucial. Traditional broadcasting techniques like *Ghurbi* and *Wat Khair* lead to uneven seed distribution and poor plant stands. In contrast, modern precision sowing methods i.e. Raised Bed, Ridge, and Drill Sowing offer substantial advantages. Raised Bed Planting saves 30–40% irrigation water and boosts yield by 16.4% (Asif et al., 2019). Ridge Sowing conserves water and increases yields by 22% (Hussain et al., 2019), while Drill Sowing ensures uniform depth and spacing, improving yields by about 9% (Khan et al., 2000).

Optimized Planting Time, Variety Selection, and Weed Management for Wheat Productivity

The timing of wheat sowing is one of the most decisive factors influencing yield potential in Pakistan. Delayed planting exposes the crop to terminal heat stress during grain filling, resulting in severe yield losses ranging from 8.3% to 63.85% (Tahir et al., 2019). Optimal sowing should ideally occur in early November when temperatures favor germination, tillering, and spike development. Selecting region-specific and climate-resilient varieties is equally important. For Sindh and southern Punjab, early sown varieties such as *Sarsabz*, *Kiran*, and *NIA-Amber* are recommended, as

they mature before the onset of terminal heat and resist rust and other diseases (Channa et al., 2016). Farmers are encouraged to consult local agricultural extension departments to align variety choice with agro-climatic zones and sowing windows, ensuring genetic potential is fully realized.

Alongside proper sowing practices, weed management plays a pivotal role in achieving optimal yields. Weeds compete with wheat for light, nutrients, and water, causing annual yield losses of up to 25% (Ali et al., 2017). Integrated Weed Management (IWM) combines cultural and chemical measures to provide sustainable control. Precision sowing methods such as raised beds and drill sowing inherently suppress early weed emergence by ensuring uniform seed placement and optimal spacing. When necessary, selective herbicides such as Isoproturon 50 WP at 1.0 kg a.i./ha can achieve up to 84% weed control efficiency (Fahad et al., 2013). For broader control, combinations like carfentrazone ethyl ester + isoproturon provide over 93% weed suppression (Shah et al., 2016). Timely sowing, variety optimization, and effective weed management together form a synergistic strategy to boost wheat yields, enhance input efficiency, and secure Pakistan's food supply.

Balanced Nutrition, Efficient Irrigation, and Proactive Disease Management

Achieving high and sustainable wheat yields in Pakistan depends on the precise integration of balanced nutrient management, efficient irrigation, and effective disease control. Fertilizer misuse both over- and under-application remains one of the most significant barriers to yield optimization. Balanced nutrient applications can enhance wheat production by up to 70% (Rashid et al., 2024, citing NFDC principles). Integrated Nutrient Management (INM), which combines organic and inorganic fertilizers, ensures sustained soil fertility and improved crop performance. Studies show that applying 6 t/ha of poultry manure with 128-114-62 kg/ha of NPK or

10 t/ha of farmyard manure at land preparation achieves the highest yields (Abbas et al., 2012). However, fertilizer application should always be guided by soil testing to tailor nutrient doses to field conditions and prevent leaching losses.

In Sindh, specific NPK recommendations vary across varieties. For instance, TD-1 requires 50 kg N, 25 kg P, and 25 kg K per acre, while NIA-SUNDAR needs slightly higher phosphorus (45 kg P/acre) but no added potash (Khan et al., 2014). Adopting such site- and variety-specific fertilizer strategies enhances nutrient use efficiency and reduces input costs.

Efficient irrigation scheduling is equally critical. Over-irrigation causes nutrient leaching, waterlogging, and salinity, which are chronic problems in Sindh's canal command areas, where shallow water tables cover 28–69% of farmland (Salam et al., 2023). Precision irrigation practices, as outlined by PCRWR (2023), recommend a total of about 480 mm of water for the NIA-SARANG variety, comprising a 100 mm soaking dose followed by five irrigations at 21-day intervals. Maintaining the water table at around 1.5 m allows capillary rise to meet up to 25% of crop water requirements, conserving both water and energy.

Finally, disease management remains a key determinant of yield stability. Fungal diseases such as leaf rust, loose smut, and root rot can reduce yields by up to 50% (Rahman et al., 2017). Preventive seed treatment using fungicides like Tebuconazole + Imidacloprid (Hombare @ 4 ml/kg) or Difenconazole + Cyproconazole (Dividend Star @ 1 ml/kg) ensures protection against major seed-borne pathogens (Shahbaz et al., 2018). Balanced nutrition, early sowing, and resistant varieties such as *Bakhtawar* and *Sassui* also minimize rust incidence (Channa et al., 2016). During outbreaks, foliar sprays of Propiconazole (Tilt) can reduce disease severity from 100% to less than 5% (Ali et al., 2022).

Conclusion

Pakistan's wheat productivity challenge is not merely an agronomic issue, it is a matter of national food security and rural resilience. The persistent yield gap, despite decades of research and technological progress, reflects a systemic need for integrated and adaptive management. Sustainable intensification of wheat production requires a holistic strategy that combines science-driven agronomy with farmer-centered implementation. Optimized land preparation through laser leveling, precision sowing, and timely planting are foundational to maximizing resource use efficiency and improving plant establishment. Balanced fertilization, guided by soil testing and integrated nutrient management, can restore soil health and sustain productivity, while efficient irrigation scheduling ensures that every drop of water contributes directly to yield.

Equally, proactive disease management and integrated weed control are indispensable for maintaining crop vigor and minimizing losses. The success of these practices, however, depends on strong extension services, farmer education, and timely access to quality inputs. Strengthening institutional coordination between research, policy, and field-level operations will be essential to closing the yield gap sustainably.

By embracing precision agriculture, resource efficiency, and climate-smart practices, Pakistan can move closer to realizing the full potential of its wheat sector ensuring food security, economic stability, and a resilient agricultural future for millions who depend on this vital crop.

References: Ali et al; API; Ashraf et al; Asif et al; Atiq et al; Channa et al; Fahad et al; GoP; Hussain et al; Khan et al; PCRWR; Rahman et al; Rashid et al; Rizwan et al; Salam et al; Shah et al; Shahbaz et al; Tahir et al.

Please note that the views expressed in this article are of the author and do not necessarily reflect the views or policies of any organization.

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Sustainable Farming for Pakistan's Agricultural Future

Pakistan's agricultural future hinges on today's choices amidst challenges like water scarcity, soil degradation, and climate stress. Embracing sustainable farming is essential for ensuring food security and strengthening rural livelihoods, paving the way for a resilient agricultural economy.

Nadeem Riyaz

10/22/2025

Pakistan stands at a critical juncture, facing an agricultural reckoning that will determine its economic stability, food sovereignty, and social cohesion for generations to come. Once sustained by the majestic Indus River system, the country's farmlands are now under unprecedented pressure from a dangerous triad: *extreme water scarcity, accelerating soil degradation, and intensifying climate volatility*. These challenges are no longer distant warnings; they are a living reality for millions of farmers who depend on agriculture for their livelihoods.

Agriculture remains the backbone of Pakistan, employing a significant share of the population and serving as the foundation of its food supply. Yet this very backbone is weakening. Rapid glacier melt, unpredictable monsoons, and prolonged droughts have made river flows erratic, disrupting age-old irrigation patterns. Canal inefficiencies, groundwater over-extraction, and poor water governance further compound scarcity. At the same time, fertile lands are steadily being lost to salinity, sodicity, nutrient depletion, and waterlogging—symptoms of mismanagement and ecological neglect. Climate change acts as a force multiplier, amplifying crop failures, pest outbreaks, and heat stress, especially in staples like wheat, rice, and cotton.

Thus, the challenge before Pakistan is not simply to grow *more* food, but to grow food *sustainably, efficiently, and resiliently*. Traditional expansion-based models cultivating more land and extracting more water are no longer viable in a climate-constrained future. What Pakistan needs is a paradigm shift: embracing climate-smart agriculture, modern irrigation technologies, soil

restoration practices, and diversified cropping systems. Equally essential are strong institutions, empowered farming communities, and science-led policymaking. In the decades ahead, the battle for Pakistan's resilience will be won or lost in its fields. The nation's ability to adapt today will decide whether agriculture remains at its strength or becomes its greatest vulnerability.

The Bedrock of the Economy Under Threat

Sustainability, defined as meeting present needs without limiting the ability of future generations to meet their own, is not a choice for Pakistan; it is a matter of national survival. With a rapidly growing population of over 241 million people (Pakistan Bureau of Statistics, 2023), food security, rural income stability, and economic resilience all depend on a thriving agricultural sector. Agriculture contributes 22.9% to the national GDP and employs 37.4% of the labor force, making it the backbone of Pakistan's economy and the lifeline of rural communities (Pakistan Economic Survey, 2023–24). Yet, this backbone is now under severe strain from simultaneous environmental and structural challenges.

Pakistan's worsening water crisis lies at the heart of this threat. The country relies overwhelmingly on the Indus Basin Irrigation System, which sustains more than 90% of agricultural production (FAO, 2023). However, per capita water availability has plunged from 5,260 cubic meters in 1951 to just 900 cubic meters, well below the scarcity threshold (PCRWR, 2023). With water storage capacity of only 30 days, compared to the world standard of 220 days for arid countries, Pakistan's agriculture remains

dangerously exposed to seasonal fluctuations, canal losses exceeding 50%, and groundwater depletion (World Bank, 2023; IUCN, 2023).

Climate change is further intensifying this crisis. Despite contributing less than 1% of global emissions, Pakistan ranks among the world's most climate-vulnerable nations. The 2022 floods, which submerged one-third of the country and caused over \$30 billion in losses, were a stark reminder (World Bank, 2022). Rising temperatures, erratic monsoons, and new pest pressures threaten to cut agricultural output by up to 10% by 2040 (ADB, 2023). Meanwhile, 43% of land is degraded and 6.3 million hectares are salt affected, reducing fertility and yields (UNCCD, 2022).

Pakistan's agricultural future, therefore, hangs in the balance, demanding urgent, science-based, and climate-smart reforms to preserve the very foundation of its economy.

Socioeconomic Fragility and the Smallholder

Pakistan's agricultural structure is overwhelmingly dominated by smallholders, with 64% of farmers cultivating less than 2 hectares of land (Agriculture Census, 2020). These farmers form the backbone of national food production, yet they remain the most economically vulnerable. Their limited access to formal credit, certified climate-resilient seeds, quality inputs, and modern mechanization traps them in low-productivity cycles. Extreme weather events whether droughts, floods, or heatwaves hit smallholders hardest, as they lack savings, crop insurance, or safety nets. A single climate shock can wipe out an entire season's income,

pushing families into debt and deepening rural poverty. This vulnerability fuels rural-urban migration, swelling informal settlements in major cities and straining urban infrastructure.

Gender inequality compounds these structural weaknesses. Although women contribute 60–70% of agricultural labor particularly in planting, harvesting, and livestock management they own less than 3% of agricultural land and receive minimal access to finance, technology, training, or decision-making platforms (UNDP, 2023). Unlocking the full potential of Pakistan's agricultural economy is impossible without closing this gender gap.

A sustainable turnaround demands a holistic national strategy centered on water efficiency, climate-resilient crops, digital and financial inclusion, and smarter policy incentives. Transitioning from flood irrigation to drip and sprinkler systems could reduce water use by 30–50% and raise yields by up to 30% (IWMI, 2023). Simultaneously, restoring soil health and promoting drought- and heat-resistant varieties would protect yields under extreme climate stress. Digital advisory systems, mobile-based extension services, and climate-indexed crop insurance could provide real-time

support while shielding farmers from shocks. At the policy level, Pakistan must shift agricultural subsidies from input-driven incentives to outcomes that reward resource conservation, climate resilience, and reduced post-harvest losses.

Conclusion

Pakistan's agricultural future rests on the choices it makes today. The crises of water scarcity, soil degradation, and climate stress are not distant threats they are unfolding now, eroding productivity, destabilizing rural livelihoods, and weakening food security. Yet, within this challenge lies an opportunity to rebuild agriculture on stronger, smarter, and more resilient foundations. Sustainable farming is no longer an environmental slogan; it is an economic and social imperative for a nation whose stability depends on the prosperity of its fields and farmers.

A climate-smart transformation, driven by efficient water use, healthier soils, empowered smallholders, and evidence-based policymaking, can set Pakistan on a path toward long-term resilience. This shift requires political will, institutional reform, investment in research, and inclusive support systems that leave no

farmer especially women and smallholders behind. Technology, innovation, and digital services must bridge the gap between knowledge and practice, while market incentives should reward sustainability rather than short-term exploitation.

If Pakistan commits to these reforms with urgency and unity, its agriculture can once again become a pillar of strength productive, competitive, equitable, and sustainable. The time for incremental change has passed. The nation must act decisively to cultivate resilience today, securing a food-secure and prosperous tomorrow for generations to come.

References: ADB; FAO; IWMI; IUCN; Pakistan Bureau of Statistics; PCRWR; UNDP; UNCCD; World Bank.

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Pakistan's Path to Agro-Sovereignty

Explore Pakistan's journey towards agro-sovereignty, an essential economic transformation. With fertile lands and diverse climates, the nation aims to become an agricultural powerhouse while addressing food insecurity and modernizing its farming practices.

Mushaf Ali & Shahan Aziz

10/24/2025

Pakistan stands at a pivotal juncture, endowed with the natural capital to forge a prosperous and sustainable future. With over 30.5 million hectares of cultivable land, representing 47% of the country's total area, a diverse agro-climatic range spanning from temperate northern highlands to tropical coastal belts, and one of the world's largest contiguous irrigation networks fed by the Indus Basin, the nation possesses the ecological foundation for agricultural excellence (World Bank, 2023). Agriculture remains the backbone of Pakistan's economy, contributing 24% to GDP, employing 38% of the labour force, and serving as the primary livelihood source for most rural households (Pakistan Economic Survey, 2023–24). From cotton, wheat, and rice to a vast array of horticultural products and livestock, the country has the capacity to emerge as a major global food supplier.

Yet, this potential remains vastly underexploited. Although the sector's value expanded from \$56 billion in 2019 to an estimated \$89.52 billion in 2024, Pakistan's global agricultural ranking slipped from 7th to 10th, reflecting a widening performance gap as competitor nations modernize more rapidly (FAO, 2024; Pakistan Bureau of Statistics). This paradox highlights deep structural shortcomings: low productivity, weak research-to-farm linkages, inefficient water use, fragmented markets, outdated farming practices, and excessive dependence on external inputs and loans. These weaknesses perpetuate a cycle of vulnerability, where Pakistan remains prone to food inflation, import pressures, and climate shocks.

To break this cycle and unlock true national strength, Pakistan must shift

toward Agro-Sovereignty, a model in which agriculture becomes the engine of economic power, food self-sufficiency, and export-driven growth. The path forward demands bold transformation built on agri-financial independence, robust research and innovation, technological modernization, and mass-scale farmer education. Only through such systemic change can Pakistan turn its natural advantages into enduring economic sovereignty and emerge as a leading agricultural nation in the decades ahead.

Opportunities for an Agro-Sovereign Pakistan

Pakistan today stands at a rare moment in its agricultural and economic trajectory, where global market shifts, domestic innovation, and institutional reforms are converging to create opportunities for true Agro-Sovereignty. Changing trade patterns have opened new avenues for agricultural exports. Historically, the United States has applied relatively lower average tariff rates on Pakistani products approximately 19%, compared to 30% on Chinese goods and 50% on Indian goods (World Trade Organization, 2023). This differential creates an export window that Pakistan can leverage to expand its agricultural footprint in the U.S. market. At the same time, access to the European Union through the GSP+ framework provides tariff-free entry for a wide range of agricultural and textile products, while high-income Gulf markets continue to demand premium halal food, dairy, fruits, and meats (European Commission, 2024). With deliberate branding, stronger sanitary and phytosanitary compliance, and export-oriented value addition, Pakistan can secure long-term trade advantages.

Domestically, technological transformation is already underway. Pakistan's agri-tech landscape now includes more than 87 active startups, signaling a wave of market-driven modernization (Karachi School of Business, 2023). Digital platforms such as Bazaar and Dastgir are enabling over 500,000 farmers to bypass exploitative intermediaries, improving farm-gate earnings by nearly 25%. Meanwhile, solar-powered cold-chain solutions introduced by companies like Cool Crop are drastically reducing post-harvest losses historically as high as 40% for fruits and vegetables (UNDP, 2023). These innovations are supported by emerging fintech solutions that are widening access to credit, crop insurance, and digital payments, allowing smallholders to invest in quality inputs and shock-proof their livelihoods.

Pakistan's diverse agro-ecology further expands opportunity through diversification into high-value crops and advanced livestock systems. Quinoa, saffron, olives, berries, and avocados can target fast-growing niche markets worldwide, while the livestock industry anchored by 225 million animals and valued at over PKR 5.5 trillion possesses untapped export potential (MNFSR, 2023). Introducing improved breeds, scientific feed systems, and a shift from raw exports to processed halal products can multiply earnings and create rural agro-industries.

Policy momentum is also moving in the right direction. The State Bank of Pakistan's agricultural financing reforms such as the Credit Guarantee Scheme, Crop and Livestock Insurance programs, and the Electronic Warehouse Receipt system are reducing risk and injecting

liquidity into rural markets. Mechanization support, including Rs. 31.6 billion financed for modern equipment, is enhancing farm productivity and lowering labor inefficiencies (SBP, 2023).

Internal and External Impact of Advancing Toward Agro-Sovereignty

The shift toward agro-industrialization has the potential to transform Pakistan's internal socio-economic landscape by generating employment, slowing rural-to-urban migration, and creating modern value-chain opportunities in processing, logistics, packaging, and marketing. By equipping youth with subsidized modern machinery, skill development, and credit guarantees, the rural economy can be revitalized, empowering local communities and reducing pressure on already overburdened urban centers. This transformation also expands the national tax base through formalization and commercialization. The Federal Board of Revenue estimates that agriculture could yield up to Rs. 300 billion annually by broadening direct taxation, property-based agricultural levies, and commercial duties (FBR, 2024). At the same time, climate-smart agricultural practices will be essential to ensure sustainability, particularly in a country with the second-highest deforestation rate in Asia (WWF, 2023). Efforts such as roadside orchards can function as carbon sinks while supporting biodiversity and curbing environmental degradation, ultimately strengthening long-term productivity.

Externally, agricultural transformation holds equal strategic value. Pakistan is already the world's fourth-largest exporter of rice and a leading producer of leather and textile goods, with agriculture-derived textiles constituting nearly 60% of total exports (TDAP, 2023). By moving beyond raw commodities and embracing value-addition, Pakistan can significantly boost its export earnings and reinforce its global economic stature. This aligns with the aspirations of initiatives like "URAAN Pakistan," which envisions a trillion-dollar participation in the world

economy by 2035. A stronger agricultural base also increases resilience to global shocks. Unlike industries dependent on volatile international financial systems or fuel markets, agriculture remains comparatively stable. Its resilience was evident during the COVID-19 pandemic and in conflict-affected regions such as Ethiopia's Tigray, where land remained under cultivation despite crisis conditions (NASA Harvest, 2022).

Moreover, Pakistan's diverse agro-ecological terrain offers an attractive platform for foreign investment and research partnerships. International agencies such as ACIAR are already prioritizing collaboration in dairy, horticulture, and water management (ACIAR, 2023). CSR initiatives, like those by Pakistan Organic Farms, demonstrate how certification and capacity-building can integrate smallholders into premium global chains. In addition, the growing global agritourism market projected to reach \$141 billion by 2030 presents an opportunity to reshape Pakistan's international image (Allied Market Research, 2022). By showcasing its orchards, valleys, farms, and rural culture, Pakistan can reposition itself as a destination of peace, nature, and heritage, while generating new streams of rural income. Through these combined internal and external impacts, agro-sovereignty can serve as a cornerstone for national prosperity.

Policies and Strategic Suggestions for an Agro-Sovereign Future

Achieving agro-sovereignty in Pakistan requires a bold, coordinated, and future-focused policy framework that addresses institutional fragmentation, market volatility, and technological stagnation. A foundational step is the creation of a Pakistan National Agricultural Coordination System (PNACS), a centralized federal-provincial platform designed to harmonize agricultural governance. By integrating policy planning, data sharing, and national production targets, PNACS would provide a unified direction for the sector.

Its mandate would include market forecasting to guide crop choices, prevent avoidable gluts and shortages, and regulate input distribution to curb exploitation by middlemen who manipulate prices and inflame inflation.

To complement this, a National Crop Allocation and Rotation Plan (NCARP) would institutionalize scientific crop planning across agro-ecological zones. By aligning crop selection with soil health, climate suitability, and evolving market demand, NCARP would help stabilize farmer incomes while mandating rotation cycles that naturally break pest chains, reduce chemical dependency, and restore fertility. Tailored support structures for small, medium, and large farms would ensure equity in subsidy allocation and technology access.

Structural reforms must also address governance distortions. Agricultural policymaking has long been influenced by industrial lobbies, commodity traders, and politically connected cartels. A clear separation between business interests and public office is essential to end rent-seeking behavior and prioritize food security, farmer welfare, and transparent market operations.

Simultaneously, Pakistan must pivot toward value addition rather than remaining a bulk commodity exporter. Investing in processing zones, branding, packaging, and certification (organic, Halal, and HACCP-compliant) would unlock premium global markets and dramatically increase export revenues. Parallel to this, smart agricultural innovations offer transformative potential. Techniques such as vertical farming can multiply yields in urban centers while conserving land and water, and aquaponics present a closed-loop model ideal for water-scarce regions. Emerging concepts like liquid trees and zero-acreage farming can improve urban sustainability, enhance local food availability, and support climate resilience.

Conclusion

Pakistan's journey toward Agro-Sovereignty is both an economic necessity and a historic opportunity. With fertile land, diverse climates, and a strategic geographic position, the country possesses the natural advantages required to become an agricultural powerhouse. However, for decades, structural inefficiencies, fragmented governance, and outdated practices have constrained growth, leaving the nation vulnerable to food insecurity, import dependence, and climate stress. The evidence is clear: incremental reforms are no longer sufficient. What Pakistan needs is a bold transformation anchored in scientific planning, technological modernization, value-added production, and empowered farming communities.

By adopting coordinated national policies, strengthening research-to-farm linkages, expanding agri-finance, and incentivizing innovation, Pakistan can unlock a new era of rural prosperity, job creation, and global competitiveness. Export-oriented value chains, climate-smart production systems, and transparent market mechanisms will be pivotal in moving the country beyond subsistence toward sovereignty. If pursued with political will, institutional integrity, and long-term vision, Agro-Sovereignty can serve as the cornerstone of national resilience—reducing poverty, stabilizing the economy, and elevating Pakistan's position in global food systems. The path forward is clear: agriculture must not only feed the nation but lead it. With the right choices today, Pakistan can emerge as a confident,

food-secure, and globally influential agricultural state in the decades to come.

References: ACIAR; Allied Market Research; European Commission; FAO; FBR; Karachi School of Business; Ministry of National Food Security & Research; NASA Harvest; Pakistan Bureau of Statistics; Regonesi; Sarfraz; SBP; TDAP; UNDP; World Bank; WTO; WWF.

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Climate-Smart Agriculture: Securing Pakistan's Future

Pakistan's agriculture faces critical challenges due to climate change, threatening food security and rural livelihoods. Climate-smart agriculture offers solutions through resilient crops, efficient water management, conservation practices, and digital advisory tools.

Muhammad Ather Nadeem

10/27/2025

Agriculture is the cornerstone of Pakistan's economy, contributing approximately 22.7% to the national GDP and employing 37.4% of the labor force, while serving as the primary source of livelihood for most rural households (Pakistan Economic Survey, 2023–24). However, this critical sector now stands at the frontline of the climate crisis, facing escalating threats that undermine national food security, economic stability, and social well-being. Over the past decade, Pakistan has witnessed an alarming increase in climate-induced disasters, including erratic monsoon patterns, prolonged droughts, glacial melt, extreme heatwaves, and recurrent flooding. These events are no longer isolated occurrences; they are intensifying in frequency and severity.

The devastating floods of 2022 marked a turning point, submerging one-third of the country, inflicting more than USD 30 billion in economic losses, and destroying vast swathes of cropland (World Bank, 2023). Subsequent flooding in 2025 further exposed the structural fragility of Pakistan's agricultural systems, displacing millions, disrupting supply chains, and crippling seasonal crop cycles. The fallout has been severe: the major crop subsector contracted by an estimated 13.5% in FY 2024–25, with wheat, maize, sugarcane, and cotton, the backbone of Pakistan's food and export economy, suffering the greatest setbacks (Ministry of National Food Security & Research, 2025).

Looking ahead, climate projections paint an equally troubling picture. Scientific studies warn that wheat yields alone could decline by up to 16% by 2050 due to rising temperatures and shifting rainfall patterns (Arif et al., 2022). Such losses would exacerbate food shortages,

increase import dependence, and heighten rural poverty. These realities underscore the urgent need for systemic adaptation through Climate-Smart Agriculture (CSA) an approach that enhances productivity, strengthens resilience, and reduces emissions. Without swift and strategic action, Pakistan risks deeper food insecurity and widening economic vulnerability in the decades to come.

The Escalating Challenge: Climate Vulnerability of Pakistani Agriculture

Pakistan stands at a perilous crossroads as its agriculture already the backbone of rural livelihoods and national food security faces intensifying climate pressures. Ranked among the top ten countries most vulnerable to climate change (Global Climate Risk Index, 2021), the nation's agrarian system is now confronting a multidimensional crisis that threatens its productivity, sustainability, and economic stability. The worsening frequency of extreme weather events has ushered in a new era of climate volatility. The catastrophic floods of 2022 were followed by another devastating episode in 2025, displacing over four million people and destroying thousands of acres of standing crops. These repeated disasters reveal a troubling pattern, what were once rare climatic shocks have now become cyclical disruptions.

Compounding these events is Pakistan's rapidly escalating water crisis. Per capita water availability has fallen from 5,000 cubic meters in 1951 to approximately 900 cubic meters today, pushing the country into the category of water-scarce nations (PCRWR, 2024). This decline poses a severe threat to irrigation-dependent farming systems. At the same time, rising temperatures are exerting direct stress on major crops. Evidence shows that a 1°C increase during the

wheat grain-filling stage can reduce yields by 5–7%, a staggering loss for a staple crop that feeds millions (Hussain et al., 2023).

Soil degradation further worsens this vulnerability. Unsustainable agricultural practices have accelerated erosion, salinization, and nutrient depletion, diminished soil organic matter and reduced its ability to retain moisture (Shahzad et al., 2020). As soil weakens, farms become more susceptible to drought, crop failure, and long-term productivity decline. Taken together, these challenges paint a stark picture: without urgent adaptation and sustainable management, Pakistan's agricultural future and its food security hangs in the balance.

Defining Climate-Smart Agriculture (CSA)

Climate-Smart Agriculture (CSA), as defined by the Food and Agriculture Organization (FAO), is an integrated approach designed to transform agri-food systems through environmentally sustainable and climate-resilient practices (FAO, 2022). At its core, CSA focuses on three mutually reinforcing objectives. First, it seeks to sustainably increase agricultural productivity and farmers' incomes by enhancing output without degrading natural resources, ensuring that economic growth does not come at the expense of ecological stability. Second, it emphasizes adaptation and resilience, equipping farming communities and production systems to withstand climate-related stocks such as droughts, floods, and heatwaves, which are becoming increasingly frequent in countries like Pakistan. Third, CSA promotes mitigation by reducing or removing greenhouse gas emissions from agricultural activities wherever possible, recognizing that the

sector must be part of the global climate solution.

What makes CSA distinct is its flexibility and contextual relevance. Rather than promoting a universal model, CSA encourages locally informed solutions tailored to specific agro-ecological and socio-economic conditions. This means that conservation agriculture and precision irrigation may be most effective in the irrigated plains of Punjab, while drought-tolerant crops and rainwater harvesting may offer greater resilience in the arid landscapes of Balochistan. Similarly, agroforestry and integrated livestock systems may better support the rain-fed regions of Khyber Pakhtunkhwa. By aligning climate action with locally adaptive strategies, CSA provides a practical pathway for countries like Pakistan to safeguard food security, protect natural resources, and build resilient rural economies in the face of accelerating climate change.

Proven CSA Practices for Pakistani Farmers

For Pakistan's predominantly smallholder farming community, the transition to Climate-Smart Agriculture (CSA) must be anchored in practical, affordable, and locally adaptable solutions. Several evidence-based practices have already demonstrated measurable success across diverse agro-ecological zones of the country. The use of climate-resilient crop varieties is among the most effective strategies. Heat-tolerant wheat cultivars such as Zincol-2016 have reduced yield losses by 10–12% during high-temperature episodes in Punjab and Sindh, while drought-resistant rice and maize varieties are supporting production in increasingly water-stressed regions (NARC, 2023). Alongside varietal improvements, water-smart irrigation systems are becoming essential. Techniques like Alternate Wetting and Drying (AWD) in rice cultivation have achieved up to 30% water savings without compromising yield, as confirmed by Punjab field trials (IRRI, 2022). Complementary practices such as laser

land leveling and drip irrigation further enhance water productivity and reduce waste.

Conservation agriculture including minimum tillage, crop rotation, and residue retention has also shown promising results in the Indus Basin, where farmers have recorded 15–20% yield gains and lower fuel and labor costs (CIMMYT, 2021). Similarly, agroforestry systems that integrate multipurpose species such as Acacia and Moringa help stabilize soils, diversify incomes, and increase carbon sequestration, making them particularly beneficial for semi-arid landscapes. In parallel, digital climate services are proving to be a game-changer. Mobile-based agro-advisories and early warning systems enable farmers to adjust sowing dates, irrigation schedules, and harvesting plans. A recent pilot in Punjab showed that farmers who received SMS weather alerts reduced climate-induced crop losses by nearly 15% (PARC, 2023).

Realizing the full potential of CSA, however, requires strong institutional and policy support. Implementation must move beyond policy statements toward tangible action. Strengthening research–extension linkages is crucial to ensure that innovations developed by institutions such as UAF, PARC, and NARC reach farmers in the field. Financial incentives, including targeted subsidies, climate-linked crop insurance, and accessible credit, can reduce the risk burden on smallholders. Investment in localized climate-information systems, coupled with international cooperation through FAO, the World Bank, and CGIAR networks, will further accelerate CSA adoption. Together, these approaches can build a resilient, water-efficient, and climate-adaptive agricultural future for Pakistan.

Conclusion

Pakistan's agriculture now stands at a defining moment. As climate shocks grow in frequency and magnitude, the traditional systems that once sustained

rural livelihoods are no longer sufficient to ensure food security or economic stability. The evidence is clear: without decisive intervention, climate change will continue to erode crop productivity, deepen rural poverty, and intensify the country's dependence on food imports. Climate-Smart Agriculture offers a pragmatic and forward-looking pathway to confront these challenges. By integrating resilient crop varieties, efficient water management, conservation practices, and digital advisory tools, CSA enables farmers to adapt, sustain yields, and safeguard natural resources even under unpredictable climate conditions.

However, technology and on-farm practice alone are not enough. Progress will depend on strong institutional commitment, sustained policy implementation, and inclusive support for smallholders, who form the backbone of Pakistan's food system. Strengthening research-extension linkages, expanding climate finance, and scaling early warning systems will be critical steps in accelerating this transformation. With coordinated action from government, academia, development partners, and farming communities, Pakistan can build a resilient agricultural future. CSA is not merely an option it is an urgent national imperative. By acting today, Pakistan can protect its farmlands, secure its food systems, and ensure a more prosperous and climate-resilient tomorrow for generations to come.

References: Arif et al; CIMMYT; FAO; Global Climate Risk Index; Hussain et al; IRRI; NARC; Pakistan Economic Survey; PARC; PCRWR; Shahzad et al; World Bank.

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Turkish Agriculture: Resilience Amid Economic Shocks

Explore how the global financial crisis has impacted Turkish agriculture, revealing both its strengths and vulnerabilities. Discover the effects of financial volatility, currency depreciation, and rising input costs on farmers and the agricultural sector.

Mithat Direk

10/31/2025

In an era marked by recurring global economic shocks from the COVID-19 pandemic to successive supply chain disruptions, rising energy prices, and persistent inflationary pressures the agricultural sector faces unprecedented uncertainty. The key question is no longer whether agriculture is affected by financial crises, but how deeply and through what mechanisms these economic tremors ripple through the system. For Turkey, where agriculture remains a vital pillar of both the economy and national identity, this issue carries significant weight. The sector employs roughly 17% of the national labor force and contributes nearly 6% to GDP (Turkish Statistical Institute, 2024). It also serves as a critical buffer for food security, rural livelihoods, and export earnings.

Traditionally, agriculture has been viewed as relatively resilient to financial downturns due to the inelastic nature of food demand people must eat regardless of economic conditions. Yet, in an increasingly globalized and market-integrated economy, Turkish agriculture is far from insulated. Input costs such as fertilizers, seeds, energy, and animal feed are often priced in foreign currencies, making the sector highly sensitive to exchange rate volatility. Similarly, tightening credit conditions and reduced access to agricultural loans during financial crises can constrain production and investment, particularly among smallholders.

In the short term, global shocks tend to manifest through price volatility, input shortages, and disrupted supply chains. However, the long-term effects are more structural: declining profitability, reduced competitiveness, and shifting labor dynamics as rural workers migrate toward

urban areas. Climate change further compounds these vulnerabilities, amplifying the consequences of economic stress through droughts and unpredictable weather patterns.

The Turkish Agricultural Landscape: A Sector in Transition

Turkey's agricultural sector, long a cornerstone of its economy and cultural heritage, is undergoing a profound transformation. As of 2023, about 15.4% of Turkey's workforce remained employed in agriculture, a steady decline from past decades but still representing millions of rural livelihoods (TURKSTAT, 2024). This shift reflects a broader structural transition from traditional subsistence farming toward a market-oriented, capital-intensive system increasingly influenced by global trade dynamics and financial markets.

Agriculture in Turkey today generates a gross production value exceeding USD 65 billion annually, contributing significantly to national GDP and export earnings (Ministry of Agriculture and Forestry, 2023). The country ranks among the world's leading producers of fruits, vegetables, nuts, and cereals, and it serves as a key supplier of agri-food products to Europe, the Middle East, and North Africa. Yet beneath these impressive figures lies a system facing mounting profitability pressures. Many farmers operate on narrow margins, with rising input costs particularly for fertilizer, fuel, and feed eroding income stability.

The sector's increasing financialization has deepened its exposure to macroeconomic volatility. Agricultural production now depends heavily on credit financing, particularly short-term loans to purchase input and sustain operations. As a result, shifts in interest rates, currency

depreciation, or banking sector liquidity directly affect farm-level productivity and investment capacity. This tight cooperation between agriculture and finance, while promoting modernization and export competitiveness, has also created channels for financial contagion.

Moreover, as Turkey's agriculture becomes more embedded in global value chains, it is increasingly vulnerable to international price swings, trade restrictions, and geopolitical shocks. The transition, while positioning Turkish agriculture for long-term growth, demands renewed policy attention to financial resilience, inclusive credit access, and sustainable production systems to safeguard the livelihoods that depend on it.

Transmission Channels: How Financial Stress Reaches the Farm

The impact of global financial crises on Turkish agriculture is rarely immediate or isolated; instead, it unfolds through a network of interrelated transmission channels that link farms to broader macroeconomic dynamics. One of the most critical pathways is the credit and input cost channel. Financial instability typically triggers tighter lending conditions, as banks facing liquidity shortages or increased risk aversion reduce agricultural credit. Farmers, often categorized as high-risk borrowers, find it increasingly difficult to access affordable financing. This coincides with currency depreciation, a recurring feature of Turkey's economic turbulence, which inflates the cost of imported agricultural inputs such as fertilizers, pesticides, and machinery. In 2023, imported input prices rose by more than 40% year-on-year (Central Bank of the Republic of Turkey, 2024), forcing many smallholders to cut back on essential inputs or take on costly

informal loans, heightening the risk of insolvency.

A second channel operates through domestic demand and purchasing power. High inflation, averaging 65% in 2023 (TURKSTAT, 2024) has sharply eroded real household incomes, compelling consumers to prioritize basic staples over higher-value foods like meat, dairy, and fruit. This shift in consumption patterns has led to declining farmgate prices for perishable and premium goods, particularly impacting livestock producers and horticultural farmers. The result is a vicious cycle in which production costs rise while output prices stagnate or fall.

The third transmission channel involves investment and technological stagnation. Agriculture's modernization depends heavily on sustained investment in mechanization, irrigation, and digital tools. However, during financial crises, uncertainty and restricted credit discourage long-term investment. As observed in recent OECD (2023) analyses, postponed or cancelled investments impede productivity growth and slow the sector's transition toward sustainability and competitiveness, leaving Turkish agriculture more vulnerable to future economic shocks.

Differential Impacts and Structural Resilience

The effects of financial crises on Turkish agriculture are far from uniform, reflecting the sector's diverse composition and varying degrees of exposure to domestic and international markets. Some segments demonstrate notable resilience, while others face acute vulnerability to external shocks. Among the more resilient segments are producers of staple crops such as wheat and barley, along with contracted crops like sugar beet and tobacco. These subsectors benefit from government intervention and institutional arrangements that stabilize prices. Guaranteed procurement programs, input subsidies, and pre-agreed purchase prices under contract farming models provide a critical buffer against market volatility. This safety net ensures

production continuity even during broader economic downturns and helps preserve rural employment in key grain-growing regions.

Conversely, the livestock sector remains particularly exposed to financial stress due to its dependence on imported feed. Currency depreciation often accompanying financial crises drives up the cost of soymeal, corn, and other essential inputs, eroding profit margins and threatening production sustainability. Similarly, export-oriented producers of fruits and vegetables experience heightened risk from fluctuating global demand, rising transport costs, and tightening trade finance conditions. These vulnerabilities became evident during the COVID-19 pandemic and subsequent energy price shocks, when Turkish exporters faced delayed payments, cancelled contracts, and logistical bottlenecks.

Yet, Turkey retains a notable structural resilience stemming from the limited role of speculative trading in domestic agricultural markets. Unlike the United States or the European Union where futures and derivative markets can magnify price volatility, Turkey's agricultural commodities market remains relatively insulated from speculative pressures. As the World Bank (2023) notes, the underdevelopment of agricultural futures trading in Turkey has inadvertently shielded farmers and consumers from extreme price swings caused by financial speculation, providing a modest but meaningful layer of stability within an otherwise vulnerable system.

Policy Recommendations for Crisis Mitigation in the Agricultural Sector

To safeguard the agricultural sector from financial instability and future crises, a comprehensive and forward-looking policy framework is indispensable. Agriculture serves as the backbone of rural economies, and its resilience directly determines food security, employment, and national stability. Therefore, policies must combine immediate relief with long-term sustainability to ensure that farmers

remain productive even in challenging economic conditions.

First, strategic planning for food security should be at the core of agricultural policy. Governments must prioritize the cultivation of essential crops such as cereals and pulses by offering targeted subsidies, input support, and guaranteed procurement prices. This ensures that local farmers remain motivated to produce key commodities that form the foundation of national food security, even during market downturns or supply shocks.

Second, expanding access to affordable agricultural credit is vital. Strengthening the capacity of state-backed credit institutions such as the Türkiye Sınai Kalkınma Bankası (TSKB) and Ziraat Bankası can help farmers obtain timely financial assistance. Introducing flexible credit products with grace periods matched to agricultural production cycles and offering low or subsidized interest rates during crises will prevent farmers from falling into debt traps while sustaining production.

Third, risk management mechanisms such as agricultural insurance and warehouse receipt financing should be promoted. These tools can protect farmers from unpredictable losses caused by natural disasters or price fluctuations. Insurance coverage and collateral-based financing enhance farmers' creditworthiness and reduce their vulnerability to shocks.

Finally, agricultural surpluses should be utilized strategically for national benefit. Excess production can support social safety programs, be directed toward humanitarian exports, or be stored as strategic reserves. Such measures not only stabilize markets but also create additional income streams for the agricultural sector, fostering resilience and sustainability in times of crisis.

Conclusion

The global financial crisis and its cascading economic shocks have revealed both the strengths and fragilities of Turkish agriculture. Once perceived as a naturally resilient sector, agriculture in

Turkey now operates within a deeply interconnected economic system where financial volatility, currency depreciation, and global trade disruptions have direct and immediate consequences at the farm level. Rising input costs, tightening credit conditions, and inflation-driven declines in consumer purchasing power have collectively tested the sector's endurance. While staple crop producers have benefited from government price supports and contract farming arrangements, high-value and export-oriented producers particularly in livestock and horticulture remain acutely vulnerable to external market fluctuations.

Yet, amidst these challenges, Turkey's agricultural system retains a degree of structural resilience rooted in its diversified production base, government intervention mechanisms, and limited exposure to speculative financial trading. Moving forward, the country's ability to withstand future crises will depend on strengthening its financial safety nets, expanding access to affordable agricultural credit, and promoting adaptive investments in technology and climate-smart practices. Ultimately, ensuring the stability of Turkish agriculture requires a balanced policy approach one that combines immediate macroeconomic stabilization with long-

term sustainability strategies to safeguard livelihoods, maintain food security, and support the sector's continued role as a cornerstone of national resilience.

References: CBRT; Ministry of Agriculture and Forestry, Turkey; OECD; TURKSTAT; World Bank.

Please note that the views expressed in this article are of the author and do not necessarily reflect the views or policies of any organization.

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RURAL INNOVATION



Agritourism in Türkiye: A Pathway to Sustainable Rural Development

Discover how agricultural tourism revitalizes Türkiye's rural economy, empowers communities, and preserves cultural heritage through sustainable agritourism models.

Mithat Direk

10/10/2025

Agricultural tourism (agritourism) has emerged as a powerful means of revitalizing rural economies by blending agriculture with tourism. It allows farmers to supplement their income through non-traditional, experience-based activities that draw upon the natural landscapes, cultural heritage, and traditional lifestyles of rural communities. In Türkiye, where nearly half of the population maintains strong links to the countryside, agritourism presents both an economic opportunity and a tool for cultural preservation. The country's diverse geography, from the lavender fields of Isparta and olive groves of Aydın to the vineyards of Tekirdağ and the highland plateaus of the Black Sea region, offers a unique setting for authentic rural experiences.

Tourists increasingly seek meaningful escapes from urban stress, preferring destinations that provide hands-on engagement with nature and local traditions. In Türkiye's agritourism sector, visitors can milk goats, pick cherries, harvest olives, or learn the art of cheese-making, often while staying in renovated farmhouses or eco-lodges. These immersive activities not only provide economic diversification for smallholder farmers but also foster a sense of connection between producers and consumers. Moreover, agritourism supports the conservation of traditional farming methods, handicrafts, and rural cuisine, ensuring that local heritage remains vibrant amid modernization.

As global demand for sustainable and experience-based travel continues to grow, Türkiye's agritourism sector stands poised for expansion. By integrating hospitality with agriculture, rural communities can create inclusive, environmentally conscious business models that promote local employment, empower women, and preserve cultural landscapes. Ultimately,

agritourism offers more than leisure, it becomes a bridge between economic development, environmental sustainability, and cultural continuity, making Türkiye's rural heartlands destinations of both beauty and purpose.

The Multifaceted Benefits of Agricultural Tourism for Rural Development in Türkiye

Agricultural tourism (agritourism) plays a transformative role in revitalizing Türkiye's rural areas, generating economic, social, cultural, and environmental benefits that align with the nation's sustainable development goals. As global travelers increasingly seek authentic, experience-based tourism, Türkiye's rich agricultural traditions and scenic landscapes provide an ideal foundation for agritourism expansion.

Economically, agritourism offers rural communities a path toward diversification and resilience. By combining farming with hospitality and local craftsmanship, farmers can supplement traditional income through activities such as farm stays, guided harvests, local product tasting, and handicraft sales. This additional revenue circulates through the local economy, benefiting nearby shops, transport providers, and artisans. In Türkiye, where the rural population has declined to just 5.6% (TurkStat, 2023), such ventures are vital for preventing economic stagnation. Initiatives supported by the Ministry of Agriculture and Forestry's *Rural Development Investment Support Program* and regional Development Agencies have already helped rural entrepreneurs, especially women and youth, establish profitable agritourism businesses. This not only generates employment but also discourages rural-to-urban migration, contributing to balanced regional development (Demir & Özcan, 2022).

Socially and culturally, agritourism acts as a mechanism for safeguarding Türkiye's rural heritage. It keeps alive age-old practices such as olive oil pressing, carpet weaving, pottery, and organic cheese-making, while fostering cross-cultural exchange between hosts and visitors. The success of *Cittaslow* towns like Seferihisar, Halfeti, and Vize demonstrates how tourism can coexist with the preservation of local identity and traditions (Ertürk, 2021). Enhanced local pride and intergenerational knowledge transfer strengthen social cohesion and community well-being.

Environmentally, agritourism supports conservation by promoting sustainable resource management and discouraging land conversion. Tourists who experience organic farming and eco-friendly accommodation become advocates for environmental protection, while farmers gain incentives to maintain biodiversity and traditional landscapes. Ultimately, agritourism in Türkiye is more than an income strategy, it is a holistic development tool that sustains livelihoods, preserves heritage, and nurtures the environment for future generations.

Challenges and Drawbacks of Agricultural Tourism in the Turkish Context

While agricultural tourism holds remarkable promise for Türkiye's rural revitalization, its implementation faces several economic, social, and environmental challenges that must be addressed for the sector to achieve long-term sustainability.

From an economic and administrative standpoint, the foremost obstacle lies in high initial investment costs. Rural entrepreneurs often lack the capital to upgrade essential infrastructure, such as accommodation facilities, sanitation

systems, and access roads, to meet tourism standards. Even with government grants and development funds, the financial burden can be prohibitive for smallholder farmers. Moreover, agritourism revenues are often highly seasonal, concentrated during summer or harvest months, resulting in irregular income flows and uncertainty. Another pressing issue is the shortage of trained personnel. Agritourism demands a blend of agricultural expertise, hospitality management, and environmental awareness, yet vocational programs that address these interdisciplinary needs remain scarce in Türkiye (Gürel & Altunöz, 2023). As a result, many rural ventures struggle to maintain professionalism, effective marketing, and visitor satisfaction.

Socially, agritourism can create tensions within rural communities. When rural traditions are altered or commercialized to appeal to tourists, there is a risk of cultural dilution and loss of authenticity. The unequal distribution of economic benefits can also generate resentment among locals, especially when profits are concentrated among a few families or cooperatives. Additionally, differences in lifestyle, values, and behavior between visitors and residents can cause misunderstandings if cultural exchange is not managed sensitively.

Environmentally, unplanned growth of agritourism brings serious risks. Increased

visitor numbers can overburden fragile ecosystems, deplete water resources, and lead to improper waste disposal. The construction of unregulated guesthouses or facilities on fertile farmland further threatens agricultural sustainability. As Öztürk and Ter (2022) emphasize, every rural destination has a finite carrying capacity; exceeding it can transform a sustainable initiative into an ecological burden. Balancing economic ambition with environmental and social integrity remains Türkiye's central agritourism challenge.

Conclusion

Agricultural tourism represents one of Türkiye's most promising pathways toward sustainable rural transformation. By integrating agriculture with tourism, it provides a multifaceted model that revitalizes rural economies, preserves cultural heritage, and promotes environmental stewardship. For smallholder farmers, agritourism offers a vital opportunity to diversify income sources and reduce vulnerability to market and climate fluctuations. It strengthens rural entrepreneurship, particularly among women and youth, while fostering community pride and intergenerational knowledge transfer. Visitors, in turn, gain authentic, educational, and environmentally responsible experiences that deepen their appreciation of rural life and traditional production systems.

However, realizing this potential requires strategic planning and support. Addressing challenges such as limited infrastructure, seasonal income fluctuations, inadequate training, and uneven benefit distribution is critical to ensuring inclusive and sustainable growth. Policymakers must strengthen institutional coordination, invest in capacity building, and enforce environmental safeguards to prevent overexploitation of rural landscapes.

If implemented thoughtfully, agritourism can evolve from a niche activity into a cornerstone of Türkiye's rural development policy. It embodies the principles of the "triple bottom line", economic viability, social equity, and environmental balance, transforming rural communities into living landscapes of productivity, culture, and sustainability. In doing so, Türkiye can position its countryside as both a destination and a model for sustainable rural prosperity.

References: Demir & Özcan; Ertürk; Gürel & Altunöz; Öztürk & Ter; TurkStat.

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Transforming Pakistan's Organic Farming with Innovation

Discover how resilient seeds and the multi-agent value approach (MAVA) can revolutionize organic farming in Pakistan. Explore innovative strategies, effective policies, and sustainable practices that drive agricultural transformation.

RURAL INNOVATION

Sarmad Veesar

10/13/2025

The shift toward organic farming in Pakistan is more than an agricultural adjustment, it is a transformative movement toward sustainability, self-reliance, and ecological harmony. Yet, despite the growing awareness and policy interest, one of the most fundamental prerequisites for this transition, seed resilience, remains underemphasized. Traditional high-yielding varieties (HYVs), designed for conventional agriculture, rely heavily on synthetic fertilizers and pesticides. When cultivated under organic systems that prohibit such inputs, these seeds often underperform, yielding less and exhibiting lower resistance to pests, diseases, and climatic stresses. This mismatch between seed characteristics and organic conditions undermines the productivity and profitability of organic farming, discouraging many smallholders from making the transition.

A new framework is therefore essential one that recognizes the interconnectedness of biological, social, and economic factors in seed development. The Multi-Agent Value Approach (MAVA) provides such a model by integrating the perspectives of farmers, breeders, policymakers, and market actors to co-create seed varieties suited to local conditions. In Pakistan's diverse agro-ecological zones, where water scarcity, soil degradation, and climate variability pose mounting challenges, MAVA can guide participatory breeding programs that prioritize resilience over short-term yields.

By promoting farmer involvement in selection, emphasizing local adaptation, and valuing genetic diversity, this

approach supports not only organic certification but also long-term food sovereignty. Strengthening seed systems through cooperative networks, public-private partnerships, and community seed banks can ensure that the organic farming transition becomes both scientifically grounded and socially inclusive. Ultimately, resilient seeds form the living foundation of Pakistan's organic agriculture empowering farmers to cultivate sustainability from the soil up.

The Critical Role of Suitable Seeds in Organic Systems

In the context of Pakistan's growing interest in organic agriculture, the availability and quality of suitable seeds stand as a decisive factor in determining the long-term success and sustainability of organic farming. Conventional breeding programs have largely been designed for high-input agriculture systems dependent on synthetic fertilizers, pesticides, and irrigation. Such seeds perform well under controlled and resource-intensive conditions but tend to struggle when shifted to organic environments where chemical inputs are prohibited and ecological balance drives productivity. Organic systems, by their very nature, demand seeds with intrinsic resilience, capable of adapting and thriving under diverse and often challenging conditions.

The traits most vital for organic agriculture include enhanced disease and pest resistance, ensuring protection against local pathogens without chemical intervention; superior nutrient use efficiency, allowing plants to effectively absorb nutrients from compost, manure, and natural soil processes; and abiotic

stress tolerance, critical for coping with drought, salinity, and temperature extremes. For Pakistan, where water scarcity in Sindh and Balochistan contrasts sharply with fluctuating climates in northern regions, locally adapted varieties are indispensable for stable yields and ecological sustainability.

When farmers use conventional high-yielding varieties (HYVs) under organic management, studies suggest that yields can drop by 15–25% (Ponisio et al., 2015). This yield gap is not an inherent flaw of organic farming but rather a reflection of genetic mismatches. Without seeds bred for organic resilience, farmers face reduced profitability, weakened confidence in organic systems, and difficulty competing in local and export markets.

Developing organic-specific seed varieties, therefore, is not simply a technical need, it is an economic and environmental imperative. By investing in participatory breeding programs and adaptive research, Pakistan can empower its farmers with seeds that align with the principles of sustainability, resilience, and self-reliance, ensuring that organic agriculture flourishes as a viable alternative to input-dependent farming systems.

Understanding the Multi-Agent Value Approach

The Multi-Agent Value Approach (MAVA) offers a comprehensive framework for assessing the true success of seed breeding programs by recognizing that agricultural value extends beyond yield. Instead of viewing productivity as the sole indicator of success, MAVA evaluates the benefits that seeds generate

for all key stakeholders, farmers, consumers, supply chain actors, and the environment. This approach is particularly relevant to Pakistan's emerging organic agriculture sector, where multiple dimensions of sustainability must align for long-term viability.

For farmers, value is derived not only from higher yields but also from risk reduction and economic independence. Seeds bred for resilience against drought, pests, and diseases protect against climate-induced losses. Open-Pollinated Varieties (OPVs) empower farmers by allowing seed savings and reuse, lowering annual input costs and reducing dependency on commercial seed companies (Kloppenborg, 2014). Additionally, varieties developed to meet organic certification standards grant farmers access to high-value domestic and international markets.

For consumers, the benefits include food safety and cultural relevance organic seeds produce crops free from harmful chemical residues and aligned with traditional culinary preferences, such as chapati-friendly wheat or aromatic Basmati rice.

The supply chain also gains from seeds that produce uniform, durable, and easily processed crops, which reduce post-harvest losses and improve market efficiency.

Finally, the environment benefits through reduced chemical dependency, enhanced soil biodiversity, and improved water efficiency. Seeds that promote ecosystem health contribute to long-term agricultural sustainability.

Thus, MAVA reframes seed breeding as a shared value enterprise one that balances profitability with ecological and social resilience, paving the way for a sustainable organic future in Pakistan.

Current Challenges in Pakistan's Organic Seed Sector

The transition toward a resilient organic seed sector in Pakistan remains hindered by deep-rooted structural, institutional, and policy constraints. Despite growing

demand for organic produce, the supporting seed infrastructure lags far behind. Limited research and development remain one of the most critical obstacles. Both public and private breeding programs in Pakistan are heavily oriented toward conventional, high-input agriculture that depends on chemical fertilizers and pesticides. Consequently, little to no investment has been made in developing organic breeding lines that can perform effectively in low-input, ecologically balanced systems (NFDC, 2022).

Another pressing issue is the severe shortage of organic seed supply. According to estimates, fewer than 10% of smallholder farmers in Pakistan have consistent access to certified organic seeds (PARC, 2023). The majority are compelled to use untreated conventional seeds, which compromises the integrity of organic certification and weakens the credibility of the sector. Compounding the problem is the fragmentation of value chains, where breeders, extension agents, farmers, and markets operate in isolation. This lack of coordination slows innovation, prevents feedback-based improvements, and hinders the adoption of suitable varieties.

Policy and regulatory support for organic seed production remains minimal. Pakistan lacks a cohesive national framework defining standards for organic seed production, certification, and distribution. Moreover, the absence of fiscal incentives or subsidies for organic breeders disincentivizes research investment in this niche.

Globally, countries such as Brazil and members of the European Union provide instructive models. Brazil's farmer-participatory seed breeding programs have increased organic yields by up to 30%, while preserving genetic diversity (IFOAM Organics International, 2022). Similarly, the EU's well-defined organic seed regulations have spurred innovation and enhanced market confidence.

For Pakistan, the path forward lies in institutionalizing participatory breeding, supporting decentralized community seed

systems, and aligning R&D incentives with organic priorities. Strengthening extension services, integrating organic seed standards into national policy, and adopting the Multi-Agent Value Approach (MAVA) for continuous impact assessment will be essential steps. Through these reforms, Pakistan can lay the foundation for a robust organic seed system that supports both farmer prosperity and environmental sustainability.

Conclusion

The future of Pakistan's organic farming movement depends fundamentally on how effectively the country can cultivate resilience at its roots through the development of strong, adaptive, and inclusive seed systems. This study underscores that seed resilience is not just a biological trait but a socio-economic and ecological necessity. Without seeds bred specifically for low-input, diverse environments, the promise of organic agriculture higher sustainability, better nutrition, and rural empowerment remains incomplete.

The Multi-Agent Value Approach (MAVA) offers a transformative framework for bridging these gaps by aligning the interests of farmers, breeders, consumers, policymakers, and the environment. It redefines success in seed breeding beyond yield, emphasizing value creation across the agricultural ecosystem. Through participatory breeding, community-based seed systems, and integrated policy support, Pakistan can build a self-reliant organic seed sector that enhances productivity while protecting biodiversity.

However, achieving this vision requires sustained commitment. Strengthening institutional coordination, incentivizing organic R&D, and mainstreaming farmer participation are essential. By embracing this inclusive and science-based model, Pakistan can transform its seed systems into engines of resilience and innovation. In doing so, the nation not only secures the foundation of its organic transition but also reaffirms agriculture's role as a

driver of sustainable rural prosperity and ecological balance.

References: IFOAM Organics
International; Kloppenburg; PARC;
Ponisio et al; World Bank.

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Reforestation: Combat Climate Change in Pakistan

Discover how large-scale reforestation efforts in Pakistan can effectively combat climate change, enhance carbon sequestration, and support sustainable livelihoods for local communities. Join the movement towards a greener future.

Muzamil Abbasi

10/15/2025

Climate change continues to exert unprecedented pressure on ecosystems worldwide and developing nations like Pakistan remain at the frontline of this crisis. With agriculture, water resources, and rural livelihoods deeply intertwined with climatic patterns, Pakistan's exposure to rising temperatures, erratic rainfall, and land degradation poses grave socioeconomic challenges. Forests, as a natural defense mechanism, play a crucial role in climate regulation and environmental stability. Globally, they act as massive carbon sinks, absorbing an estimated 7.6 billion metric tonnes of CO₂ equivalent annually (IPCC, 2022). However, widespread deforestation and land-use change contribute around 4.1 billion tonnes of CO₂ emissions each year, undermining these benefits and accelerating global warming.

In Pakistan, forest depletion has reached alarming levels, with only 5.7% of total land area under forest cover, one of the lowest rates in South Asia and drastically below the ecologically sustainable threshold of 25% (World Bank, 2023). The consequences of this decline are multifaceted. Reduced canopy cover has disrupted local rainfall patterns, intensified flooding in the north, and increased desertification in southern regions. Moreover, the resulting soil erosion and declining organic matter have led to an estimated 18% reduction in agricultural productivity in key provinces such as Punjab and Sindh (PARC, 2024).

Reforestation and forest management, therefore, must be recognized as both an environmental necessity and an economic strategy. Expanding forest cover can restore degraded lands, enhance carbon sequestration, stabilize water cycles, and create employment through community-based forestry initiatives. Strategic investment in tree planting, sustainable

timber production, and agroforestry could transform rural landscapes, contributing simultaneously to climate resilience, poverty alleviation, and national sustainability goals. In essence, forest restoration offers Pakistan a dual dividend, protecting the environment while fostering inclusive economic growth for future generations.

The Deforestation Crisis: Eroding Carbon Sinks and Livelihoods

Deforestation remains a primary driver of environmental degradation in Pakistan. The country has one of the highest annual deforestation rates in South Asia, estimated at 2.7%, contributing nearly 40% of its national greenhouse gas emissions from the forestry and land-use sector (MoCC, 2023). This stands in stark contrast to regional neighbors; India has increased its forest cover to 24.62% and Bangladesh to 14.47%, demonstrating the feasibility of reversal through sustained policy commitment (FSI India, 2023; FAO, 2022).

The carbon sequestration implications are severe. Mature native forests in the Himalayas can sequester between 5 to 7 tons of CO₂ per hectare annually, whereas degraded and deforested lands absorb less than 1 ton (IUCN, 2022). This potential remains largely untapped due to systemic failures. A critical bottleneck is the low survival rate of saplings in government-led campaigns, which is a mere 40-50%, compared to over 80% in community-managed forests (UNDP, 2023). This is exacerbated by the preferential allocation of irrigation, with over 70% directed to agricultural zones versus only 30% for reforestation projects (World Bank, 2023). Furthermore, an over-reliance on exotic species, which constitute up to 80% of planted trees compared to ecologically resilient native species, further depresses

long-term survival and biodiversity benefits (Pakistan Forest Institute, 2022).

The socio-economic costs are profound. Deforestation has diminished the availability of non-timber forest products, impacting the livelihoods of an estimated 5 million people in forest-adjacent communities. With only 12% of forest areas under legally recognized community management, local populations have limited incentive for stewardship (MoCC, 2023). Consequently, Pakistan is utilizing only an estimated 35% of its total carbon sequestration potential, a critical gap in its strategy to meet its Nationally Determined Contributions (NDCs) under the Paris Agreement.

Global Lessons and a Strategic Pathway for Pakistan

Global experiences in reforestation and forest restoration offer powerful insights for Pakistan as it seeks to address its severe deforestation crisis and enhance climate resilience. Countries such as China, India, and Ethiopia have demonstrated that large-scale reforestation is possible when environmental goals are aligned with economic incentives and community participation. China's "Grain for Green" program, one of the world's largest ecological restoration initiatives, has successfully converted degraded farmland into forest, leading to an increase in national forest cover and the sequestration of approximately 2.5 billion tons of CO₂ annually (UNEP, 2022). Similarly, India's Green India Mission has effectively merged ecological restoration with poverty alleviation by linking afforestation efforts to rural employment and livelihood programs (NITI Aayog, 2023). Ethiopia's Green Legacy Initiative exemplifies how mass

mobilization and civic engagement can yield extraordinary outcomes, planting hundreds of millions of trees in a single day while ensuring strong community stewardship (World Bank, 2022).

For Pakistan, these examples highlight the need for a holistic, participatory, and science-driven approach. Policy reform should prioritize community rights and gender inclusion, particularly by involving rural women in reforestation programs and decision-making roles. Strengthening legal frameworks under the National Forest Policy to protect native species like *Acacia nilotica* and *Prosopis cineraria* would help preserve biodiversity and ecosystem stability.

Furthermore, Pakistan must capitalize on emerging climate finance opportunities. Establishing a domestic carbon market and securing funding from the Green Climate Fund or voluntary carbon offset programs could generate a sustainable financial base for long-term forest management. The integration of technologies such as drone-assisted seeding, GIS mapping, and remote sensing would ensure transparency, precision, and efficiency in afforestation efforts. Finally, transitioning from top-down plantation schemes to community-led forest management—supported

through Payment for Ecosystem Services (PES) and carbon credit sharing—would embed sustainability within local economies, ensuring that Pakistan's forests are not only restored but also protected for generations to come.

Conclusion

Reforestation stands as one of Pakistan's most powerful yet underutilized strategies for addressing climate change, environmental degradation, and rural poverty. As this analysis reveals, the nation's dwindling forest cover, now below 6%, is not merely an ecological concern but a threat to national food security, water stability, and long-term economic resilience. Forest ecosystems are natural allies in the fight against global warming, serving as cost-effective carbon sinks while providing essential ecosystem services such as soil conservation, groundwater recharge, and biodiversity protection.

For Pakistan, revitalizing its landscapes through reforestation must evolve from short-term tree-planting campaigns to a comprehensive national movement grounded in science, policy, and community participation. Lessons from China, India, and Ethiopia prove that when environmental goals are tied to

economic incentives and social inclusion, transformative outcomes are possible. By investing in native species, recognizing community forest rights, and leveraging climate finance through carbon markets, Pakistan can unlock both ecological and economic gains.

Ultimately, restoring forests is about more than trees, it is about restoring balance between people, nature, and the economy. A nationwide commitment to sustainable forest management can help Pakistan move toward carbon neutrality, strengthen climate resilience, and secure a greener, more prosperous future for generations to come.

References: FAO; FSI; IPCC; IUCN; MoCC; NITI Aayog; PARC; Pakistan Bureau of Statistics; Pakistan Forest Institute; UNDP; UNEP; World Bank.

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Türkiye: An Agricultural Powerhouse with Smart Marketing

Türkiye has the potential to become a leading agricultural powerhouse through strategic transformation. By evolving the marketing mix from the traditional 4Ps to the modern 7Ps, Turkish producers can get higher prices, reduce dependence on intermediaries, and reach both domestic and global consumer.

Mithat Direk

10/24/2025

Türkiye's agricultural sector possesses immense and distinctive potential, rooted in its fertile soils, favorable geography, and rich biodiversity. From the plains of Konya to the Black Sea's hazelnut orchards and the Aegean's olive groves, the country enjoys a diversity of climate zones that enables the production of a wide range of high-value crops. Despite this natural advantage, Türkiye has not yet converted its agricultural strength into proportionate global market power. Much of its produce is still exported as bulk, unbranded commodities, which limit profit margins and keep farmers dependent on fluctuating international prices. To unlock the sector's full potential and ensure sustainable income growth for producers, it has become essential to adopt modern and competitive marketing approaches.

In this context, the marketing mix commonly structured around product, price, place, and promotion serves as a comprehensive strategic framework for agricultural enterprises. It provides guidance on how to design market-oriented products, determine competitive pricing, select effective distribution channels, and build strong communication with target consumers (Kotler & Keller, 2022). By mastering these elements, Turkish agricultural businesses can move beyond the role of low-value raw material suppliers and instead position themselves as trusted brands in domestic and international markets.

Applying the marketing mix effectively will also help agricultural firms generate value-added products such as packaged olives, organic dried fruits, regional cheeses, branded honey, and ready-to-eat exports. Such transformation not

only elevates brand recognition but also attracts premium prices, diversifies market destinations, and strengthens bargaining power across the supply chain. Ultimately, the integration of modern marketing strategies into Turkish agriculture can accelerate rural development, enhance export competitiveness, and increase farmers' long-term profitability. In an era where global consumers favor transparency, quality, and authenticity, Türkiye's agricultural sector can rise to its rightful place if it successfully combines its natural abundance with strategic marketing intelligence.

The Evolution of the Marketing Mix: From 4Ps to 7Ps and Beyond

The marketing mix has undergone a remarkable transformation since its inception. The original 4Ps framework, i.e. Product, Price, Place, and Promotion introduced by McCarthy in 1960, provided the first systematic approach for firms to plan and execute their market strategies. For decades, this model served as a cornerstone of agricultural marketing, guiding producers on how to design attractive offerings, set suitable prices, and deliver products effectively to consumers. However, as the agricultural sector in Türkiye increasingly began to incorporate service elements such as agritourism, branded retail experiences, and direct-to-consumer sales, it became clear that the traditional 4Ps were no longer sufficient.

By the early 1980s, Booms and Bitner expanded the model to 7Ps, adding People, Process, and Physical Evidence. These new elements were especially relevant for agriculture, where trust, transparency, and customer experience play decisive roles. At every stage of the "field-to-fork" chain from farm workers

and supply-chain actors to customer service and retail environments people became central to value creation. Likewise, clear and efficient processes, supported by certifications and traceability systems, emerged as indicators of quality and safety. Physical evidence, such as packaging, labeling, and store presentation, helped build brand credibility and differentiate Turkish products in competitive markets.

In today's digital era, the marketing mix has evolved even further. The explosive growth of e-commerce, social media, and data analytics has expanded the farmer-consumer relationship beyond physical markets. Digital tools now shape buyer perceptions, enable precision targeting, and provide real-time feedback. Turkish consumers increasingly discover, evaluate, and purchase agricultural products online, making digital storytelling, influencer partnerships, QR-code traceability, and online marketplaces indispensable components of a modern marketing strategy. As a result, the marketing mix has shifted from a static checklist into a dynamic, interactive system, allowing agricultural businesses in Türkiye to engage consumers continuously, build loyalty, and compete more effectively in both domestic and global markets.

The 7Ps of Marketing: A Strategic View for Turkish Agriculture

The 7Ps marketing framework offers a powerful strategic roadmap for transforming Turkish agriculture from a raw-material supplier into a competitive, value-added, and globally recognized brand sector. The first component, product, emphasizes that the offering must go beyond unprocessed commodities. For Türkiye, this means

shifting from selling Grade-A figs or bulk hazelnuts to supplying organic dried figs in premium packaging, fig jams with geographical indication (GI) labels, or roasted hazelnuts marketed as a gourmet snack. The global success of Antep Baklava and Malatya Apricot shows that place-based branding works. With the Turkish organic farming market surpassing 5 billion TL in 2023 (TÜRKTOB, 2023), consumer preference already supports higher-value, certified, and traceable products that focus on authenticity, origin, and health.

Pricing is equally transformative. Historically, pricing in Turkish agriculture has been shaped by intermediaries and cost-based logic, limiting farmer profitability. A shift toward value-based pricing allows producers to capture the true market value of quality, story, and experience. A greenhouse-grown, washed, and ready-to-eat packaged Sultana grape can command 25–40% higher prices than regular table grapes (TÜRKSTAT, 2023) because consumers are willing to pay more for convenience, standards, and safety. This requires financial literacy, price differentiation, and segmentation strategies.

Place, or distribution, determines visibility and accessibility. While traditional wholesale markets remain important, new channels are rapidly growing. Farmers' markets, municipal direct-sale points, cooperatives, and e-commerce platforms such as Tarım Kredi and FromTürkiye are becoming crucial bridges between producers and consumers. Digital distribution can raise farmer profit margins by nearly 30% by eliminating unnecessary intermediaries (TARNET, 2023). Cold chain logistics and regional collection hubs are also enabling fresh products to reach distant markets with minimal loss.

Promotion has evolved from word-of-mouth to digital storytelling. Today, 65% of agricultural SMEs in Türkiye use social media to promote products (Türkiye Digital Agriculture Report, 2024). A small olive oil producer sharing

the harvest journey from the grove to the bottle on Instagram or YouTube can build brand loyalty, attract urban buyers, and justify premium pricing. Visual storytelling, influencer collaborations, and QR-based traceability are reshaping consumer engagement.

People remain at the heart of agricultural marketing. Trained farmers, informed sales representatives, and responsive customer service teams help build trust and long-term loyalty. Process is equally important, encompassing cold-chain management, order handling, logistics, and feedback systems. With post-harvest losses still at 25–30% (TMMOB, 2023), improving the process from field to fork is essential for profitability and customer satisfaction.

Finally, physical evidence strengthens credibility. Attractive, sustainable packaging; clear labeling; professional websites; and GI or organic logos signal reliability and quality. Physical proof reinforces trust and heavily influences purchase decisions, especially in export markets.

The Role of the Marketing Mix in Türkiye's Agricultural Growth

The marketing mix plays a central role in shaping the future competitiveness of Turkish agriculture by aligning production with evolving consumer expectations, global market standards, and value-added strategies. Effective branding is one of the strongest opportunities. Türkiye is home to globally admired geographically indicated (GI) products such as Antep Baklava, Aydın Fig, and Malatya Apricot. By telling the authentic stories behind these products highlighting terroir, tradition, and production culture, the country can create emotional connections that multiply product value in both domestic and international markets. Branding converts agricultural commodities into premium goods.

Value-addition is another critical dimension, especially for exports. Instead of shipping raw hazelnuts, raisins, or olives at low margins, Türkiye can strengthen its trade position by

exporting hazelnut paste, roasted packaged nuts, gourmet olive oils, and ready-to-eat fruit products. According to Turkish Exporters Assembly data, processed food exports are growing three times faster than raw agricultural exports (TIM, 2023), proving that value-addition increases foreign exchange earnings, strengthens national brand perception, and expands market share. At the same time, modern marketing tools such as QR-based traceability, blockchain food transparency, and “farm-tracking” mobile apps can deepen consumer trust, assuring buyers of authenticity, origin, and food safety.

For these gains to be fully realized, urgent policy and implementation measures are needed. Strengthening cooperatives will allow small producers to standardize products, negotiate better prices, and co-invest in branding and packaging. Expanding digital infrastructure and e-commerce training will accelerate SME participation in online markets. Strategic investments in logistics and cold chains will reduce post-harvest losses and preserve quality throughout distribution. Finally, international promotion under a unified “Türkiye Agriculture” master brand, supported by trade fairs, export missions, and global marketing campaigns will reinforce Türkiye's position in high-value markets. By integrating these actions, the marketing mix can become a transformative force for agricultural growth, farmer prosperity, and national competitiveness.

Conclusion

Türkiye possesses all the natural foundations needed to become a leading agricultural powerhouse, but realizing this potential requires strategic transformation driven by smart marketing. The evolution of the marketing mix from the traditional 4Ps to the modern 7Ps demonstrates that success in today's agricultural markets is no longer achieved only through production volume, but through branding, value-addition, consumer trust, and differentiated market

positioning. By applying the marketing mix effectively, Turkish producers can command higher prices, reduce dependence on intermediaries, and reach both domestic and global consumers with branded, story-rich, and premium-quality products.

Digitalization, improved logistics, and e-commerce have further expanded opportunities for market access, allowing even small farmers to build direct relationships with customers. Meanwhile, value-added strategies such as processed exports, traceability systems, and strong packaging can multiply income and enhance

competitiveness. However, this transformation also requires supportive policies, cooperative structures, and continued investment in cold chains and digital skills.

If Türkiye successfully aligns its agricultural strengths with a modern marketing mindset, it can transition from being a bulk commodity supplier to a globally recognized brand nation in food and agriculture. By uniting tradition with innovation, Türkiye can secure sustainable farmer incomes, strengthen its export profile, and lead confidently in the future of agri-food markets.

References: Booms & Bitner; Kotler & Keller; McCarthy; TMMOB Chamber of Agricultural Engineers; TURKSTAT; TÜRKTOB; Turkish Exporters Assembly; TARNET; Türkiye Digital Agriculture Report.

Please note that the views expressed in this article are of the author and do not necessarily reflect the views or policies of any organization.

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Sustainable Agriculture: A Future for Food Systems

Explore how sustainable agriculture is essential for addressing climate change and building resilient food systems. Learn about practices that enhance productivity while conserving resources, ensuring stability for farmers and economies.

Jamal Nasir Jarwar

10/29/2025

In an era increasingly defined by climate extremes, soil degradation, and rapidly growing food demand, the shift toward sustainable agriculture has become not just a theoretical aspiration but an urgent necessity for global survival. The frequency of droughts, floods, pest outbreaks, and rising temperatures has placed immense strain on traditional farming systems, threatening food security and rural livelihoods. As the global population is expected to reach nearly 9.7 billion by 2050, the Food and Agriculture Organization (FAO, 2022) projects that food production must expand by about 60% to meet future demand. Achieving this growth while protecting the environment poses one of the greatest challenges of our time.

Sustainable agriculture offers a balanced solution integrating economic, environmental, and social dimensions of development. It emphasizes efficient resource use, soil and water conservation, biodiversity protection, and reduced dependence on chemical fertilizers and pesticides. Practices such as crop rotation, organic farming, precision agriculture, and integrated pest management not only enhance productivity but also restore degraded ecosystems. Importantly, these approaches lower input costs over time, creating a more resilient and profitable farming model.

Farmers, researchers, and policymakers increasingly recognize that sustainability is no longer a niche agenda. It is a pragmatic economic strategy essential for ensuring long-term agricultural viability and competitiveness. Investment in sustainable practices protects natural capital, stabilizes yields against climate shocks, and strengthens rural economies. Moreover, the integration of technology such as climate-smart irrigation systems,

digital monitoring tools, and data-driven farm management further accelerates the transition toward greener food systems.

Ultimately, sustainable agriculture represents the foundation of future global food security. It connects the health of the planet with that of people and economies, ensuring that growth today does not compromise the well-being of future generations.

The Imperative for Smarter Farming

Modern agriculture stands at a crossroads, facing an unprecedented convergence of environmental, economic, and social challenges. Declining arable land, severe water scarcity, rising energy and fertilizer costs, and the intensifying effects of climate change have created a crisis of sustainability. For decades, conventional high-input farming systems heavily dependent on chemical fertilizers, pesticides, and intensive irrigation helped feed the world but at a tremendous environmental cost. According to the United Nations Convention to Combat Desertification (UNCCD, 2022), nearly 33% of global soils are now degraded. The Economics of Land Degradation (ELD) Initiative (2023) estimates that the annual economic losses from soil erosion, nutrient depletion, and declining productivity amount to a staggering \$6.3 trillion worldwide. These figures underscore the urgent need for a smarter, more regenerative form of agriculture that replenishes rather than depletes natural resources.

Sustainable agriculture provides a comprehensive framework for this transformation. By adopting intelligent and resource-efficient practices, farmers can increase yields while restoring ecological balance. Techniques such as precision irrigation optimize water use,

integrated nutrient management ensure balanced soil fertility, and crop diversification enhance resilience to pests and climatic shocks. Agroecology, which blends traditional knowledge with scientific innovation, fosters ecosystem services such as pollination, pest control, and carbon sequestration.

Empirical evidence supports the effectiveness of these methods. A meta-analysis by Pretty et al. (2018) found that sustainable intensification practices increased crop yields by an average of 79% across 57 developing countries. This demonstrates that environmental protection and productivity gains are not contradictory goals but mutually reinforcing outcomes.

In essence, the future of agriculture depends on making it smarter integrating technology, ecology, and economics to create systems that sustain both farmers' livelihoods and the planet's health. Smarter farming is not only a choice but a necessity for long-term food security and environmental resilience.

The Convergence of Technology and Tradition

One of the most transformative shifts in modern agriculture is the emerging synergy between advanced technology and traditional ecological wisdom. For centuries, farmers relied on deep local knowledge of soils, weather patterns, and crop cycles to sustain production. Today, that wisdom is being revitalized and empowered by precision technologies that enable smarter, more sustainable farming. Precision agriculture tools such as drones for crop health mapping, Internet of Things (IoT) soil sensors, satellite imagery, and AI-driven analytics are revolutionizing how resources are managed on farms. These technologies

allow for precise application of water, fertilizers, and pesticides only where and when they are needed, dramatically improving efficiency. According to the World Bank (2023), such targeted management can lower production costs by 10–20% while significantly reducing nutrient runoff, one of the leading contributors to freshwater pollution and eutrophication.

At the same time, there is a growing return to nature-positive farming practices rooted in traditional methods. Techniques like agroforestry, conservation tillage, and cover cropping restore soil fertility, promote biodiversity, and enhance carbon sequestration. When integrated with modern technologies such as digital soil mapping or sensor-based nutrient monitoring these methods become part of a scalable model often referred to as “smart sustainability.” This approach marries the precision of modern tools with the resilience of natural systems.

Recent empirical evidence reinforces the value of this hybrid model. A 2023 study published in *Nature Sustainability* found that combining cover crops with sensor-based nitrogen management increased farm profitability by 16% while cutting nitrogen leaching by 35% (Basso et al., 2023). Such findings confirm that the convergence of technology and tradition can redefine productivity creating farming systems that are economically viable, environmentally sound, and socially responsible. In essence, the future of agriculture lies not in abandoning tradition but in enhancing it through intelligent innovation.

The Enduring Economic and Climate Resilience Benefits of Sustainable Agriculture

Although the upfront investment in sustainable agricultural practices can be challenging for many farmers, the long-term economic, environmental, and social returns are substantial. Healthier soils enriched with organic matter significantly improve water-holding capacity, enabling farmers to reduce irrigation needs by up to 30% while enhancing resilience to droughts and erratic rainfall patterns

(Rodell et al., 2018). Such improvements translate into direct cost savings and greater stability in crop yields even under extreme weather conditions. Moreover, the integration of renewable energy technologies, such as solar-powered irrigation systems, reduces dependence on fossil fuels, lowers operational expenses, and ensures energy self-sufficiency in rural areas.

Crop diversification also plays a critical economic role by reducing vulnerability to price fluctuations, pests, and diseases. By cultivating multiple crops, farmers spread risk and maintain income stability even when one crop fails due to climatic or market shocks. Meanwhile, the global demand for sustainably produced and organic products continues to expand, providing new opportunities for farmers to access premium markets and earn higher returns. These economic incentives demonstrate that sustainability is not only environmentally sound but also financially viable over time.

From a broader perspective, sustainable agriculture has become a cornerstone of climate resilience and food security. The agricultural sector, responsible for roughly 17–21% of global greenhouse gas emissions (IPCC, 2022), can simultaneously reduce emissions and adapt to climate impacts through practices such as regenerative grazing, composting, and no-till farming. According to the Rodale Institute, global adoption of regenerative methods could potentially sequester more than 100% of annual CO₂ emissions. By preserving soil fertility, reducing emissions, and stabilizing yields, sustainable farming ensures that we safeguard tomorrow’s resources while meeting today’s needs laying the foundation for enduring prosperity and food security in a changing climate.

The Critical Role of Policy, Finance, and Education

Farmers alone cannot carry the responsibility of transforming agriculture into a sustainable system. Strong policy support, innovative financial mechanisms, and comprehensive education programs are essential pillars

for this transition. Governments need to take a leading role by reshaping existing subsidy structures that often promote unsustainable practices. Redirecting these funds toward climate-smart agriculture, organic farming, and renewable energy technologies can create strong incentives for farmers to adopt environmentally responsible methods. For instance, the Food and Agriculture Organization (FAO, 2023) notes that repurposing the world’s annual \$470 billion in agricultural producer support could transform food systems toward sustainability and resilience. Additionally, green crop insurance schemes and low-interest loans for sustainable technologies would encourage small and medium-scale farmers to invest in eco-friendly innovations.

However, financial measures alone are not enough without education and knowledge dissemination. Capacity-building programs through agricultural universities, research institutions, and extension services must focus on equipping farmers with practical skills in soil management, water conservation, and digital agriculture. Non-governmental organizations (NGOs) also play a vital role in bridging the knowledge gap between policymakers and rural communities, ensuring that even smallholders have access to modern, sustainable practices. Empowering farmers with information enables them to make better decisions for both productivity and environmental health.

Education and financial incentives combined can transform rural economies by creating a new generation of informed, innovative, and resource-efficient farmers. When governments, research institutions, and private actors work together under coherent policies, the agricultural sector becomes not just more sustainable but also more inclusive and economically viable. The synergy between policy, finance, and education is therefore the backbone of sustainable agriculture, ensuring long-term food security and resilience in the face of climate and economic challenges.

Conclusion

Sustainable agriculture stands as the cornerstone of humanity's future an approach that balances productivity, environmental stewardship, and social well-being. As global challenges such as climate change, resource scarcity, and population growth intensify, the need for a resilient food system has never been more pressing. The evidence is clear: practices that conserve soil, water, and biodiversity while integrating modern technology not only enhance yields but also strengthen resilience against climatic shocks. Sustainable agriculture, therefore, is not merely an environmental obligation; it is a sound economic investment that ensures stability for

farmers, food systems, and national economies.

The transformation toward sustainability requires more than individual effort. Governments, research institutions, and private stakeholders must align through coherent policies, innovative financing, and continuous education. Redirecting subsidies, promoting renewable energy, and investing in knowledge transfer are essential steps to empower farmers to adopt eco-friendly technologies. As youth-driven innovation and digital agriculture advances, a new generation of smart, sustainable farmers is emerging capable of feeding the world while restoring its ecosystems.

Ultimately, embracing sustainable agriculture is an act of foresight and

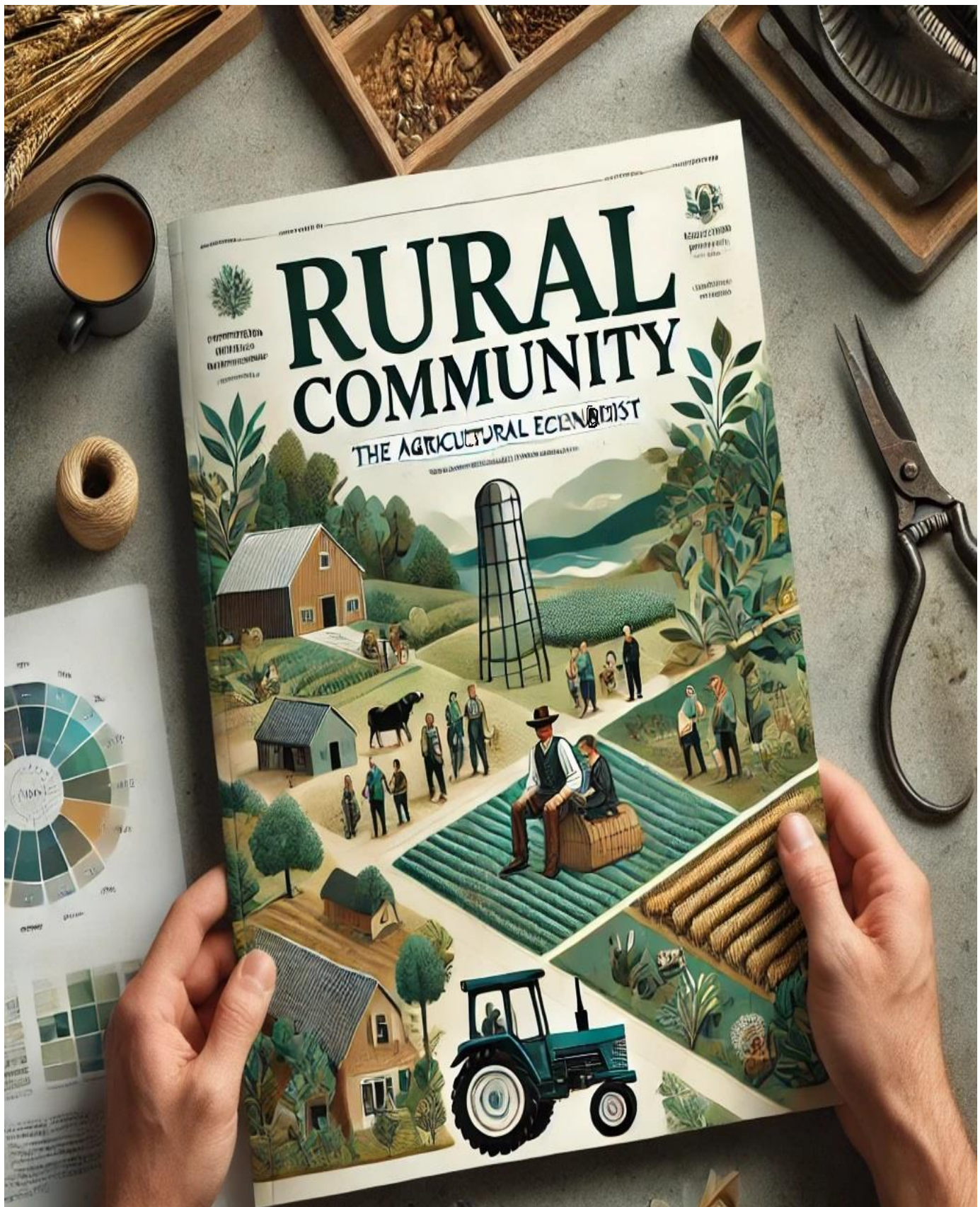
responsibility. It is the path toward long-term prosperity, food security, and climate resilience, ensuring that future generations inherit a planet rich in both resources and hope.

References: Basso et al; Economics of Land Degradation (ELD) Initiative; FAO; IPCC; Pretty et al; Rodell et al; UNCCD; World Bank.

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Agricultural Land Use Intensity in Pakistan

Explore Pakistan's shift in agricultural land use, its environmental costs, and policy pathways for sustainable intensification and rural equity.

Sarmad Veesar

10/2/2025

Pakistan's agriculture sector remains the backbone of its economy, contributing 22.9% to the national GDP and providing livelihoods for nearly 37.4% of the labor force (Pakistan Economic Survey, 2022-23). It not only feeds the population but also supports the country's textile exports and rural development. Over the past two decades, in response to population growth, market demand, and climate pressures, the sector has undergone a marked transformation. Traditional subsistence farming is characterized by low inputs and modest yields has given way to input-intensive production systems. This shift is evident in the rise of national cropping intensity, which increased from around 112% in 2000 to more than 140% by 2023 (Pakistan Bureau of Statistics, 2023).

While this intensification has contributed to higher output, it has also generated profound challenges. Heavy reliance on chemical fertilizers and pesticides has deteriorated soil fertility, while over-extraction of groundwater for irrigation has led to alarming declines in aquifer levels. Simultaneously, the uneven distribution of inputs and technologies has widened socio-economic inequalities. Large-scale farmers are better positioned to benefit from mechanization and credit access, while smallholders often face debt burdens, low bargaining power, and vulnerability to climate shocks. These disparities not only constrain inclusive growth but also exacerbate rural poverty.

The challenge ahead is to balance productivity gains with long-term sustainability. Moving toward sustainable intensification practices that increase yields without exhausting natural resources is essential. This involves integrating climate-smart agriculture, promoting efficient irrigation technologies such as drip systems,

diversifying cropping patterns, and scaling up renewable energy solutions for mechanization. Equally critical is ensuring policy support for smallholder farmers through credit access, training, and equitable resource allocation.

Thus, Pakistan's agriculture now stands at a crossroads: it must transition from short-term yield maximization toward a more resilient and sustainable model that secures food, livelihoods, and environmental stability for future generations.

Changing Patterns of Land Use Intensity: Trends and Consequences

The intensification of agriculture in Pakistan is most visible across the irrigated plains of the Indus Basin, where fertile soils and a vast canal system have long supported national food security. Over the last two decades, the expansion of rice–wheat and cotton–wheat rotations have pushed cropping intensity to nearly 140%, with Punjab and Sindh leading this transformation (GoP, 2023). In Punjab, often called Pakistan's agricultural heartland, more than 70% of farmers now practice double cropping, while a growing number attempt triple cropping in areas where tube wells or canal water ensure year-round irrigation (PARC, 2024).

Yet, this surge in productivity masks profound inequalities. Large landowners, who enjoy greater access to credit, mechanization, and reliable irrigation, have intensified farming far more successfully. By contrast, smallholders who represent more than 64% of farm holdings (Agricultural Census, 2020) struggle to keep pace. According to the World Bank (2023), only about one in four small farmers have regular access to dependable canal water, compared with more than 80% of medium and large farmers. The productivity gap is stark:

wheat and cotton yields on farms smaller than five acres lag behind those of larger farms by 20–30% (FAO, 2023). This dual structure risks widening rural inequality even as overall output expands.

The environmental costs of intensification are equally troubling. Groundwater extraction, especially in central Punjab and lower Sindh, is depleting aquifers at an unsustainable rate of 0.5 to 1.0 meters annually (IUCN, 2023). Soil salinity already compromises over 6.3 million hectares of farmland (PARC, 2024), while inefficient use of fertilizers particularly nitrogen, with an efficiency rate of only 30–35% contributes both to economic waste and environmental contamination through leaching and runoff (IFPRI, 2024).

Policy Pathways for Sustainable Intensification

Pakistan's agricultural future depends on reconciling productivity gains with long-term sustainability and social equity. The structural challenges of water scarcity, land degradation, and rural inequality require not fragmented fixes but a comprehensive, integrated policy framework. Lessons from regional models, such as India's digital land record reforms or Bangladesh's promotion of climate-smart rice practices, provide valuable insights that can be contextualized for Pakistan.

Land and water governance reforms must be placed at the center of this agenda. Legislation that regulates unsustainable groundwater extraction, combined with practical incentives for the adoption of High-Efficiency Irrigation Systems (HEIS), offers one of the most immediate avenues for conservation. At present, fewer than 8% of irrigated farms employ drip or sprinkler irrigation (World Bank, 2023). Scaling these systems could cut

water use by 30–50% for major crops, alleviating mounting pressure on aquifers. Simultaneously, digitizing land records and enforcing tenurial security would encourage tenants and smallholders to make long-term investments in soil fertility, organic matter restoration, and water-saving technologies.

Financial and technical empowerment of smallholders is equally critical. Expanding instruments like the Kisan Card to subsidize climate-resilient inputs drought-tolerant seeds, biofertilizers, and integrated pest management solutions can narrow the resource gap. Complementary training through Farmer Field Schools and digital platforms would build farmer capacity. Bangladesh's successful experience with Alternate Wetting and Drying (AWD) in rice, which cut water use by 30% without yield loss (FAO, 2022), illustrates the potential impact of such targeted interventions.

Finally, post-harvest infrastructure must be strengthened to reduce waste and improve income. Currently, losses for fruits and vegetables reach 35–40% due to weak cold chains and rural logistics (PARC, 2024). Strategic investments in cold storage, processing hubs, and

efficient rural transport can reduce these losses significantly, thereby easing pressure on land expansion and enhancing farmer profitability.

Conclusion

Pakistan's agricultural sector stands at a defining moment in its history. The past two decades of intensification have undeniably boosted cropping intensity and overall output, but these gains have come with mounting economic and environmental costs. Unequal access to resources has widened the divide between large landholders and small farmers, reinforcing structural inequalities that limit inclusive growth. At the same time, excessive reliance on groundwater and inefficient fertilizer use are eroding the very natural capital upon which agriculture depends. Left unaddressed, these challenges threaten both food security and rural livelihoods.

Yet the path forward is clear. Sustainable intensification anchored in water-efficient technologies, diversified cropping systems, and climate-smart practices offers the means to reconcile productivity with conservation. Stronger land and water governance, combined with

targeted financial and technical support for smallholders, can narrow existing inequalities. Strategic investment in post-harvest infrastructure will reduce losses and enhance value addition, directly raising rural incomes.

Ultimately, the future of Pakistan's agriculture depends not only on higher yields but on building resilience and equity into its farming systems. By embracing integrated reforms and aligning productivity goals with environmental stewardship, Pakistan can secure a more inclusive, sustainable, and food-secure agricultural economy for generations to come.

References: FAO; GoP; IFPRI; IUCN; PARC; World Bank.

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Women in Pakistan's Rural Economy: Faith, Rights & Growth

Rural women power Pakistan's agriculture but face exclusion from land, finance, and rights. Discover why faith and policy reforms are key to growth.

Riaz Ahmed

10/3/2025

Pakistan's rural economy, often described as the backbone of its agricultural sector and the foundation of national food security, is weakened by a striking paradox. On one hand, it depends heavily on women's labor for crop production, livestock management, and post-harvest processing. On the other, it systematically undermines these same women, treating them not as economic actors but as invisible, undervalued contributors. Rural women are often relegated to roles defined by social norms that view them either as cheap units of labor or as symbols of family honor, stripping them of recognition as entrepreneurs, innovators, or decision-makers.

This marginalization is not just a cultural or social issue; it is a structural economic crisis. Women provide nearly 70% of labor in livestock care and contribute significantly to cotton picking, seed processing, and small-scale farming. Yet, they rarely control the income they generate or own the land they cultivate. Without access to credit, property rights, or modern technologies, their potential to enhance productivity and drive rural innovation is deliberately stifled. The absence of women's empowerment in agriculture directly suppresses rural economic growth, perpetuating cycles of poverty and dependency.

Ironically, this exclusion is frequently justified through distorted interpretations of religion. Islamic teachings historically granted women rights to property, inheritance, trade, and financial autonomy principles that, if implemented today, could transform rural economies. By misusing faith to entrench patriarchy, rural communities deny themselves the economic dynamism that comes with gender-inclusive participation.

Ultimately, unlocking the suppressed potential of rural women is not only a matter of justice but an urgent economic necessity. A rural economy that has half its workforce cannot sustain long-term growth or resilience in the face of climate, market, and social challenges.

The Statistical Reality: The Cost of Excluding Rural Women

The exclusion of rural women from Pakistan's agricultural economy is not merely a matter of social injustice; it carries profound economic costs that ripple across the entire national landscape. Women constitute nearly 70% of the agricultural labor force, engaging in activities such as sowing, weeding, harvesting, livestock rearing, and post-harvest processing. Yet, they own less than 3% of agricultural land (Pakistan Bureau of Statistics, 2022). This stark disconnect between labor contribution and asset ownership means women lack both incentives and collateral for accessing agricultural credit. Without secure land rights, their ability to invest in productivity-enhancing inputs such as fertilizers, machinery, or irrigation technology is constrained, leaving overall sectoral productivity suppressed.

Beyond land ownership, rural women's contributions are systematically undercounted. Most of their labor is categorized as "unpaid family work," rendering them invisible in formal economic statistics. This invisibility distorts policy priorities and resource allocations. A World Bank (2023) study estimates that bridging the gender gap in agriculture could increase yields on women-managed farms by as much as 30%, a transformation that would not only improve household food security but also inject billions into rural economies. Such

gains highlight how gender equity is not a peripheral issue but a core determinant of national prosperity.

Equally significant is the exclusion from finance and technology. Social restrictions on women's mobility, coupled with gendered biases in financial institutions, leave rural women with little access to extension services or formal credit. According to the State Bank of Pakistan (2021), only 15% of formal bank account holders are women, with rural representation even lower. This lack of financial inclusion cripples' entrepreneurial capacity and limits innovation, trapping communities in cycles of low productivity. The data thus underscores a critical truth: excluding rural women comes at a direct and measurable cost to Pakistan's agricultural growth, food security, and economic resilience.

The Theological Disconnect: Faith Co-opted for Economic Control

The subjugation of rural women in Pakistan's agricultural economy is not simply a matter of cultural inertia but often reinforced through selective and distorted interpretations of religious texts. These interpretations are strategically deployed to justify the confinement of women to unpaid, informal labor while systematically denying them access to education, property ownership, and financial independence. Such practices sustain patriarchal structures that rely on a disempowered, low-cost workforce. Yet this directly contradicts the principles of Islam itself. Fourteen centuries ago, Islamic law explicitly recognized women's right to own, inherit, and manage property independently a revolutionary reform in a context where

women were historically treated as property rather than property holders.

The Qur'anic injunction "For men is a share of what they have earned, and for women is a share of what they have earned" (Qur'an 4:32) unequivocally establishes economic equity as a divine principle. The widespread denial of inheritance rights to rural women in Pakistan is therefore not an expression of faith but a blatant violation of religious decree, repurposed for economic control. By excluding women from rightful entitlements, rural households and entire communities are deprived of critical assets that could uplift productivity, financial stability, and intergenerational welfare.

Islamic history further undermines the legitimacy of these distortions. The Prophet Muhammad's first wife, Khadija, stands as one of the most influential economic actors of her time: a wealthy merchant whose independence, business acumen, and social stature shaped the foundations of early Islam. Beyond Khadija, Muslim history is replete with examples of women who financed public works, supported scholarship, and endowed charitable institutions (waqfs). These legacies affirm that female economic participation is not an external imposition but an intrinsic part of Islamic tradition. Reclaiming this authentic heritage is essential to dismantling exploitative systems and restoring women as rightful economic agents.

The Path Forward: An Economic and Spiritual Imperative

Revitalizing Pakistan's rural economy demands a transformative approach that recognizes women not as peripheral contributors but as central economic agents. This transformation is not only a matter of developmental necessity but also a spiritual and ethical imperative grounded in Islam's original vision of justice and equity. The foundation of such change begins with securing land and property rights. Enforcing women's Qur'anic entitlement to inheritance and

ownership is essential for unlocking their capacity to invest in agriculture, access credit, and participate fully in the rural economy. Without secure assets, women remain trapped in cycles of dependency and exclusion.

Equally critical is the promotion of female-centric agribusiness. Women already play a significant role in dairy, poultry, and horticulture, yet their contributions remain undervalued and undercapitalized. By linking them to microfinance, digital banking, and organized markets, these existing strengths can be transformed into profitable enterprises. In parallel, agricultural extension services must be reformed to include and prioritize female farmers. Training and deploying women extension officers will ensure that rural women have equitable access to modern farming knowledge, including climate-resilient crops and integrated pest management.

Islamic finance offers another powerful tool for change. Sharia-compliant microfinance and credit products tailored for rural women entrepreneurs can overcome cultural barriers while framing economic empowerment as a religiously legitimate pursuit. Such framing aligns with the Qur'anic principle that both men and women are entitled to the fruits of their labor, restoring dignity and purpose to women's economic participation.

Ultimately, integrating women as full economic partners strengthens not only rural households but the national economy. It bridges the gap between developmental logic and spiritual responsibility, affirming that genuine progress arises when justice, faith, and productivity converge.

Conclusion

Pakistan's rural economy cannot achieve resilience or prosperity while continuing to marginalize the very women who sustain it. Women contribute most of the agricultural labor, yet remain systematically denied land rights,

financial access, and recognition as legitimate economic actors. This exclusion is not only a moral injustice but a measurable economic loss, suppressing productivity, weakening food security, and perpetuating intergenerational poverty. Evidence consistently shows that empowering rural women through land ownership, financial inclusion, and access to technology has transformative effects on household income, agricultural yields, and community welfare.

The justification of such exclusion through distorted religious interpretations further compounds the crisis, misrepresenting Islam's foundational principles of equity and dignity. Islamic history offers abundant examples of women as independent economic actors, from Khadija's leadership in trade to the legacy of women who funded education and social welfare. Reclaiming this authentic tradition reaffirms that women's empowerment is not a cultural imposition but a spiritual obligation.

Moving forward, Pakistan must align development strategies with both economic logic and religious ethics by securing inheritance rights, fostering female agribusiness, and integrating women into extension and finance systems. Only then can the rural economy harness its full potential and build a foundation for inclusive, sustainable growth.

References: Pakistan Bureau of Statistics; World Bank; State Bank of Pakistan; FAO; Iqbal et al; Ali & Khan.

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Gender Inequality in Agriculture: Women's Invisible Role in Sindh's Rural Economy

Explore how gender inequality shapes Sindh's agricultural economy. Women's invisible labor sustains farms but remains unpaid, unrecognized, and undervalued.

Asad Ali Khuwaja

10/10/2025

In the fertile plains of Sindh, the district of Tando Allahyar stands as both an emblem of agricultural potential and a stark reflection of gender inequality. The region's farming economy, rooted in a complex web of landownership hierarchies, caste traditions, and patriarchal social norms, assigns rigidly gendered roles that determine who tills the land, who markets the produce, and who remains unseen in the economic narrative. Men typically dominate decision-making, access to land, and participation in formal markets, while women's contributions, though extensive and indispensable, are confined largely to unpaid or underpaid labor. Women engage daily in seed cleaning, livestock feeding, cotton picking, and post-harvest handling, yet their work is seldom recognized in economic statistics or remunerated fairly.

This inequality is not merely cultural; it is structural and institutional. Limited access to education, credit, and extension services perpetuates women's dependence on male intermediaries for market participation. At local produce centers such as the Sultanabad vegetable market, women rarely appear as traders or sellers despite being integral to the production chain. The lack of gender-responsive agricultural services further marginalizes them from training, technology adoption, and input subsidies. Consequently, female farmers remain locked in low-productivity roles, with little control over income or assets.

The repercussions of this imbalance extend beyond economics. Women in Tando Allahyar often experience psychological stress, fatigue, and diminished agency, juggling agricultural labor with unpaid domestic responsibilities. The cumulative effect is

a dual burden that erodes their well-being and limits their potential as agents of growth. Ultimately, this gendered division of labor not only entrenches poverty and inequality but also curtails the district's overall productivity and its contribution to Pakistan's agricultural GDP. Addressing these disparities through inclusive policies and institutional reforms is therefore essential to unlock Sindh's, and Pakistan's, true rural potential.

Women's Invisible Role in Agriculture: The Silent Backbone of Tando Allahyar

In the agricultural heartland of Tando Allahyar, women form the unacknowledged backbone of the district's farming economy. They are central to every stage of agricultural production sowing seeds, weeding, irrigating fields, harvesting crops, and processing produce yet their contributions remain largely invisible in both statistical data and policy discourse. In the district's famous mango orchards, women meticulously perform delicate and skilled operations such as pruning, grafting, and fruit grading, tasks that demand precision and care. However, because this labor is often performed within the family structure or on smallholdings, it remains unpaid and unrecorded. According to the Pakistan Bureau of Statistics (Labour Force Survey 2020–21), nearly 72% of women working in Sindh's agricultural sector are categorized as unpaid family workers, compared to only 29% of men. This classification effectively renders their economic participation invisible, erasing their critical role in sustaining household livelihoods and the rural economy.

When women do receive wages, the disparity is striking. In the vegetable markets around Sultanabad, female workers typically earn 30–40% less than men for equivalent labor. Their reliance on male intermediaries whether contractors or family members limits their ability to negotiate fair compensation or access direct market opportunities. Social norms restricting women's mobility further compound these inequalities, trapping them in low-wage, low-recognition roles.

The situation is further worsened by what researchers describe as the "double burden" of women's work. Beyond their agricultural responsibilities, women shoulder the entirety of unpaid domestic labor cooking, cleaning, fetching water and fuel, and caring for children and the elderly. In areas where public infrastructure is weak and social services are scarce, this labor-intensive routine consumes most of their day, leaving little time for education, rest, or income-generating activities.

The invisibility of women's work in Tando Allahyar is thus not a matter of neglect alone but a reflection of deep-rooted structural inequities. Recognizing and valuing their contributions is not only essential for gender justice but also for improving productivity and ensuring inclusive agricultural growth in Sindh.

Systemic Discrimination and Occupational Segregation in Rural Sindh

In Tando Allahyar, gender inequality in agriculture extends far beyond wage disparities, it is embedded within the structure of the rural economy itself. Women's participation in the labor market is largely confined to low-paid, seasonal, and physically demanding tasks,

such as transplanting rice, weeding, and cotton picking, while men dominate the relatively better-paying and mechanized segments of agricultural work. Occupations such as tractor operation, pesticide application, irrigation management, and market trading are almost exclusively reserved for men, reflecting deep-rooted cultural beliefs about women's physical capabilities and social roles. This occupational segregation not only limits women's income potential but also perpetuates their dependence on male intermediaries.

Structural inequalities further widen this divide. According to the World Bank (2021), women farmers in Sindh are 60% less likely than men to receive agricultural extension services training, technology transfer, and advisory support that are essential for improving productivity. Their access to formal credit, quality seeds, fertilizers, and land titles remains minimal, largely due to bureaucratic and cultural barriers. The exclusion from these institutional services keeps female farmers trapped in a cycle of low productivity and informal labor, undermining their economic empowerment and social mobility.

For Hindu minority women, particularly from marginalized castes such as the Kohlis and Bheels, the layers of exclusion are even more severe. They face triple discrimination based on gender, religion, and caste. As mostly landless laborers, they depend on exploitative tenancy systems or daily wage work under harsh conditions. Their vulnerability intensifies during crises: the 2022 floods exposed how relief and rehabilitation programs often failed to reach minority communities, leaving them isolated and without support (Amnesty International, 2022; UCA News, 2022).

In essence, systemic discrimination and occupational segregation in Tando Allahyar are not isolated issues, they represent a structural barrier that continues to deny women, especially minority women, equitable participation in Sindh's agricultural progress.

Psychological and Social Barriers and Pathways to Equity

The barriers facing women in Tando Allahyar's agricultural economy extend well beyond income inequality, they penetrate the social fabric and psychological well-being of rural communities. Deep-rooted patriarchal norms have conditioned many women to perceive their labor as secondary or "supplementary" to men's work. This internalized belief erodes confidence, limits aspirations, and perpetuates dependence. Generations of exclusion from decision-making spaces whether in households, cooperatives, or markets have resulted in a learned invisibility, where women's voices are seldom heard even in matters that directly concern their livelihoods.

These psychological barriers are reinforced by what economists call the zero-sum fallacy, the notion that empowering women comes at men's expense. This mindset fuels resistance from male community members and policymakers alike, impeding progress toward gender equity. Yet, empirical evidence consistently disproves this myth. Studies by the International Food Policy Research Institute (2019) demonstrate that gender-equitable systems enhance household productivity, income diversification, and overall community resilience. When women have equitable access to resources, the benefits extend to families and entire rural economies.

On the policy front, there are glimmers of hope. The Sindh Women Agriculture Workers Act (2019) legally guarantees equal pay, written contracts, and social security for women agricultural workers. However, its implementation remains limited due to weak enforcement and low awareness. Grassroots initiatives like the Green Value Social Enterprise Platform in Jhando Mari are pioneering change by organizing Farmer Marketing Communities (FMCs), facilitating direct market access, and reducing exploitation by middlemen.

To advance equity, reform must be multi-dimensional recognizing women's unpaid labor in national statistics, ensuring access to land, credit, and technology, and investing in rural infrastructure that reduces domestic burdens. Equally vital is engaging men as allies in dismantling outdated gender norms, transforming empowerment into a shared path toward inclusive and sustainable agricultural development in Sindh.

Conclusion

The gendered agrarian divide in Tando Allahyar is not merely a social or economic disparity, it is a structural constraint that weakens the very foundation of Sindh's agricultural economy. Women are indispensable contributors to farming, livestock, and post-harvest activities, yet their work remains invisible, undervalued, and largely unpaid. This invisibility stems from entrenched patriarchal norms, unequal access to resources, and weak institutional mechanisms that fail to acknowledge women as legitimate farmers or decision-makers. The resulting inequities have far-reaching consequences, including reduced household income, lower productivity, and the perpetuation of rural poverty.

However, this divide is not irreversible. The implementation of progressive legislation such as the Sindh Women Agriculture Workers Act (2019) and the emergence of inclusive community-led initiatives like the Green Value Social Enterprise Platform show that transformation is both possible and necessary. Recognizing and formalizing women's roles, improving access to education, land, credit, and markets, and addressing the social barriers that constrain their participation can create a more just and resilient agricultural system.

True rural development in Sindh will depend on dismantling gender bias and building systems that value women's labor equally. Empowering women is not only a matter of social justice it is an economic imperative for achieving

sustainable agricultural growth and poverty reduction in Pakistan.

References: Amnesty International; ADB; Halepoto; IFPRI; Khuwaja; PBS; Siddique et al; Sindh Government; UCA News; World Bank.

Please note that the views expressed in this article are of the author and do not necessarily reflect the views or policies of any organization.

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Empowering Farmers Through Agricultural Cooperatives in Türkiye

Discover how agricultural cooperatives in Türkiye empower farmers, enhance food security, and promote sustainable rural development, ensuring a brighter future for rural communities.

Mithat Direk

10/17/2025

Food security and safety are not only essential components of social welfare but also the bedrock of a nation's economic and political stability. In Türkiye, where agriculture remains a vital contributor to both employment and GDP, achieving a balance between economic viability and environmental sustainability is an enduring challenge. Modern agricultural practices increasingly rely on a diverse array of inputs (seeds, fertilizers, machinery, irrigation systems, and credit facilities) all of which have become costlier and more complex with the intensification of farming. Individual farmers, especially smallholders who form the majority of Türkiye's agricultural workforce, often face difficulty accessing these inputs on fair terms.

This exposes them to volatile input prices, unpredictable market demand, and supply chain disruptions, undermining both productivity and profitability. Agricultural cooperatives offer an effective and sustainable solution to these systemic constraints. Rooted in the principle of *"unity in strength,"* cooperatives empower farmers by pooling resources, sharing risks, and collectively negotiating with suppliers and buyers. This organizational model enhances access to agricultural finance, modern technology, and marketing channels areas where individual farmers typically lack leverage. Moreover, cooperatives facilitate knowledge sharing, extension services, and quality control, ensuring that members adhere to food safety standards and sustainable production practices.

For Türkiye, strengthening the cooperative movement is not merely an economic reform but a pathway toward inclusive rural development and long-term food security. Well-functioning

cooperatives can reduce production costs, stabilize prices, and enhance resilience against climate and market shocks. By transforming fragmented rural producers into a coordinated and competitive network, cooperatives can serve as a powerful engine for achieving national goals of agricultural modernization, equitable growth, and sustainability—ultimately ensuring that the Turkish agricultural sector remains both globally competitive and socially grounded.

The State of Cooperatives in Türkiye and the Global Context

Cooperatives have deep historical and institutional roots in Türkiye's rural economy, serving as crucial vehicles for collective action, social solidarity, and economic empowerment. According to the latest statistics from the Ministry of Trade's General Directorate of Cooperatives, there are more than 12,500 active agricultural cooperatives in the country, encompassing over 8.5 million members (Ministry of Trade, 2022). These cooperatives span a wide range of activities, including Agricultural Development Cooperatives (*Tarımsal Kalkınma Kooperatifleri*), Irrigation Cooperatives, and product-based associations dedicated to crops like olives, hazelnuts, and cotton. This extensive membership base provides a strong platform for expanding cooperative-driven development, though the sector still faces structural and organizational challenges that limit its full potential.

On the global stage, cooperatives represent a powerful economic force. The World Cooperative Monitor (2023) reported that the top 300 cooperatives and mutuals worldwide achieved a combined turnover of over USD 2.16 trillion in 2021 equivalent to the GDP of one of the world's ten largest economies. In

countries such as France, Denmark, and the Netherlands, agricultural cooperatives command more than 50% of market share in both production and processing (International Cooperative Alliance, 2023). These examples illustrate how cooperatives can transform rural sectors into globally competitive industries through scale, coordination, and innovation.

By contrast, Türkiye's cooperative movement, while large in number, remains fragmented and under-capitalized. Strengthening governance, professional management, and policy support could unlock enormous potential, positioning Turkish cooperatives as central actors in achieving food security, export competitiveness, and sustainable rural development.

Core Values, Principles, and Modern Application

The enduring strength and adaptability of cooperatives across the world stem from their firm grounding in the seven principles of the International Cooperative Alliance (ICA). These principles (Voluntary and Open Membership, Democratic Member Control, Member Economic Participation, Autonomy and Independence, Education, Training and Information, Cooperation among Cooperatives, and Concern for Community) form not just an ethical framework but a comprehensive governance model that balances economic performance with social responsibility.

In Türkiye, however, the challenge lies not in the absence of cooperative structures but in the inconsistent implementation of these foundational principles. Many cooperatives are formally democratic but lack meaningful

participation from members in decision-making processes. The principle of Education, Training, and Information remains particularly underdeveloped; without continuous learning opportunities, members often lack the knowledge to exercise oversight, engage with markets, or adopt modern technologies. Similarly, Cooperation among Cooperatives, one of the most transformative ICA principles, is still limited in practice. Most cooperatives operate in isolation rather than forming federations or consortiums that can pool resources for processing, value addition, and export promotion.

The modern reinterpretation of these principles is essential for relevance in today's digital and globalized agricultural economy. Transparency can be strengthened through digital governance platforms, where members access financial statements, vote electronically, and receive real-time updates on cooperative decisions. Likewise, sustained training programs in sustainable agriculture, digital literacy, and cooperative management can build leadership and accountability at all levels.

By aligning traditional cooperative values with technology-driven inclusiveness and capacity-building, Turkish cooperatives can evolve into resilient, democratic, and competitive institutions. Such modernization will not only revitalize member engagement but also position cooperatives as pivotal actors in achieving national goals of food security, rural equity, and sustainable economic growth.

Persistent Challenges and Strategic Recommendations for Strengthening Cooperatives

While agricultural cooperatives in Türkiye hold immense potential for rural transformation, they continue to face structural and operational challenges that constrain their growth and effectiveness. Three key issues, governance weaknesses, low member participation, and economic fragmentation, stand at the core of these limitations.

First, governance and transparency deficits remain a pressing concern. In some cooperatives, managerial control has become concentrated in the hands of a few, resulting in weak accountability and a drift away from the core principle of democratic participation. Financial opacity and limited member oversight undermine trust and discourage long-term commitment. Without robust auditing systems and transparent communication, cooperatives risk losing their credibility and member confidence.

Second, member apathy and disengagement further weaken cooperative performance. Many members perceive their cooperation as a service provider rather than a collective enterprise they co-own and govern. This mindset diminishes active participation in decision-making and erodes the culture of shared responsibility that is essential for cooperative success.

Third, economic fragmentation and lack of scale hinder competitiveness. Many Turkish cooperatives remain small and localized, unable to achieve the economies of scale necessary for value-added production, marketing, and export. This limits their bargaining power and confines them to low-profit segments of the agricultural value chain.

To overcome these barriers, a strategic approach is vital. Institutional strengthening through digitalization, including online governance platforms and real-time auditing, can enhance transparency and operational efficiency. Continuous education and capacity-building programs should be institutionalized to empower members with managerial, financial, and technical knowledge. Lastly, promoting consolidation and the formation of higher-level cooperative unions will enable resource pooling and large-scale investment. The success of Anadolu Birlik Holding, born from sugar beet growers' unions, demonstrates the transformative potential of strategic cooperation and scale integration (Özcan, 2021). Strengthening these dimensions can reposition Turkish cooperatives as engines of sustainable rural growth, equity, and competitiveness.

Conclusion

Agricultural cooperatives stand as one of Türkiye's most powerful yet underutilized

tools for achieving sustainable food systems, rural prosperity, and national economic resilience. Their collective potential lies not only in pooling financial and physical resources but also in fostering trust, knowledge sharing, and community empowerment. As demonstrated by successful international models, cooperatives thrive when guided by strong governance, transparent management, and an unwavering commitment to member participation. For Türkiye, realizing this potential requires moving beyond traditional frameworks toward a modernized, technology-driven cooperative system that prioritizes digital transparency, continuous education, and inclusive decision-making.

The future of Turkish agriculture depends on transforming fragmented producers into unified networks capable of competing in global markets while adhering to environmental and social sustainability standards. Strategic reforms that promote federation among cooperatives, expand access to finance, and encourage value-added production will be crucial. When cooperatives operate as genuine democratic enterprises—owned and controlled by farmers, they not only stabilize markets but also enhance food security, reduce rural poverty, and contribute to climate resilience.

In essence, strengthening the cooperative movement in Türkiye is not just an agricultural reform, it is a cornerstone for building a sustainable, equitable, and self-reliant food system that ensures prosperity for rural communities and security for future generations.

References: ICA; Ministry of Trade, Republic of Turkey; Özcan; FAO; World Bank.

Please note that the views expressed in this article are of the author and do not necessarily reflect the views or policies of any organization.

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Transforming Livestock with High-Yield Fodder

Discover how an integrated approach to high-yield fodder production, especially through berseem cultivation, can revolutionize Pakistan's livestock sector and enhance rural livelihoods. Explore effective strategies for soil management, irrigation, and nutrient balancing.

Nazar Gul & Hafiz Abdul Salam

10/29/2025

Fodder crops form the backbone of Pakistan's agricultural economy, sustaining a livestock sector that contributes nearly 62.68% to agricultural value-added and 14.36% to the national GDP (GoP, 2024). This sector not only ensures food security through milk and meat production but also provides livelihoods for millions of rural households. Despite its importance, fodder cultivation remains underdeveloped. Grown at approximately 3.60 million hectares with an annual output of 176.88 million tons, the sector faces persistent yield and quality constraints (GoP, 2024). The national average fodder yield is alarmingly low at 49.16 tons per hectare below potential causing a substantial supply-demand gap amid a livestock population that has surged to 231.34 million heads (GoP, 2024; Leghari et al., 2018).

This imbalance is further aggravated by two critical forage scarcity periods, November to January and May to June, when fresh feed becomes scarce and prices of available fodder spike (Rasheed & Ahmad, 2025). Additionally, growing competition for land and water from lucrative cash crops such as sugarcane and wheat further reduces fodder availability. The outcome is a widespread nutritional deficit in livestock diets, leading to lower milk yield, poor meat quality, and reduced reproductive performance, directly impacting rural income and national food security.

Among available options, Berseem (*Trifolium alexandrinum* L.), a nutrient-rich legume containing about 18.3% protein, stands out as a promising solution. Introduced in 1904, it is well-suited to Pakistan's agro-climatic conditions and offers multiple cuttings per season. Yet, despite a potential yield

exceeding 100 tons per hectare, the average farmer harvests only 64.80 tons (Leghari et al., 2018). Bridging this yield gap demands a coordinated approach integrating improved seed varieties, balanced fertilization, optimized irrigation, and farmer training through extension services. Strengthening institutional support, promoting research, and developing region-specific best practices are essential steps toward achieving sustainable fodder productivity and ensuring a resilient livestock economy in Pakistan.

The Integrated Strategy for Maximizing Berseem Yield

Bridging the yield gap in Berseem cultivation requires more than isolated improvements, it demands a comprehensive, integrated approach that harmonizes agronomic, environmental, and management strategies. Research and field experience reveal that a well-coordinated system of tillage, sowing, irrigation, nutrient management, and intercropping can boost yields by 35–50%, turning fodder farming into a high-return, sustainable enterprise. Such an integrated strategy ensures that both productivity and soil health improve simultaneously, securing long-term benefits for Pakistan's livestock-dependent rural economy.

A crucial first step lies in optimized tillage, which creates an ideal seedbed and enhances root development. Studies by Hassan et al. (2022) confirm that conventional tillage consisting of two chisel plow passes to a depth of 30 cm, followed by disc harrowing and leveling provides the best soil structure and moisture retention. This method yields up to 85.1 tons per hectare, surpassing reduced tillage (79.3 t/ha) and no-till systems (67.1 t/ha). The enhanced soil

aeration and weed suppression achieved through this method contributes to robust plant establishment and vigorous growth, providing a strong foundation for high productivity.

Sowing time also plays a decisive role in determining total output and the number of harvests. Regional adaptation is key: in lower Sindh, the optimal sowing window for the 'Egyptian' Berseem variety is between October 15th and 30th, while in Punjab and Khyber Pakhtunkhwa, sowing from late September to mid-October ensures optimal performance (Mahar et al., 2017). Delayed sowing, often due to overlapping with summer crop harvesting, reduces the number of possible cuttings and limits overall yield potential. Early establishment before the onset of winter allows the crops to take full advantage of favorable growing conditions.

Given Pakistan's increasing water stress, data-driven irrigation scheduling is vital for efficient water use and yield optimization. Research at Sindh Agriculture University, Tandojam, indicates that 12 irrigations at 15-day intervals, combined with balanced fertilization, produce the highest yields and economic returns (Leghari et al., 2018). For water-scarce regions, eight irrigations at 18-day intervals are sufficient to maintain acceptable yields. Regular irrigation immediately after each cutting is critical for rapid regrowth and sustaining multiple harvests throughout the season.

Another cornerstone of yield improvement is balanced nutrient management through Integrated Nutrient Management (INM). Combining inorganic fertilizers with organic inputs improves soil structure, nutrient availability, and microbial activity. A

three-year study in Okara revealed that the application of 90 kg/ha P₂O₅, 60 kg/ha K₂O, and 62 kg/ha Nitrogen produced an impressive 111 tons of green fodder per hectare (Rasheed & Ahmad, 2025). Similarly, research from the University of Agriculture, Peshawar, found that incorporating 10 tons per hectare of Farmyard Manure (FYM) before sowing enhances soil fertility and green fodder yield (Khan et al., 2025).

Lastly, strategic mixed cropping offers a means to intensify production while improving fodder quality. Experiments at the Ayub Agricultural Research Institute, Faisalabad, showed that intercropping 75% Berseem with 25% oats resulted in the highest yield of 136.58 tons/ha, followed closely by a 75% Berseem and 25% barley mixture yielding 129.83 tons/ha (Salama, 2020). These combinations not only optimize land use and balance nutrient uptake but also provide higher-quality fodder and stronger initial cuts compared to pure Berseem stands.

In conclusion, maximizing Berseem yield requires a cohesive strategy where soil health, water management, nutrition, and cropping systems work in unison. When applied systematically, these integrated practices can transform Pakistan's fodder sector from a struggling sub-sector into a thriving pillar of livestock productivity and rural economic resilience.

The Role of Institutional Support and Technology Transfer

The transformation of Pakistan's fodder sector particularly in maximizing Berseem yield cannot rely solely on technological innovations; it requires robust institutional support and effective mechanisms for technology transfer. Without an enabling policy and institutional environment, even the most advanced agronomic solutions remain confined to experimental plots rather than reaching farmers' fields. To bridge this gap, coordinated action among government institutions, research organizations, and the private sector is essential.

Policy incentives form the cornerstone of this transformation. Smallholder farmers, who make up the majority of Pakistan's agricultural workforce, often struggle to adopt improved technologies due to high upfront costs. Providing subsidies on certified Berseem seeds, laser land levelers, precision irrigation systems, and balanced fertilizers can significantly lower these financial barriers. Similarly, offering low-interest credit facilities and crop insurance schemes tailored for fodder producers would promote greater confidence in adopting modern, sustainable practices.

Equally important is the revitalization of agricultural extension services. Traditional extension models must evolve into dynamic, technology-enabled systems that provide timely, localized guidance. Through mobile applications, SMS alerts, and social media platforms, farmers can receive real-time advisories on sowing schedules, pest management, and irrigation planning. Collaborations with universities and local research stations can ensure that these advisories are evidence-based and region-specific.

Lastly, farmer training programs are indispensable for translating research into practice. Regular field demonstrations, workshops, and capacity-building initiatives should emphasize the integrated package of Berseem management from soil preparation and nutrient balancing to irrigation scheduling and mixed cropping. Training community-level master farmers can further enhance peer-to-peer learning, ensuring continuity and scalability.

In essence, institutional backing and effective technology dissemination are the catalysts that turn research-driven innovation into widespread agricultural transformation, securing Pakistan's fodder and livestock productivity for the future.

Conclusion

An integrated approach to high-yield fodder production, particularly in Berseem cultivation, holds immense potential to transform Pakistan's livestock

sector and strengthen rural livelihoods. The evidence from research and field practices clearly demonstrates that synchronized improvements in soil management, irrigation scheduling, nutrient balancing, and intercropping can substantially raise productivity while preserving soil health. However, realizing this potential requires more than agronomic efficiency; it demands sustained institutional commitment and effective technology dissemination.

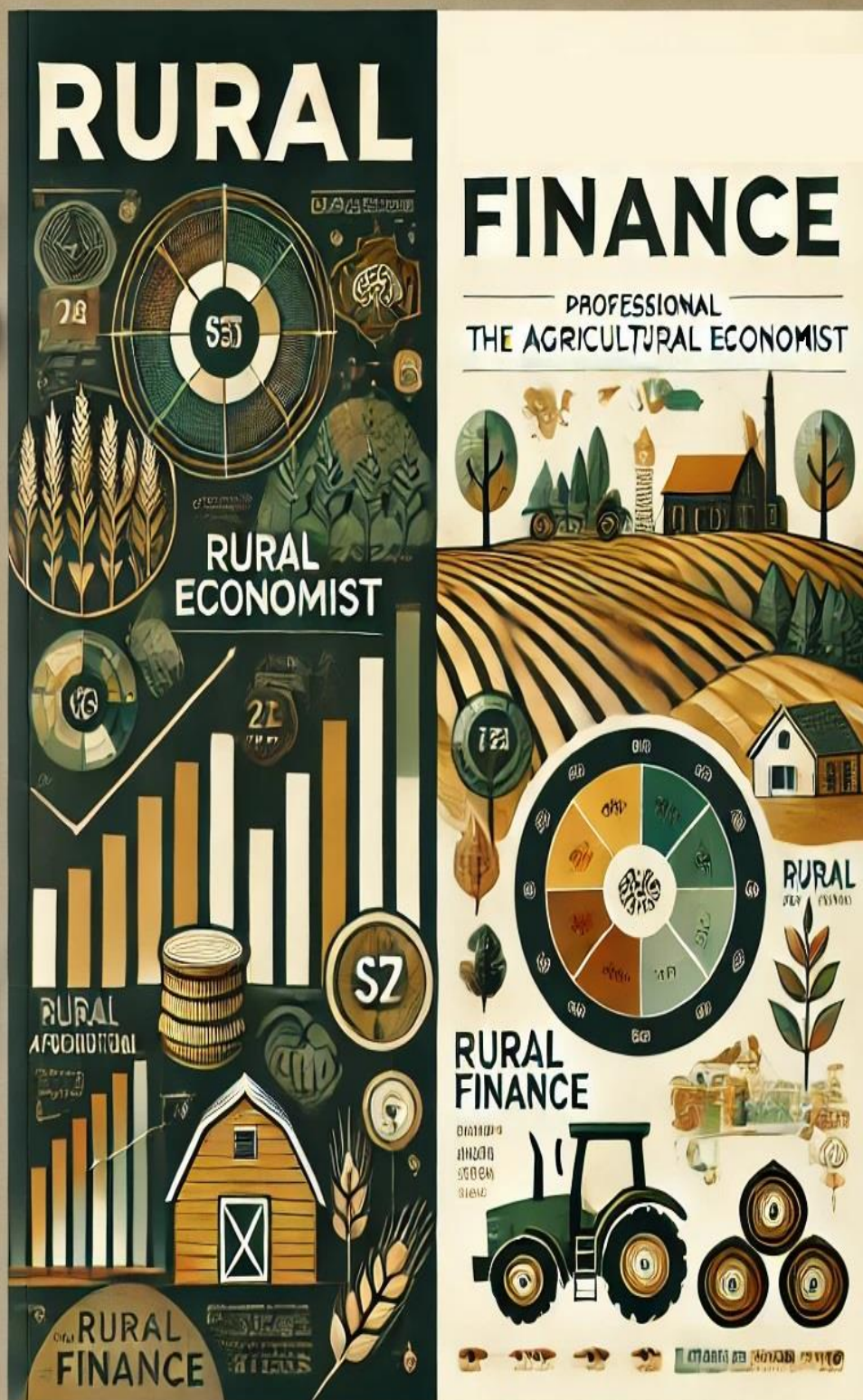
Strong policy support in the form of subsidies for certified seeds, precision irrigation tools, and balanced fertilizers can reduce adoption barriers for small farmers, who are the backbone of Pakistan's fodder economy. Equally critical is the modernization of agricultural extension systems through digital tools, enabling farmers to access localized, real-time information for better decision-making. Capacity-building initiatives and farmer training programs must continue to bridge the gap between research and practice, fostering a culture of evidence-based farming.

Ultimately, integrating technological innovation with institutional support will not only enhance fodder yield and livestock productivity but also contribute to national food security, income stability, and sustainable agricultural growth. Such a comprehensive framework can help Pakistan close its persistent fodder gap and move toward a more resilient, self-sufficient livestock economy.

References: GoP; Hassan et al; Khan et al; Leghari et al; Mahar et al; Rasheed & Ahmad; Salama.

Please note that the views expressed in this article are of the author and do not necessarily reflect the views or policies of any organization.

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Closing the Poverty Gap: How Digital Microfinance Can Empower Rural Pakistan

Digital finance is transforming rural economies. Learn how mobile banking and microcredit can reduce poverty and empower women in Pakistan.

Abdul Baseer

10/1/2025

Sindh, home to nearly 55.7 million people, is often described as the backbone of Pakistan's agricultural economy. Fertile plains, a strong irrigation system, and major crop outputs give the province immense economic importance. Yet, its Human Development Index (HDI) of 0.628 (UNDP, 2022) highlights a paradox: agricultural abundance exists alongside widespread poverty and underdevelopment. This contradiction is rooted in systemic barrier-limited access to education, weak infrastructure, and, most critically, exclusion from digital financial systems (Ahmed et al., 2022).

The digital divide is among the most pressing concerns. In rural Sindh, only 14.33% of households have internet access, compared with 46.11% in urban areas (PBS, 2023). This disparity is not simply about connectivity; it represents a widening gap in opportunity. Without digital access, rural households are systematically excluded from modern banking, mobile payments, agricultural advisories, and online marketplaces. Studies confirm that digital financial inclusion directly improves household productivity and welfare (Asongu & Odhiambo, 2020). Its absence in Sindh restricts farmers' ability to access credit, sell produce at fair prices, or hedge against risks, thereby slowing rural development.

Global examples provide compelling evidence. Kenya's M-Pesa mobile money system revolutionized financial inclusion, lifting around 2% of Kenyan households nearly 194,000 families out of poverty (Suri & Jack, 2016). Similarly, Bangladesh's bKash has expanded access to savings, remittances, and payments for millions of rural households. These successes show that

well-designed mobile financial systems can overcome infrastructure and literacy challenges.

Sindh represents a critical test case. If digital microfinance can overcome barriers such as gender inequality, restrictive cultural norms, and poor infrastructure in this context, it could serve as a scalable model for South Asia and other developing regions. Unlocking this potential requires targeted policies, investment in connectivity, and inclusive financial innovations that reach the province's most marginalized communities.

Digital Microfinance as a Catalyst for Inclusive Rural Growth in Sindh

The barriers to financial inclusion in rural Sindh remain steep, deeply entrenched, and disproportionately gendered. A stark mobile ownership gap illustrates the challenge: only 8.97% of rural women own a mobile phone compared to 57.6% of men, a nearly 49-point disparity (GSMA, 2023). This figure places Sindh among the regions with the widest global gender gaps, eclipsing Sub-Saharan Africa's 13%. The exclusion of women from even the first step toward digital access locks them out of mobile banking, online advisories, and broader participation in the financial system. Internet usage mirrors this inequality. Just 3.11% of rural women use the internet compared with 12.06% of rural men (PBS, 2023), while countries like Rwanda have shown through deliberate policies that over 30% rural female internet penetration is achievable (ITU, 2023).

Nationally, Pakistan exhibits one of the world's largest financial inclusion gender gaps, with only 21% of women formally included compared to 71% of

men (World Bank Global Findex, 2021). In India, by contrast, government-backed reforms such as the Pradhan Mantri Jan Dhan Yojana have narrowed this gap to less than 6%, demonstrating that meaningful policy frameworks can transform outcomes. Closing Sindh's financial gap would not only address poverty but unlock a vast reservoir of dormant economic potential.

Practical evidence highlights the promise of digital microfinance. The Sindh Microfinance Bank has disbursed over PKR 2.5 billion in loans to women entrepreneurs, mostly in rural areas, while JazzCash processed PKR 2.4 trillion in transactions in Q1 2024, with women borrowers forming a rapidly growing share (JazzCash, 2023). International models from Kenya's M-Pesa to Bangladesh's bKash confirm that digital finance reduces poverty, increases household resilience, and empowers women. For Sindh, adopting similar scalable solutions could boost agricultural productivity, cushion climate shocks, and deliver measurable welfare gains.

Policy Pathways for Digital Microfinance in Sindh

Unlocking the potential of digital microfinance in Sindh requires deliberate, multi-pronged policy action. The priority is investment in digital infrastructure. Rural Sindh continues to lag in mobile coverage and affordable broadband, leaving millions excluded from financial services. Drawing lessons from India's "Digital India" program, where targeted public investment substantially narrowed the rural-urban divide (Choudhary et al., 2020), Pakistan must channel resources into network expansion and subsidized access to

ensure that connectivity reaches even remote communities.

Equally vital is the adoption of gender-sensitive policies. The severe mobile ownership gap between men and women in Sindh demands interventions that go beyond connectivity. Simplified Know Your Customer (KYC) procedures for women without formal identification and subsidized smartphone schemes, tied to financial literacy training, can directly empower women. Bangladesh has demonstrated the effectiveness of such approaches, where women-focused initiatives rapidly expanded inclusion (Islam & Muqtadir, 2021).

Strengthening consumer protection frameworks is also essential. Without clear regulations, rural households risk falling prey to exploitative lending practices. The State Bank of Pakistan should therefore establish transparent guidelines on interest rates, fair lending standards, and accessible grievance mechanisms, ensuring that trust underpins adoption.

Moreover, digital microfinance must be integrated with broader rural development services. Platforms that combine finance with agricultural extension, digital marketplaces, and climate insurance can deliver transformative benefits. Weather-indexed insurance, proven effective in East Africa for flood- and drought-prone regions (Hazell & Hess, 2023), could be particularly valuable for Sindh, where climate shocks remain a recurring threat.

Finally, fostering public-private partnerships is critical. Collaboration between telecom operators, fintech innovators, and agricultural cooperatives can generate affordable, context-specific financial products designed for scalability. These partnerships can align incentives across sectors while ensuring that rural communities gain access to inclusive, sustainable financial solutions.

Conclusion

The case of Sindh underscores both the urgency and the opportunity of digital microfinance in transforming rural economies. Despite its agricultural strength, the province continues to grapple with entrenched poverty, low human development, and stark gender disparities in access to technology and finance. The evidence shows that without digital inclusion, rural households remain excluded from essential services credit, savings, insurance, and market information that are critical for income growth, agricultural productivity, and resilience against shocks.

Global experiences from Kenya's M-Pesa and Bangladesh's bKash confirm that mobile-based finance can lift households out of poverty, expand resilience, and empower women by increasing autonomy in financial decision-making. Sindh, with its deep rural-urban and gender divides, represents a vital test case for replicating such transformative models in South

Asia. Addressing infrastructure deficits, closing the mobile and internet gender gap, and embedding financial literacy into microfinance programs are not optional but necessary steps.

Equally important is the alignment of policy and practice. Regulatory protections, targeted subsidies, and public-private partnerships can create an enabling environment where digital microfinance thrives. By integrating financial services with agriculture and climate resilience strategies, Sindh can not only reduce poverty but also unlock the untapped potential of its rural communities especially women driving inclusive and sustainable growth.

References: Ahmed et al; Asongu & Odhiambo; Choudhary et al; Demirgüç-Kunt et al; GoP; GSMA; Hazell & Hess; ITU; Islam & Muqtadir; JazzCash; Kabeer; Khandker & Samad; Kumar et al; Mbiti & Weil; Morawczynski; NDMA; PBS; UNDP; World Bank.

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Climate-Resilient Finance in Post-Flood Sindh: Building Rural Recovery and Adaptation

Explore how climate-resilient finance can rebuild Sindh's flood-hit economy through adaptive microloans, insurance, and inclusive rural financial systems.

Zahoor Ahmed

10/6/2025

The escalating frequency and intensity of climate-induced disasters represent an existential threat to the agrarian economy of Sindh, Pakistan. The catastrophic floods of 2022, which submerged a third of the country, were not an isolated incident but a stark preview of a climate-altered future (World Bank, 2022). These events have profoundly disrupted agrarian livelihoods, pushing already vulnerable communities deeper into poverty and indebtedness. With over 60% of Sindh's population reliant on climate-sensitive agriculture (Pakistan Bureau of Statistics, 2023), the need for climate-resilient finance is critically urgent. Traditional aid and standard microcredit are insufficient to address such systemic shocks; what is required are financial mechanisms specifically tailored for post-disaster recovery and long-term adaptation.

Financial resilience is the cornerstone of community resilience. When farmers lose their assets overnight, their capacity to participate in the next cropping season vanishes, creating a multi-year poverty cycle. Climate-resilient finance can enable smallholder farmers to rebuild sustainably, adopt adaptive technologies, and mitigate future climate risks, thereby securing both their incomes and regional food security. This approach moves beyond mere recovery, aiming to "build back better" by integrating risk mitigation into the fabric of rural economic planning. The case for such finance is not just economic but also a matter of climate justice, protecting those who bear the disproportionate burden of a crisis they did little to create. Ultimately, investing in climate-resilient financial systems is an investment in the stability and sustainable future of Sindh itself.

The Impact of Climate Shocks on Rural Livelihoods

Sindh's agrarian economy, dependent on the Indus River system, is a national breadbasket and a climate vulnerability hotspot. The 2022 floods served as a devastating case study, submerging 4.4 million acres of cropland in Sindh alone, destroying over 80% of its staple crops like cotton and rice (NDMA, 2022; FAO, 2022). The destruction was comprehensive: an estimated 1.2 million homes were damaged or destroyed, displacing 8 million people and creating a humanitarian crisis that reversed decades of development (PDNA, 2022). The economic backbone of rural Sindh, the small-scale farmers who constitute most of the agricultural workforce, faced near-total ruin, losing standing crops, livestock, and seeds.

Post-flood assessments reveal a grim financial picture. A survey by the World Bank (2023) found that 65% of affected households resorted to high-interest informal loans, often at rates of 30–40%, trapping them in inescapable debt cycles. The formal banking sector, with its rigid collateral requirements, was largely inaccessible. Women, central to agricultural labor, faced heightened financial exclusion; less than 15% were able to directly access government compensation schemes, hindered by sociocultural and procedural barriers like a lack of formal land titles (UN Women, 2023).

The long-term impacts are equally severe. Prolonged waterlogging has increased soil salinity, reducing fertility for future seasons. Waterborne diseases spiked, impacting workforce health and productivity. The collective trauma and erosion of savings have diminished the

community's risk-taking appetite, threatening the long-term productivity of the entire region.

Barriers to Climate-Resilient Finance

A complex web of structural, social, and informational barriers prevents the flow of climate-resilient finance to Sindh's communities. The limited financial infrastructure is a primary hurdle. Only 15% of villages in flood-affected regions have a functional bank branch, and the digital divide is stark: while mobile phone ownership among rural men is over 70%, it falls to just 26% for women (GSMA, 2023), a key tool for accessing mobile banking.

Existing financial products are ill-suited for post-disaster contexts. They rarely account for gender-specific constraints; nearly 82% of women require male consent to engage with formal financial institutions, legally limiting their autonomy (State Bank of Pakistan, 2022). A profound knowledge gap exacerbates this; studies indicate only 14% of farmers understand insurance products or resilient credit lines (IFPRI, 2022).

The collateral requirement of formal institutions is a significant structural barrier. Banks demand land titles, which excludes most smallholders and landless peasants, particularly women, as only 12% hold land ownership in their own name (World Bank, 2022). This requirement fails to recognize other forms of capital. Finally, a critical lack of tailored products such as those with grace periods aligned with agricultural cycles or bundled services remains a fundamental obstacle to building resilience.

The Role of Climate-Resilient Financial Products

In a climate-stressed economy like Pakistan's, where extreme weather events repeatedly erode rural assets and income security, financial innovation has become a key pillar of resilience. Traditional lending mechanisms often fail to address the cyclical risks that climate-vulnerable communities face. In contrast, climate-resilient financial products are designed to provide flexibility, risk protection, and incentives for adaptation bridging the gap between short-term recovery and long-term sustainability.

One of the most promising tools is climate-adaptive microloans, which offer small-scale financing for investments such as drought-tolerant seeds, drip irrigation systems, and solar-powered water pumps. The *Sindh Climate Resilience Project* (World Bank, 2023) documented that farmers accessing such credit achieved yield gains of up to 25% post-flood compared to those using traditional practices. Similarly, index-based insurance which triggers automatic payouts when rainfall or temperature thresholds are crossed, has emerged as a game changer. In Jacobabad, pilot schemes have already protected 15,000 farming households, reduced default risks and restoring confidence among both lenders and borrowers.

Equally important are gender-sensitive credit lines. Women, often the most climate-affected yet financially excluded, require tailored instruments such as mobile-wallet savings, group-based loans, and collateral-free microfinance. Scaling the State Bank of Pakistan's *Banking on Equality* initiative could enable thousands of women to lead adaptation-driven enterprises.

Beyond the household level, grant-based finance combined with training and input support creates an enabling environment for climate-resilient agriculture. At the macro scale, instruments like green or resilience bonds can mobilize international capital for ecosystem restoration, mangrove protection, and renewable irrigation infrastructure.

Ultimately, the success of these financial products lies in integration linking credit,

insurance, and capacity building to create a holistic ecosystem of resilience. Climate-smart finance, therefore, is not merely an economic tool but a cornerstone of Pakistan's adaptive transformation.

Case Study: Community-Led Resilience in District Sujawal

The devastating 2022 floods paralyzed District Sujawal, one of Sindh's most challenged regions. In response, a community-led initiative demonstrated the power of locally managed finance. Local Support Organizations (LSOs) partnered with the National Rural Support Program (NRSP) to establish Community Investment Funds (CIFs) placed under the control of women-led village organizations.

The CIFs provided PKR 50 million in interest-free loans targeted at women for restoring climate-resilient businesses, such as poultry farming with resilient breeds, tailoring, and climate-smart kitchen gardening using drip irrigation. Post-intervention surveys after one year revealed a 40% average increase in household income among beneficiaries and a 30% rise in women's autonomy in financial decision-making. The community-managed fund achieved a loan repayment rate of over 95%, allowing it to become self-sustaining (NRSP, 2023). This model proves that trusting communities with resources drives efficient, effective, and socially transformative recovery.

Policy Recommendations for Climate-Resilient Finance in Sindh

Mainstreaming climate-resilient finance in Sindh requires a comprehensive, well-coordinated policy framework that aligns financial inclusion with climate adaptation goals. The State Bank of Pakistan (SBP) can play a pivotal role by integrating climate finance into national monetary and development strategies. A dedicated share of commercial bank portfolios should be reserved for climate-adaptive lending such as financing for drought-resistant crops, solar irrigation, or flood-resilient housing counting these toward priority sector lending targets.

Equally vital is the expansion of digital financial infrastructure. To reach rural and marginalized populations, the government must strengthen branchless banking networks and mobile money agent coverage in remote areas. Subsidizing smartphones for rural women will help close the gender digital divide, ensuring that financial access translates into empowerment.

Legal reforms must also underpin these efforts. Simplifying land ownership procedures to promote women's titling, and recognizing movable assets such as livestock, machinery, and future harvests as acceptable collateral, can unlock credit for those traditionally excluded from formal finance.

Furthermore, financial literacy remains essential for impact. Mobile-based training programs in Sindhi and Urdu, focusing on banking basics, insurance, and digital safety, should be integrated into local community initiatives.

Finally, innovation should be encouraged through public-private partnerships. Bundled financial products, i.e. combining credit, insurance, and technical advice should be developed and subsidized, while Business Development Service (BDS) providers offer post-loan mentorship. These combined efforts can transform climate finance from a niche concept into a cornerstone of Sindh's adaptive economic resilience.

Conclusion

Sindh's post-flood recovery demands more than temporary relief, it requires a structural shift toward climate-resilient finance as the backbone of sustainable livelihoods. The 2022 floods exposed deep vulnerabilities in both the agrarian economy and financial systems, highlighting how traditional credit and aid mechanisms fail to protect farmers from recurring climate shocks. To break this cycle, financial instruments must evolve from short-term compensation to long-term adaptation.

Climate-adaptive microloans, index-based insurance, and gender-sensitive credit lines demonstrate that innovation in

finance can directly translate into resilience on the ground. These solutions, however, must be supported by enabling policies, legal reforms, and digital inclusion to ensure accessibility for the most marginalized particularly women and landless farmers. The integration of community-led funds, as seen in Sujawal, further underscores that local ownership and trust-based financing yield stronger, more equitable outcomes than top-down interventions.

At its core, climate-resilient finance represents an investment in the stability of Pakistan's agricultural future. By aligning financial inclusion with environmental adaptation, Sindh can transform vulnerability into opportunity. Empowering farmers through adaptive finance not only rebuilds livelihoods but also safeguards food security, gender equity, and economic stability in a climate-uncertain world. In doing so, Sindh can become a model for resilience-driven development across Pakistan.

References: FAO; GSMA; IFPRI; NDMA ; NRSP Pakistan Bureau of Statistics; PDNA; SBP; UN Women; World Bank

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Financial Inclusion in Sindh: Empowering Rural Communities

Explore how microfinance, digital banking, and climate-smart tools are transforming rural livelihoods and women's empowerment in Sindh, Pakistan.

Adil Nawaz

10/8/2025

The profound economic potential of Sindh's rural heartland remains stifled by a deep and multifaceted financial divide. Rural communities, the backbone of the province's agrarian economy, face systemic exclusion from formal financial systems due to infrastructural gaps, deeply entrenched gendered norms, and a critical lack of adaptive financial products (World Bank, 2023). With approximately 52% of Sindh's population residing in rural areas and heavily reliant on climate-sensitive livelihoods like agriculture, livestock, and fishing, this exclusion is a fundamental barrier to development and stability (Pakistan Bureau of Statistics, 2023). The volatility of these livelihoods, exacerbated by intensifying climate shocks, makes access to formal financial services including savings, credit, insurance, and secure transfers, a prerequisite for survival and growth.

The concept of "bridging the gap" extends beyond physical access to a bank branch; it encompasses bridging the trust deficit between institutions and rural clients, the knowledge gap in understanding financial products, and the design gap where available tools fail to match the cash-flow patterns of agrarian families (Demirgüç-Kunt et al., 2022). Without these bridges, households remain vulnerable to minor disruptions, a failed monsoon or a family illness, capable of cascading into a full-blown crisis. This perpetuates a cycle where families cannot invest in productive assets, education, or health, thereby limiting the region's human and economic capital. This article posits that a suite of tailored financial tools, deployed through community-centric models and supported by enabling policies, can serve as the most effective bridge to a more secure and prosperous future for rural Sindh.

The State of Financial Exclusion in Rural Sindh

Financial exclusion in rural Sindh is acute and multidimensional. As of 2023, while Pakistan's overall adult bank account ownership has risen to 21%, a profound urban-rural disparity persists, with penetration in rural Sindh lagging significantly behind urban centers (World Bank, 2023). This disparity is rooted in a critical lack of physical infrastructure; a vast majority of villages lack a physical bank branch, forcing residents to undertake arduous and costly travel.

The digital finance revolution has yet to fully penetrate the last mile. Challenges such as poor internet connectivity, low digital literacy, and the affordability of smartphones create a formidable digital divide (State Bank of Pakistan, 2022). This vacuum is readily filled by informal lenders who charge exorbitant interest rates, often 30-50% annually, trapping borrowers in cycles of debt (Karandaz, 2022).

Women bear a disproportionate burden of this exclusion. Restrictive cultural norms and a lack of collateral, an estimated less than 3% of women in Pakistan have land registered in their name, legally and socially prevent their independent access to finance (World Bank, 2023). The consequences are dire: without access to affordable credit or secure savings, families cannot invest in productive assets or build buffers against shocks, forcing a short-term, survival-oriented mindset that stifles development.

Promising Financial Tools and Their Impact

The emergence of innovative financial mechanisms has played a vital role in improving rural livelihoods, promoting resilience, and fostering economic inclusion across Sindh. Microcredit and

group-lending models have long served as the foundation of community-based financial empowerment. Through institutions like the National Rural Support Program (NRSP) and Sindh Rural Support Organization (SRSO), billions of rupees have been extended to low-income households, particularly in sectors such as dairy farming, handicrafts, and small-scale retail. The social collateral system inherent in group lending ensures mutual accountability, drastically reducing default rates. Evaluations indicate that microcredit access increases household income by 20–30%, with direct benefits reflected in better nutrition, healthcare, and educational outcomes (NRSP, 2022).

A newer wave of financial inclusion comes through Digital Financial Services (DFS), which have revolutionized access to formal finance in remote areas. Platforms such as JazzCash and Easypaisa enable rural populations to transfer money, pay bills, and save securely via mobile phones. JazzCash alone reported over 15 million monthly active users in 2024, a notable portion from rural Sindh. Importantly, over two million women gained financial autonomy through digital wallets, marking a significant stride toward gender empowerment (Karandaz, 2022).

Equally transformative is the growth of weather-indexed insurance schemes, designed to shield smallholders from climate shocks. By linking payouts to measurable weather indicators like rainfall, these tools ensure timely compensation. In 2023, the World Food Program (WFP) collaborated with local insurers to protect 20,000 farmers in Sindh, encouraging investment in drought-resistant crops (WFP, 2023).

Finally, community savings groups facilitated by the Sindh Community

Foundation have strengthened financial self-reliance. Participating women reported household savings increasing by 40% within two years, reducing dependence on high-interest informal loans and fostering collective empowerment (Sindh Community Foundation, 2023). These combined instruments represent a pathway toward resilient, inclusive, and adaptive rural economies.

Case Study: The Kashmore Financial Inclusion Initiative (KFII)

The Kashmore Financial Inclusion Initiative (KFII), launched in 2022 through a partnership between the State Bank of Pakistan (SBP), the National Rural Support Program (NRSP), and a local microfinance institution (MFI), stands as a pioneering model for inclusive and sustainable rural finance. Designed specifically to address the deep-rooted barriers of financial exclusion in Sindh's flood-prone districts, the initiative adopted a holistic, community-centered strategy that combined accessibility, education, and empowerment.

One of KFII's most innovative features was the deployment of mobile banking vans to reach remote settlements where no formal financial services previously existed. These mobile units allowed residents particularly women to open accounts, apply for small business loans, and deposit savings without traveling long distances. To foster trust and comfort among women, partner banks introduced women-only banking hours and staffed branches with trained female officers. Parallel to this, the program organized financial literacy sessions that equipped communities with essential knowledge on budgeting, savings, and credit management, ensuring that new users could make informed financial decisions.

The outcomes were transformative. Within just 18 months, over 12,000 new bank accounts were opened, of which 62% were owned by women, a landmark achievement in a district where female financial participation was historically minimal. More than PKR 220 million was disbursed in loans supporting agro-based

enterprises such as poultry farming, seed processing, and small-scale trading. Average household savings rose by 40%, and over 400 women-led community savings groups were established, creating localized networks of mutual financial support.

The KFII's success highlights a vital lesson: bridging the financial gap in rural Pakistan requires more than credit access, it demands integration of education, infrastructure, and social empowerment. This coordinated approach offers a scalable blueprint for inclusive growth across climate-vulnerable regions.

Overcoming Barriers to Adoption

Despite promising advances in financial inclusion, the adoption of innovative financial tools in rural Sindh remains constrained by structural, social, and digital barriers. The foremost challenge is low financial literacy, fewer than 20% of rural adults possess basic knowledge about banking, credit, or insurance products (State Bank of Pakistan, 2022). This lack of awareness leads to mistrust and underutilization of formal financial systems, particularly in remote and flood-affected areas. Compounding this issue is the persistent digital divide: limited internet connectivity, low smartphone ownership, and inadequate mobile agent coverage leave vast regions disconnected from digital finance platforms. Cultural norms further restrict progress, as women often face mobility barriers and limited access to technology, preventing them from fully participating in the financial ecosystem.

To overcome these barriers, a comprehensive and inclusive strategy is essential. Integrated financial literacy programs, delivered through mobile applications, radio, and village-level workshops in local languages, can empower communities to understand and effectively use financial services. Financial products must be designed with gender sensitivity in mind, offering simplified Know Your Customer (KYC) procedures, collateral alternatives like group guarantees, and women-only banking spaces to enhance comfort and

trust. Public-private partnerships can play a critical role in expanding infrastructure by improving digital connectivity, mobile coverage, and branchless banking networks across remote districts.

Supportive regulation remains vital. The State Bank of Pakistan's National Financial Inclusion Strategy (NFIS) and Raast instant payment system provide the backbone for affordable, secure, and real-time financial transactions, reducing costs and barriers to entry. Moving forward, financial inclusion must be treated not as an isolated objective but as a cornerstone of sustainable development. Scaling climate-smart finance, engaging youth through entrepreneurial education, and fostering cross-sector collaboration can transform financial inclusion into a powerful driver of resilience, equity, and growth in rural Sindh.

Conclusion

Sindh's rural economy stands at a critical crossroads where financial inclusion has become more than an economic objective, it is a lifeline for resilience, empowerment, and long-term stability. The evidence from initiatives such as the Kashmore Financial Inclusion Initiative (KFII) demonstrate that inclusive finance, when paired with education, innovation, and gender sensitivity, can transform the lives of marginalized communities. Access to savings, credit, and insurance enables rural households not only to withstand shocks but to invest in livelihoods, education, and enterprise. These outcomes signify that financial inclusion is not merely about banking access, it is about breaking cycles of poverty and dependency.

However, bridging this divide requires sustained institutional commitment and collaboration. Expanding digital financial networks, strengthening regulatory frameworks like the NFIS, and promoting financial literacy must remain national priorities. Tailored approaches that integrate women, youth, and climate resilience into financial design can ensure that inclusion translates into empowerment.

Ultimately, securing livelihoods in Sindh's rural heartland demands a vision that unites technology, policy, and community-driven innovation. If scaled and supported effectively, financial inclusion can become the cornerstone of a more equitable, resilient, and prosperous rural economy where no farmer, artisan,

or woman is left behind in Pakistan's journey toward sustainable development.

References: Demirgüç-Kunt et al; JazzCash; Karandaz; NRSP; PBS; SBP; Sindh Community Foundation; World Bank; WFP.

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Unlocking Digital Financial Services in Pakistan

Explore how collaboration among government, private sector, and civil society can enhance digital financial services in Pakistan. Platforms like Easypaisa and JazzCash are key to promoting digital revolution.

Adil Nawaz

10/17/2025

For years, mobile money platforms like Easypaisa and JazzCash have been synonymous with one primary function in rural Pakistan: remittances. In the fiscal year 2022-23, the total value of mobile banking transactions in Pakistan soared to PKR 9.1 trillion, a substantial portion of which constituted domestic remittances funneled from urban to rural areas (State Bank of Pakistan [SBP], 2023). However, a quiet revolution is underway. These platforms are rapidly evolving from simple cash-transfer mechanisms into sophisticated financial ecosystems that are fundamentally reshaping the operations of rural agri-businesses.

This initial use case was crucial for building a foundation of trust and familiarity with digital transactions among a population where, despite high mobile penetration, only 21% of adults had a formal bank account as of 2021 (World Bank, 2021). Now, that foundation is being built upon in innovative ways. This article moves beyond the remittance narrative to analyse the emerging usage patterns that are integrating digital finance into the very fabric of agricultural commerce.

The shift is being driven by necessity and opportunity. The traditional agricultural economy, reliant on cash and informal credit, is fraught with inefficiencies. A study by Karandaaz Pakistan estimated that 65% of smallholder farmers rely exclusively on cash for all transactions, making them vulnerable to theft and loss (Karandaaz, 2022). Easypaisa and JazzCash, with their extensive networks of over 180,000 branchless banking agents nationwide (Pakistan Telecommunication Authority [PTA], 2024), offer a practical solution. They are not just apps; they are a new piece of infrastructure, as critical for modern agri-business as a paved road or a reliable water source.

This transformation is further accelerated by government initiatives such as the State Bank of Pakistan's (SBP) National Payment Systems Strategy (NPSS), which aims to digitize payments and promote financial inclusion. Programs like Raast, the instant payment system, are integrating with mobile wallets to enable seamless, low-cost transactions. For rural agri-businesses, this means faster settlement cycles and reduced dependency on cash, unlocking new possibilities for growth and efficiency. As more farmers and businesses adopt these tools, the entire agricultural value chain stands to benefit from increased transparency, security, and financial resilience.

Moreover, the post-pandemic landscape has acted as a catalyst, accelerating the acceptance of digital payments even among previously hesitant segments of the population. The need for contactless transactions during the COVID-19 pandemic demonstrated the practical utility of mobile money beyond remittances, leading to a permanent behavioral shift among many rural consumers and businesses. This has created fertile ground for the expansion of more complex financial services, setting the stage for a comprehensive digital transformation of the agrarian economy.

From Cash-to-Cash to Business-to-Business: The Shift in Transaction Types

The most significant shift is the move from Person-to-Person (P2P) transfers to Business-to-Business (B2B) and Business-to-Customer (B2C) transactions. While P2P still dominates volume, the merchant payment segment is the fastest growing. In its annual report, JazzCash highlighted that its merchant payment transactions grew by over 120% in 2023, indicating rapid adoption by businesses for formal and informal commerce (JazzCash, 2023).

Smallholder farmers are increasingly using these platforms to pay for seeds, fertilizers, and pesticides. For example, a leading fertilizer company, Fauji Fertilizer Company (FFC), reported that over 15% of its retail sales from small farmers in Punjab and Sindh are now settled digitally through partner platforms, reducing cash handling costs and ensuring immediate settlement. This digital record also helps farmers build a transaction history. A pilot by the State Bank of Pakistan found that farmers with a consistent digital transaction history were 40% more likely to be approved for a digital micro-loan than those without, as it provides a verifiable credit profile (SBP, 2022).

The ability to pay utility bills digitally saves invaluable time and resources. Pakistan has over 1.2 million agricultural tube wells. A farmer in Bahawalpur typically spent 3-4 hours and PKR 500-1000 in travel costs to pay a single electricity bill in town. Now, over 35% of DISCO (Distribution Company) bill payments in rural areas are made digitally, a figure that has grown exponentially from just 5% in 2019 (SBP Payment Systems Review, 2023). This efficiency directly translates into more time dedicated to productive farm activities.

The adoption of B2B and B2C transactions is also fostering financial discipline among small agri-businesses. Digital records of transactions help businesses track cash flows, manage expenses, and even prepare basic financial statements, which were previously challenging in a cash-dominated environment. This digital footprint is not only useful for day-to-day management but also strengthens their credibility when engaging with suppliers, buyers, and financial institutions. As more businesses recognize these benefits, the shift toward digital transactions is expected

to accelerate, creating a more organized and efficient rural economy.

Moreover, the integration of mobile money with inventory management systems is helping input suppliers optimize their operations. For instance, dealers can now track sales trends in real-time, manage stock levels more effectively, and offer targeted discounts to farmers who pay digitally. This synergy between financial and operational tools is enhancing the overall productivity of the agricultural sector, making it more responsive to market demands and reducing wastage. It creates a virtuous cycle where digital payments provide data that improves supply chain efficiency, which in turn incentivizes further digital adoption.

The Emergence of Integrated Digital Value Chains

The individual usage patterns are coalescing into nascent digital agricultural value chains. A successful example is the partnership between JazzCash, Nestlé Pakistan, and their milk collection centers. Over 25,000 dairy farmers supplying milk to Nestlé now receive instant digital payments directly into their JazzCash wallets. This initiative has increased farmer income by 10-15% by reducing delays and middleman commissions. The farmers then use these digital funds to pay for feed, veterinary services, and utilities, creating a closed-loop digital ecosystem.

This creates a digital footprint for the farmer's business activities. The Raast instant payment system, Pakistan's first-of-its-kind digital payment infrastructure, is further enabling this by facilitating low-cost, bulk B2B transactions. This digitization is formalizing the rural economy; the Federal Board of Revenue (FBR) has noted a 12% increase in the tax base from small rural businesses in regions with high mobile money adoption, as digital transactions create an auditable trail (FBR, 2023).

The digital value chain also empowers farmers by providing them with better access to market information. Mobile platforms can deliver real-time price updates, weather forecasts, and expert advice, enabling farmers to make informed

decisions about when to sell their produce or how to manage their crops. This access to information reduces their dependency on intermediaries and enhances their bargaining power. For instance, farmers in the Punjab region using JazzCash's market linkage features reported a 20% improvement in their ability to negotiate prices with wholesalers, leading to higher profitability.

Furthermore, digital value chains are fostering innovation in agricultural financing. With a clear record of transactions and sales, financial institutions can develop tailored products such as crop loans, insurance, and investment plans. For example, JS Bank partnered with Easypaisa to launch "Harvest Plus," a digital loan product for farmers based on their transaction history. This product disburses loans within minutes, allowing farmers to access funds precisely when needed for inputs or expansion. Such innovations are bridging the gap between traditional banking services and the unbanked agricultural community, driving sustainable growth by leveraging the data generated within the digital ecosystem itself.

Overcoming Barriers: Literacy, Connectivity, and Trust

Despite the promising trends, significant barriers remain. Adoption is not uniform. A 2023 GSMA Consumer Survey found that while 82% of Pakistani adults are aware of mobile money, only 34% actively use it. The primary barrier for non-users (45%) was a lack of knowledge and skills. The fear of making an error is a major deterrent, especially among women and older farmers (GSMA, 2023).

While mobile broadband penetration stands at 55%, the quality of service in remote rural areas remains a challenge. The Pakistan Telecommunication Authority's (PTA) performance data shows that 4G availability in rural districts can be as low as 60% compared to over 90% in urban centers, leading to transaction failures and frustration (PTA, 2024).

A deep-seated preference for tangible cash persists. A Karandaaz Pakistan study revealed that 38% of non-users distrusted

the security of mobile money platforms. Concerns about fraud, agent misconduct, and the inability to resolve disputes easily are significant hurdles that require robust customer protection frameworks (Karandaaz, 2022).

To address the digital literacy gap, organizations like the National Rural Support Program (NRSP) are collaborating with mobile network operators to conduct training workshops in villages. These workshops focus on basic mobile wallet operations, security practices, and the benefits of digital transactions. In a pilot project across 50 villages, NRSP reported a 30% increase in digital adoption among trained farmers within six months. Additionally, the use of voice-based tutorials in local languages and interactive USSD menus has made these platforms more accessible to illiterate or semi-literate users, further driving inclusion.

Building trust requires not only education but also demonstrable security and reliability. Mobile money providers are investing in advanced security features such as biometric verification, two-factor authentication, and automated fraud detection systems. Moreover, the establishment of dedicated customer support centers in rural areas, along with a streamlined process for resolving disputes, is helping to alleviate concerns. For example, Easypaisa's "Agent Ghar" initiative ensures that agents are trained to assist users with transactions and troubleshoot issues, thereby fostering a sense of security and reliability among rural customers. These efforts must be continuous and scaled up to build the long-term confidence necessary for widespread adoption.

The Road Ahead: Opportunities for Deeper Integration and Sustainability

The current usage patterns point to several exciting opportunities for deeper integration, backed by pilot data. Punjab's LIS (Land Record Information System) has digitized over 90% of its land records. Linking this database with mobile wallets, as piloted in three districts, could facilitate secure, digital leasing payments, bringing a massive informal sector into the digital

fold and providing landlords and tenants with a secure, transparent financial mechanism.

Using the digital transaction history from the Nestlé partnership, JazzCash and a microfinance institution launched a pilot credit product for dairy farmers. Based on their digital receipt history, over 5,000 farmers were pre-approved for loans ranging from PKR 15,000 to PKR 75,000 without requiring physical collateral, with a disbursement rate of over 98%. This model can be scaled to other commodities, using satellite data and AI for automated index-based insurance payouts in case of drought or flood.

The Pakistan Mercantile Exchange (PMEX), in collaboration with a telecom provider, is developing a platform for smallholder farmers to sell future contracts of commodities like wheat and cotton. The settlement will be directly into their mobile wallets, ensuring price transparency and immediate payment, potentially increasing farmer profits by 20-30% by cutting out middlemen.

The integration of Internet of Things (IoT) technology with mobile money platforms presents another transformative opportunity. For instance, smart sensors can be used to monitor soil health, crop growth, and irrigation levels, and the data can be linked to digital platforms to automate payments for inputs or trigger insurance payouts in case of adverse weather conditions. Such innovations can make farming more precise and efficient, reducing resource wastage and maximizing

yields. Pilot projects in the Thal Desert region are testing IoT-enabled drip irrigation systems that integrate with JazzCash for automated payments, resulting in 30% water savings and 15% higher crop yields.

Furthermore, mobile money platforms can play a pivotal role in promoting sustainable agricultural practices. By offering digital incentives such as cashback or lower interest rates on loans for farmers who adopt eco-friendly techniques like organic farming or water conservation, these platforms can drive positive environmental outcomes. For example, a proposed collaboration between Easypaisa and the Ministry of Climate Change aims to reward farmers who use certified organic seeds and fertilizers with digital credits, which can be redeemed for future purchases. This not only encourages sustainability but also strengthens the digital ecosystem by increasing transaction volumes and user engagement, aligning economic incentives with environmental stewardship.

Conclusion

The narrative of Easypaisa and JazzCash in rural Pakistan is being rewritten. While remittances remain crucial, their role is expanding dramatically. These platforms are becoming the operational backbone for rural agri-businesses, enabling everything from input procurement to sales and wages. The emergence of data-driven digital value chains promises a future where the entire agricultural economy is more transparent, efficient, and resilient. The challenge now lies in a concerted effort to improve digital

literacy through targeted programs and to enhance rural connectivity infrastructure. The journey beyond remittances is well underway, cultivating a more prosperous future for Pakistan's farmers by transforming them into active, empowered participants in a modern digital marketplace.

The continued collaboration between the government, private sector, and civil society will be essential to overcome existing barriers and unlock the full potential of digital financial services. As technology evolves and adoption grows, platforms like Easypaisa and JazzCash will not only facilitate transactions but also serve as gateways to a wide range of services, including healthcare, education, and e-governance. This holistic approach to digital inclusion can uplift rural communities, reduce poverty, and drive sustainable economic development across Pakistan, ensuring that the digital revolution leaves no one behind.

References: FBR; GSMA; JazzCash; Karandaaz Pakistan; PTA; SBP; World Bank.

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Smallholder Farmers in Pakistan's Agricultural Crisis

Pakistan's smallholder farmers face a severe agricultural crisis due to soaring input costs. This situation threatens farm productivity, income stability, and rural development, pushing families deeper into debt and challenging the nation's food sovereignty.

Kashaf Kaim Khani

10/28/2025

Agriculture remains the bedrock of Pakistan's economy, contributing nearly 22.7% to the GDP and employing 37.4% of the national workforce (Pakistan Economic Survey, 2023–24). It not only provides sustenance and livelihoods to millions of rural households but also supports the country's industrial and export base through cotton, rice, and other primary commodities. Yet, despite its central role, Pakistan's agricultural sector faces an escalating crisis driven by the unprecedented surge in the cost of essential inputs. The sharp rise in prices of fertilizers, certified seeds, pesticides, diesel, and electricity has created a perfect storm that threatens the sustainability of smallholders farming the backbone of rural productivity.

For instance, fertilizer prices have doubled over the past three years, while the cost of diesel and electricity, both essential for irrigation and mechanization, has made even basic farming operations prohibitively expensive. Farmers who once managed modest profitability are now trapped in a cycle of debt, forced either to reduce cultivated areas or to compromise on input quality, resulting in lower yields and declining incomes. This vicious cycle is weakening Pakistan's capacity to ensure food self-sufficiency, particularly for staples like wheat, maize, and rice.

Moreover, the crisis has social and economic ripple effects. Rising input costs not only squeeze farmers' profit margins but also drive-up food inflation, pushing nutritious food further out of reach for low-income households. The disparity between input costs and output prices has also widened, discouraging rural youth from pursuing farming as a viable livelihood. Without timely interventions such as targeted subsidies,

improved market regulation, and access to affordable credit, the country risks a deepening agricultural downturn. Addressing this issue is not just an economic imperative but a national security concern, as Pakistan's food sovereignty and rural stability depend on protecting and empowering its small farmers.

The Input Cost Squeeze: A Statistical Reality

The profitability of small-scale farming in Pakistan hinges on a few critical inputs such as fertilizers, seeds, fuel, pesticides, and electricity. However, in recent years, their escalating costs have pushed farmers into a deep economic crisis. According to the World Bank (2024), Pakistan experienced a staggering 40% inflation in agricultural input costs over the past two years far exceeding the rise in output prices for key crops such as wheat, rice, and cotton. This imbalance has led to a severe contraction in profit margins, leaving millions of smallholders struggling to sustain production.

The crisis is especially acute for small-scale farmers, who constitute nearly 80% of Pakistan's farming community. A survey by Rauf et al. (2024) revealed that almost 90% of smallholder households reported significant financial distress due to rising input prices. Many have been forced to scale back fertilizer applications or delay irrigation cycle choices that directly reduce yields and undermine long-term soil fertility. The cumulative effect has been a drop in both productivity and income, deepening rural poverty and food insecurity.

Several structural and macroeconomic factors are driving this situation. On one hand, global supply chain disruptions following the COVID-19 pandemic and

the Ukraine crisis have inflated fertilizer and fuel prices. On the other hand, domestic currency depreciation and persistently high energy tariffs have multiplied production costs. Locally, governance failures and market concentration add further pressure. Research by Zulfiqar et al. (2024) identified fertilizer cartels and monopolistic control of input supply chains as major structural impediments, allowing price manipulation and hoarding.

As a result, small farmers face an impossible choice to reduce input use and risk lower yields, absorb unsustainable costs, or rely on high-interest informal loans. This "input cost squeeze" is not just a short-term financial strain but a systemic threat to Pakistan's agricultural sustainability, food security, and rural livelihoods.

Why Small Farmers Are Especially Vulnerable

Small and marginal farmers, typically cultivating less than 12.5 acres, form the backbone of Pakistan's agriculture, yet they are also the most exposed to rising input costs and economic instability. Their vulnerability stems from a combination of financial, structural, and environmental factors that compound one another. With limited financial buffers, these farmers operate on razor-thin profit margins, meaning that even a modest increase in fertilizer, diesel, or electricity costs can obliterate their income. The State Bank of Pakistan (2023) reported that the cost of wheat production surged by over 25% within a single year, primarily due to input price inflation. Such increases leave smallholders unable to recover their investment, forcing many to scale back production or abandon farming altogether.

Access to finance remains a major hurdle. Most small farmers are excluded from formal banking systems due to a lack of collateral or credit history. As a result, they turn to informal moneylenders and input dealers (arthiyas) for seasonal loans at interest rates often exceeding 30% per cropping cycle (Chaiya et al., 2023). This reliance on high-cost credit perpetuates a cycle of indebtedness, trapping farmers in chronic financial distress.

Moreover, the fragmented nature of Pakistan's agricultural markets weakens farmers' bargaining power. Small producers depend heavily on intermediaries to sell their crops, capturing only a fraction of the final retail value. This market asymmetry prevents them from adjusting prices to offset soaring input costs. Adding to these economic constraints, climate-induced disasters such as the catastrophic 2022 floods and erratic rainfall have increased the need for supplemental irrigation, fertilizers, and pest management, further inflating costs (Rauf et al., 2024; FAO, 2023).

Consequences for Livelihoods and National Food Security

The escalating cost of agricultural inputs in Pakistan has triggered a chain reaction with deep implications for both rural livelihoods and national food security. As input prices soar, many smallholder farmers, already operating on razor-thin margins, are compelled to reduce their use of essential fertilizers, certified seeds, and pesticides. The Food and Agriculture Organization (FAO, 2023) has reported a notable decline in fertilizer application rates across Pakistan, warning that this trend could undermine soil fertility and reduce long-term productivity. Lower input use directly translates into reduced yields, declining crop quality, and stagnating farm incomes, trapping farmers into a cycle of underproduction and poverty.

At the national level, these micro-level struggles culminate in macroeconomic consequences. The cumulative decline in productivity across millions of small farms threatens domestic food supply stability. As yields of staple crops such as wheat, rice, and maize decline, Pakistan is forced to rely increasingly on costly food imports, straining foreign exchange reserves and exposing the economy to global price volatility. The resulting food shortages contribute to inflationary pressures, disproportionately affecting low-income households and exacerbating rural poverty. In effect, the cost crisis input is not just a farmer's problem, it is a national food security emergency in the making.

Addressing this challenge demands coordinated, evidence-based policy action. Expanding access to low-interest credit, regulating input markets to dismantle monopolies, and localizing fertilizer and seed production are critical steps toward stabilizing costs. Equally important is promoting climate-smart agriculture (CSA) practices that enhance efficiency, conserve resources, and build resilience to climate shocks. Furthermore, revitalizing agricultural extension services and strengthening market linkages through infrastructure and digital innovation can empower farmers to secure fairer prices. By pursuing these reforms, Pakistan can safeguard smallholder livelihoods, stabilize its food system, and move toward sustainable agricultural resilience.

Conclusion

Pakistan's smallholder farmers stand at the epicenter of a deepening agricultural crisis driven by the relentless surge in input costs. What was once a modestly profitable livelihood has now become a daily struggle for survival. The soaring prices of fertilizers, seeds, pesticides, fuel, and electricity have created a crippling cost structure that undermines

farm productivity, erodes income stability, and pushes rural families into debt. This "input cost squeeze" is not merely an economic issue it is a structural threat to Pakistan's food sovereignty, rural development, and national stability.

The vulnerability of small farmers who constitute nearly 80% of Pakistan's agricultural base reflects broader policy and institutional shortcomings. Inadequate regulation of input markets, limited access to affordable credit, and weak extension services have left farmers at the mercy of inflationary pressures and exploitative intermediaries. If left unaddressed, the result will be declining domestic production, rising import dependence, and worsening rural poverty.

However, the path to recovery remains within reach. Pakistan must urgently implement targeted reforms: regulate input monopolies, expand low-interest agricultural financing, promote local input production, and foster adoption of climate-smart and resource-efficient practices. Strengthening market linkages and extension support can empower smallholders to compete and thrive. Protecting these farmers is not just an act of economic prudence it is essential for ensuring food security, social stability, and a sustainable future for Pakistan's agriculture.

References: Chaiya et al; FAO; Government of Pakistan; Rauf et al; SBP; World Bank; Zulfiqar et al.

Please note that the views expressed in this article are of the author and do not necessarily reflect the views or policies of any organization.

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Banking Sector's Role in Agricultural Growth in Pakistan

The banking sector is crucial for agricultural growth and rural development in Pakistan. By offering accessible credit, savings, and tailored financial products, banks empower farmers to modernize practices, adopt innovative technologies, and integrate into value chains.

Kashaf Kaim Khani

10/31/2025

Agriculture remains the bedrock of Pakistan's economy, employing approximately 37.4% of the national labor force and contributing 22.9% to the country's GDP (GoP, 2024). The sector not only provides livelihoods for millions of rural households but also underpins food security, supports industrial supply chains, and fuels exports. Despite its pivotal role, Pakistan's agriculture is constrained by chronic underinvestment, inadequate infrastructure, and limited access to formal financial services. These challenges translate into low productivity, outdated farming practices, and persistent rural poverty, particularly among smallholder farmers who constitute most agricultural producers.

Banking institutions have a critical role to play in transforming this scenario. By offering accessible credit, structured savings schemes, insurance products, and tailored investment instruments, banks can help farmers modernize operations, adopt climate-smart technologies, and expand value-added production. For instance, credit for high-yield seeds, drip irrigation systems, or mechanized equipment can significantly improve output, reduce post-harvest losses, and enhance market competitiveness. Similarly, rural deposit schemes and microfinance solutions can provide households with the financial stability needed to invest in education, health, and farm improvements, fostering overall socio-economic resilience.

Strengthening the agricultural finance ecosystem is therefore not merely a sector-specific necessity but a cornerstone for inclusive national development. Accessible and timely financial services empower farmers to transition from subsistence to commercial agriculture, stimulate rural economies, and generate

employment opportunities beyond the farm gate. This article emphasizes that the banking sector is an indispensable instrument for driving sustainable agricultural modernization, enhancing rural livelihoods, and promoting equitable economic growth. By dismantling financial barriers, fostering innovation, and supporting smallholder farmers, banks can catalyze a transformation that extends benefits across Pakistan's broader economy and society.

Banking as a Driver of Agricultural Growth and Modernization

Agricultural credit is the lifeblood that enables farmers to transition from subsistence-level operations to commercial, market-oriented production. Access to formal financing empowers farmers to adopt yield-enhancing technologies such as high-quality seeds, precision fertilizers, modern irrigation systems, and mechanized equipment, all of which are essential for improving productivity and competitiveness. In Pakistan, institutions like the Zarai Taraqati Bank Limited (ZTBL) and major commercial banks have played a pivotal role in this transformation, providing targeted loans that address the specific needs of rural farmers. The agricultural credit portfolio has experienced significant growth; in the fiscal year 2022-23, the banking sector disbursed PKR 1.422 trillion in agricultural loans, surpassing the government's target by 104.3% (State Bank of Pakistan, 2023). This increase underscores both the demand for and the potential impact of financial support in the agriculture sector.

The State Bank of Pakistan (SBP) has been a key catalyst in this progress through its regulatory framework, including mandatory lending targets for

agriculture and small and medium-sized enterprises (SMEs). Beyond traditional lending, there has been a strategic shift towards Value Chain Financing, which represents a more integrated approach to agricultural development. Instead of providing credit to farmers in isolation, banks now finance entire production chains, linking input suppliers, producers, processors, and distributors. This approach not only improves operational efficiency but also reduces post-harvest losses and stabilizes farmers' incomes by ensuring secure access to both essential inputs and output markets (World Bank, 2023).

By embedding farmers within these structured financial networks, banks contribute to sustainable modernization, enabling adoption of innovative technologies, enhancing market access, and ultimately fostering resilient rural economies. The evolution of banking from simple credit provision to comprehensive value chain support demonstrates its indispensable role in driving agricultural growth, transforming livelihoods, and strengthening Pakistan's broader economy.

Persistent Challenges in Agricultural Financing

Despite significant quantitative progress in agricultural financing, qualitative gaps and structural challenges continue to limit access for the most vulnerable farmers, particularly smallholders who form the backbone of Pakistan's rural economy. A major barrier is the lack of formal land titles, acceptable collateral, and proper documentation, which automatically disqualifies many farmers from accessing formal banking services (IFC, 2022). Without these prerequisites, even creditworthy and motivated farmers remain excluded from financial systems,

forcing them to rely on informal lenders who often charge exorbitant interest rates and impose unfavorable repayment conditions.

Another critical issue is the persistent mismatch between financial products and the unique risk profile of agriculture. Farming is inherently exposed to unpredictable factors such as weather volatility, pest infestations, and sudden market price fluctuations. Conventional loans, high-interest rates, and lengthy approval processes fail to accommodate these risks, deterring farmers from seeking formal credit and limiting the effectiveness of available financial instruments. As a result, even when credit is theoretically available, it often does not translate into meaningful investment in modern technologies, inputs, or infrastructure.

Infrastructural and literacy challenges further exacerbate these constraints. Many rural areas remain underserved by physical bank branches, leaving farmers with limited or inconvenient access to formal financial institutions. Low levels of financial literacy, coupled with inadequate digital skills, reduce farmers' confidence and ability to navigate banking procedures, loan applications, and online financial platforms (Ahmad & Bashir, 2019). Collectively, these factors reinforce the perception of agriculture as a high-risk sector for banks, prompting conservative lending policies and frequent credit rationing. This structural exclusion not only hampers investment and productivity in agriculture but also perpetuates cycles of rural poverty, vulnerability, and dependence on informal financial sources. Addressing these persistent challenges is therefore essential for creating an inclusive agricultural finance ecosystem capable of supporting sustainable rural development, modernizing farm practices, and strengthening overall economic resilience.

Driving Financial Inclusion and Rural Development

Digital innovation is rapidly transforming rural finance in Pakistan, providing a

powerful tool to overcome long-standing barriers to financial inclusion. Mobile banking, digital wallets, and branchless banking platforms are bringing financial services directly to populations that were previously excluded from formal credit and savings systems. By drastically lowering transaction costs and simplifying access to financial resources, these technologies are emerging as a primary driver of rural development (KPMG, 2025). They allow farmers and rural households to receive payments, manage savings, and access loans securely, effectively integrating them into the formal economy and enhancing economic resilience.

The State Bank of Pakistan's Raast instant payment system, combined with the rapid growth of Branchless Banking (BB) accounts, has been a game-changer. As of December 2023, the number of branchless banking accounts in Pakistan had reached 114 million, with quarterly transaction values amounting to PKR 4.7 trillion (State Bank of Pakistan, 2024). These platforms have enabled secure receipt of remittances, digital loan disbursements, and convenient savings, empowering rural households to better manage cash flows and invest in agricultural productivity.

To consolidate these gains and bridge remaining gaps, a multi-pronged policy approach is essential. Financial products must become more flexible and inclusive, moving beyond collateral-based lending toward models based on farm history, cash flow analysis, and group guarantees (AFI, 2023). Risk mitigation mechanisms, such as credit guarantee schemes and loan-linked agricultural insurance, need expansion to de-risk lending for financial institutions. Simultaneously, enhancing digital and financial literacy among rural populations is critical, ensuring that farmers understand and can utilize modern financial tools effectively. Promoting gender-inclusive finance is equally important, with targeted programs providing women access to accounts, loans, and support for agro-based SMEs (Shahzadi, 2024). Finally, fostering

strategic partnerships between banks, Agri-tech firms, and farmer cooperatives can create efficient, localized systems to deliver credit to the last mile, ensuring that financial resources reach the most underserved and vulnerable communities. Together, these measures can transform digital financial inclusion into a powerful engine for equitable, sustainable rural development.

Conclusion

The banking sector plays an indispensable role in promoting agricultural growth and rural development in Pakistan. By providing accessible credit, structured savings, insurance products, and tailored financial instruments, banks enable farmers to modernize practices, adopt innovative technologies, and integrate into value chains that enhance productivity and market access. Institutions such as Zarai Taraqiati Bank Limited (ZTBL) and major commercial banks, supported by regulatory frameworks from the State Bank of Pakistan, have significantly expanded agricultural financing, demonstrating the potential of structured, timely, and inclusive credit to transform rural livelihoods.

Despite these advances, persistent challenges remain. Limited access to collateral, ill-suited financial products, infrastructural gaps, and low levels of financial and digital literacy continue to restrict smallholder farmers from fully benefiting from formal finance. Moreover, women and marginalized groups face disproportionate barriers that hinder equitable participation. Addressing these constraints through flexible lending models, risk mitigation mechanisms, digital literacy programs, and gender-inclusive initiatives is essential for building a resilient and inclusive agricultural finance ecosystem.

Digital innovations such as mobile banking, branchless banking, and the Raast instant payment system are bridging these gaps, integrating rural households into the formal economy, and reducing reliance on informal lenders. Strengthening these efforts, combined

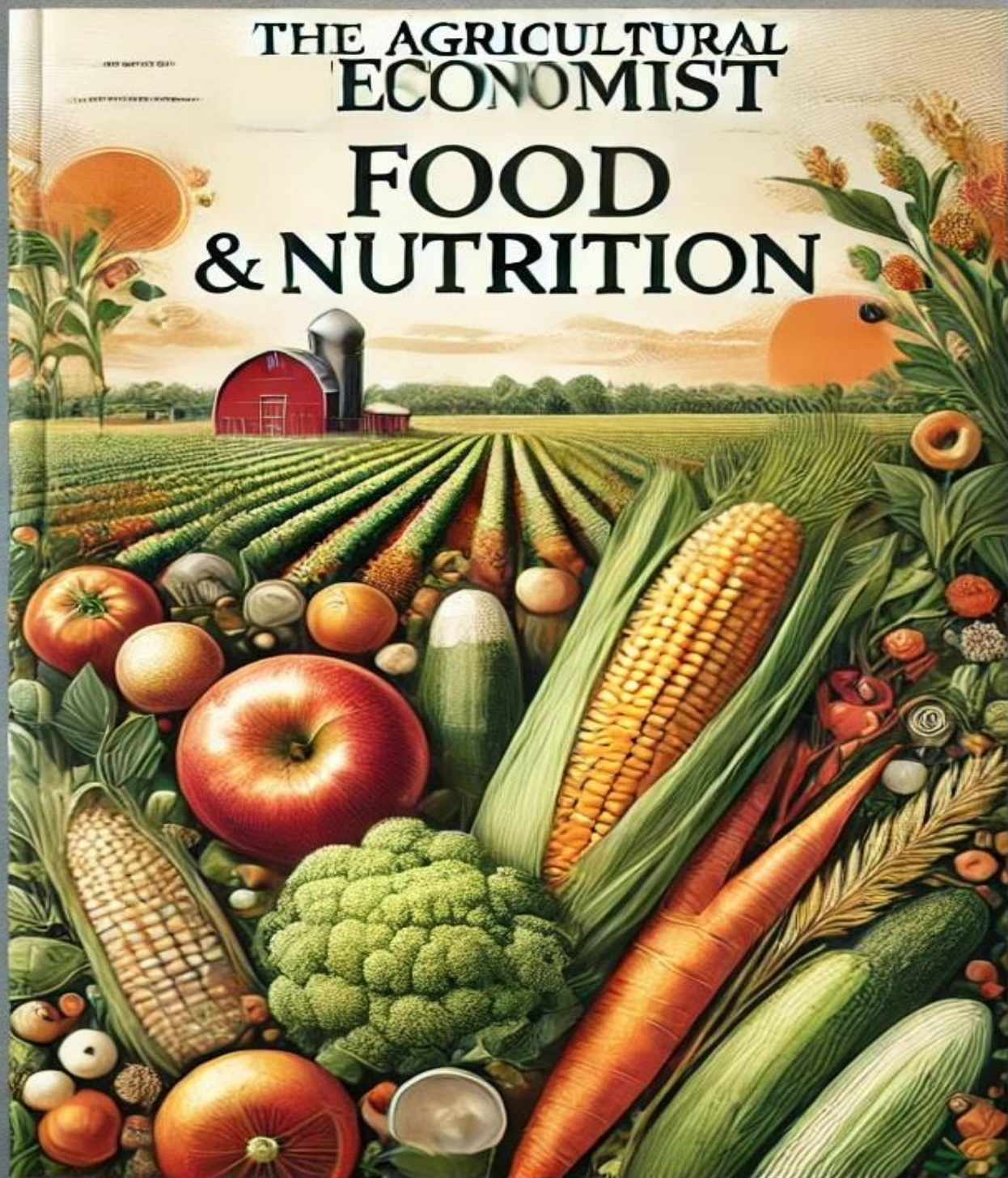
with strategic partnerships among banks, Agri-tech firms, and cooperatives, can catalyze sustainable rural development, improve livelihoods, and contribute to equitable economic growth across Pakistan.

References: AFI; Ahmad & Bashir; GoP; IFC; KPMG; Shahzadi; SBP; World Bank.

Please note that the views expressed in this article are of the author and do not necessarily reflect the views or policies of any organization.

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Pakistan's Deepening Hunger Crisis: Climate Change and Food Insecurity

Discover how climate change, floods, and policy failures are driving Pakistan from food security to chronic hunger and rural collapse.

Nadeem Riyaz

10/7/2025

Pakistan has long identified itself as an agricultural nation, a land nourished by the mighty Indus River and sustained by the labor of millions of farmers across its fertile plains. For decades, the country's agrarian base ensured self-sufficiency in staple crops like wheat and rice, earning it a reputation as a food-secure state and a modest exporter within South Asia. However, this foundation of food security has steadily eroded, replaced by a structural crisis that now threatens both livelihoods and national stability. The country's descent into food insecurity is no longer cyclical or temporary; it is systemic, shaped by a complex interplay of climate shocks, water mismanagement, and economic fragility.

The accelerating force behind this decline is climate change. Pakistan is among the world's ten most climate-vulnerable nations, and the evidence is now undeniable. The catastrophic floods of 2022 submerged one-third of the country, destroying nearly half of Sindh's croplands, killing livestock, and displacing millions. Just two years later, the floods of 2024 inflicted another round of devastation, compounding losses that communities had yet to recover from. Each disaster deepens rural indebtedness, undermines supply chains, and drives up food prices in cities.

These events signify more than natural disasters; they mark a structural unraveling of Pakistan's food system. With declining productivity, shrinking arable land, and

worsening affordability, the country faces a dual crisis: feeding its growing population and preserving the livelihoods that once sustained it. Unless immediate measures are taken to build climate resilience, improve water governance, and strengthen rural economies, Pakistan risks transitioning from an agricultural state to one chronically dependent on food imports. The warning is clear; the nation's food crisis is no longer a temporary emergency but a defining challenge of its future.

The Erosion of a Food-Secure Foundation

In the decades after independence, Pakistan's Green Revolution of the 1960s and 1970s marked a historic turning point. Through the expansion of canal irrigation networks, the adoption of high-yielding wheat and rice varieties, and the mechanization of farm operations, Pakistan achieved remarkable gains in food production. Wheat self-sufficiency became a source of national pride, while rice exports, particularly from Sindh and Punjab, established Pakistan as one of the world's leading suppliers (World Bank, 2022). For a time, the country appeared to have secured its agrarian foundation, one that could feed a growing population and support economic growth.

Yet, beneath this success lay deep structural weaknesses. The very systems that powered the Green Revolution, over-reliance on canal irrigation, chemical

fertilizers, and a narrow focus on staple crops, gradually degraded the soil, depleted groundwater, and discouraged crop diversity. Population growth, which has more than tripled since the 1960s, placed enormous strain on finite land and water resources. Meanwhile, inconsistent agricultural policies, weak extension services, and inadequate investment in research and climate adaptation steadily undermined productivity.

The 2010 floods should have served as a wake-up call, revealing how quickly gains could be erased by climate shocks. Instead, the lessons went largely unheeded. When the unprecedented floods of 2022 arrived, they submerged millions of acres of farmland and destroyed rural infrastructure on an unmatched scale. The 2024 inundations followed before recovery were complete, compounding losses and driving farmers into cycles of debt and displacement.

These consecutive crises have stripped away any illusion of resilience. Pakistan's food system, once celebrated for its productivity, now stands exposed as brittle and unsustainable. The erosion of its food-secure foundation is not merely an agricultural problem; it is a national emergency that threatens economic stability, rural livelihoods, and social cohesion alike.

Impacts of Recent Floods on Agriculture and Food Security

Floods disrupt agriculture in a multitude of ways: destroying standing crops, killing livestock, displacing communities, and shattering infrastructure. The 2022 super-floods submerged nearly a third of the country, displaced 33 million people, and destroyed over 4.4 million acres of crops, leading to the death of over 1.2 million livestock (PDNA, 2022; FAO, 2022). The FAO estimated that yields of vital crops like wheat, rice, and cotton in affected districts fell by 20–40%.

While the article mentions 2025 floods, the most recent major flooding event for which data is available occurred in 2024. These floods, particularly in Punjab and Sindh, have further deepened the crisis. Preliminary assessments from the National Disaster Management Authority (NDMA, 2024) indicate that over 1.5 million acres of farmland were affected, with maize and sugarcane losses exceeding 30% in several districts. The cotton crop, vital for the textile industry, was again devastated, with production expected to fall by over 35% in key regions.

The immediate result is a catastrophic loss of productivity and soaring food prices. After the 2022 floods, flour prices rose by over 40% in Sindh and Balochistan, and vegetable prices doubled within weeks (WFP, 2022). The 2024 floods have reignited these inflationary pressures. Disrupted supply chains from Punjab to Karachi sent vegetable and fruit prices soaring by 30–40%, while dairy costs hit record highs due to fodder loss (Pakistan Bureau of Statistics, 2024).

The long-term impacts are equally severe. Waterlogging and salinity degrade soil fertility for subsequent seasons, while farmers face the next planting season without seeds, fertilizer, or capital. This translates into a vicious cycle of debt and diminished future harvests.

The Human Cost: Nutrition, Displacement, and Instability

At its core, food insecurity is not just an economic issue, it is a crisis of human survival, dignity, and social stability. The floods of 2022 displaced more than 8 million people across Pakistan, many of whom lost not only their homes but also their sources of income and nutrition. In makeshift shelters and relief camps, conditions quickly deteriorated. Access to clean drinking water and adequate sanitation was minimal, fueling outbreaks of waterborne diseases. According to UNICEF (2022), child malnutrition reached alarming levels in flood-affected areas, with wasting and stunting rates surging well beyond emergency thresholds. These conditions have left a lasting imprint on an entire generation, undermining both physical health and cognitive development.

The human toll extends far beyond the immediate aftermath of disaster. The recurrence of extreme floods has led to patterns of pre-emptive displacement, as families migrate from flood-prone rural districts of Sindh and southern Punjab to already overcrowded urban centers. This internal migration places immense strain on urban infrastructure, inflates food and housing costs, and fosters social tensions between host and migrant communities.

The World Food Program (WFP, 2024) warns that the loss of rural livelihoods and chronic uncertainty drives vulnerable households to adopt dangerous coping mechanisms, selling productive assets, pulling children out of school, or skipping meals to survive. These short-term strategies deepen the poverty trap and erode resilience, pushing families further into dependence and despair. The human cost of Pakistan's food insecurity crisis is thus measured not only in hunger but in the erosion of stability, opportunity, and hope.

Inter-Provincial Rift and Governance Challenges

Floods repeatedly expose and exacerbate divisions between Pakistan's provinces. In 2022, Sindh accused the federal government of neglect, while Balochistan protested that its remote communities were ignored. The 2024 floods have reignited these disputes, with Sindh again blaming Punjab for upstream water mismanagement and accusations surfacing of politicized relief distribution (ICG, 2024).

Such rifts obstruct coordinated recovery and weaken national resilience. Agricultural rehabilitation requires cross-provincial cooperation, yet mistrust delays critical action. Without bridging these divides, Pakistan risks transforming food insecurity from a humanitarian challenge into a permanent political fault line.

Policy Failures: A Cycle of Reaction Over Resilience

Pakistan's worsening food insecurity is not merely the outcome of natural disasters; it is the direct result of persistent policy failures and institutional inertia. Over decades, the nation's approach to food and disaster management has been overwhelmingly reactive rather than preventive. Each flood, drought, or heatwave triggers an emergency response, yet little is done to build resilience before the next catastrophe strikes. Despite possessing one of the world's largest irrigation networks, early-warning systems, and extensive agricultural institutions, Pakistan's preparedness remains weak. Warnings issued before floods often fail to reach small farmers in time, and even when they do, limited resources prevent meaningful action.

Financial protection for farmers is virtually nonexistent. Crop insurance schemes are limited in scope, slow in delivery, and

inaccessible to most smallholders, leaving them trapped in cycles of loss and debt after every disaster. Relief efforts, when launched, are too often shaped by political patronage rather than need, deepening inequality and public disillusionment. Meanwhile, long-term resilience strategies such as investment in flood-resilient seeds, modern drainage, and efficient water governance are repeatedly sidelined in favor of short-term fixes.

This reactive mindset perpetuates vulnerability. Without robust institutions, transparent governance, and sustained commitment to climate-smart agriculture, Pakistan's food system will continue to buckle under every shock. Building resilience requires shifting from political expediency to policy continuity, anchoring national security, economic stability, and human well-being in sustainable food and climate governance.

Conclusion

Pakistan stands at a critical crossroads where its identity as an agricultural nation confronts the reality of a climate-stressed, food-insecure future. The repeated floods of 2022 and 2024 have not only washed away crops and infrastructure but have exposed the systemic weaknesses in governance, planning, and resilience. What was once a story of abundance and self-sufficiency has become a struggle for survival, with millions displaced, malnourished, and trapped in cycles of poverty and debt. The country's reliance on reactive crisis management rather than preventive, science-based planning has deepened the vulnerability of its food systems and eroded public trust in institutions.

The path forward demands a structural shift in both policy and mindset. Investing in climate-smart agriculture, equitable water governance, and social protection is

no longer optional, it is an existential necessity. Strengthening provincial cooperation, depoliticizing relief efforts, and promoting long-term adaptation can restore not just productivity but dignity and stability to rural communities. If Pakistan is to reclaim its agricultural promise, it must transition from responding to disasters to preparing for them. Only through resilience-driven reform can the nation secure a future where no citizen goes hungry and where the next flood does not erase decades of progress.

References: FAO; ICG; NDMA; PBS; PDNA; SBP; UNICEF; World Bank; WFP

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Transforming Food: Lab-Grown Meat & Alternative Proteins

Explore how lab-grown meat and alternative proteins can reshape our food system for a sustainable future. With climate change and population growth, these innovative solutions reduce land use, emissions, and resource consumption while promoting animal welfare and public health.

Aimen Younas

10/23/2025

The global food system is undergoing a profound transformation, driven by the urgent need for sustainable, climate-friendly, and ethical methods of producing protein for a rapidly growing population. Traditional livestock farming while central to global diets comes with significant environmental burdens, including high greenhouse gas emissions, land degradation, deforestation, and excessive water consumption. As the world seeks solutions that can feed nearly 10 billion people by 2050 without exhausting natural resources, new technologies in protein production are stepping into the spotlight. Among the most promising advances are lab-grown meat and alternative proteins, which together are reshaping the future of food.

Lab-grown meat, also known as cultivated or cell-based meat, is produced by painlessly harvesting stem cells from a living animal and culturing them in a nutrient-rich environment inside a bioreactor, where the cells grow into muscle tissue (Sharma et al., 2015). This method eliminates the need for raising, transporting, and slaughtering animals, while offering the possibility of producing meat with fewer antibiotics, reduced environmental impact, and a significantly smaller land and water footprint.

Parallel to this breakthrough, the alternative protein sector is expanding rapidly and diversifying at an unprecedented pace. This sector includes sophisticated plant-based meat analogs made from crops such as soy, peas, and wheat; insect-derived proteins that require minimal resources to produce; and proteins created through microbial fermentation, a technique used to

manufacture dairy-like and meat-like products without animals (GFI, 2023). Together, these innovations aim to address urgent ethical concerns related to animal welfare, reduce the carbon footprint of global diets, and provide healthier protein options for consumers.

Rather than replacing traditional agriculture overnight, lab-grown and alternative proteins represent a complementary transition toward a more resilient and sustainable food ecosystem one that protects the planet while meeting the nutritional needs of future generations.

The Imperative for Alternative Proteins

The urgency to adopt alternative proteins stems from the growing imbalance between rising global food demand and the planet's ecological limits. By 2050, the world's population is expected to reach 9.7 billion, intensifying the demand for affordable, accessible, and nutritious protein sources (United Nations, 2019). Meeting this surge through conventional livestock production is neither environmentally sustainable nor economically feasible. Livestock farming already occupies nearly 80% of global agricultural land yet contributes only a fraction of the world's protein supply, highlighting its inefficiency and enormous resource burden (FAO, 2017).

Conventional animal agriculture is also a major driver of environmental degradation. The sector contributes approximately 14.5% of global anthropogenic greenhouse gas emissions, placing it on par with the entire transportation industry (FAO, 2013). Beyond emissions, expanding

pastureland and feed crop cultivation fuel deforestation, soil degradation, and freshwater depletion. The Amazon rainforest, for example, continues to be cleared at alarming rates to make room for cattle ranching and soy production for animal feed. This destruction accelerates biodiversity loss, disrupts ecosystems, and undermines global climate goals.

Moreover, livestock production is highly inefficient from an energy and resource standpoint. A groundbreaking study in *Science* found that even the lowest-impact animal products typically have a far greater environmental footprint than plant-based alternatives, consuming more land and water while emitting significantly higher levels of greenhouse gases (Poore & Nemecek, 2018). This means that incremental improvements in animal farming efficiency will not be enough to meet sustainability targets.

Against this backdrop, alternative proteins offer a strategic solution. By decoupling protein production from land- and carbon-intensive systems, they provide a pathway to reduce emissions, conserve biodiversity, and free up land and water resources all while meeting future nutritional needs. Embracing these innovations is not just an option, but a planetary imperative.

Technological and Health Innovations Driving the Future of Alternative Proteins

The technological landscape of lab-grown meat is evolving at a remarkable pace, moving the concept from experimental labs to the brink of commercial reality. Cellular agriculture has benefitted from major breakthroughs in cell line development, enabling

scientists to cultivate stable, fast-growing muscle and fat cells that can proliferate indefinitely without repeated biopsies. Parallel progress in culture media, the nutrient solution that feeds these cells, has dramatically reduced production costs. Early prototypes relied on extremely expensive growth serums, but today, plant-based and synthetic alternatives are lowering expenses and making scaling more feasible. Meanwhile, innovations in bioreactor engineering allow cells to grow in controlled environments that mimic animal physiology at industrial volumes. Cutting-edge tools like 3D bioprinting are particularly revolutionary, enabling the creation of structured meats such as steaks and fillets by layering muscle, fat, and connective tissue to replicate the texture, juiciness, and mouthfeel of traditional meat (Kang et al., 2021). These advances have already transformed affordability: the first lab-grown burger cost \$330,000 in 2013, yet companies are now racing to launch products at mainstream price points.

The environmental promise of cultivated meat is equally compelling. A life-cycle assessment published in *Environmental Science & Technology* found that lab-grown meat could reduce global warming potential by up to 92%, shrink land use by 93%, and cut water consumption by 78% compared to conventional beef (Tuomisto & Teixeira de Mattos, 2011). Such reductions are crucial as deforestation, methane emissions, and water scarcity intensify worldwide. By bypassing animal agriculture entirely, cultivated meat offers a scalable pathway to climate-friendly protein without compromising taste or cultural preferences.

Health outcomes also stand to improve with alternative proteins. Unlike conventional livestock meat, cultivated meat can be designed with healthier fat compositions, enriched with omega-3s, and produced without antibiotics, reducing the threat of antimicrobial resistance. Plant-based proteins from soy to peas and lentils are naturally low in saturated fats and cholesterol, supporting

cardiovascular health (Harvard T.H. Chan School of Public Health, 2023). Fermented and plant-based alternatives can also be fortified with key micronutrients such as iron, zinc, and vitamin B12, helping bridge nutritional gaps. Together, these innovations position alternative proteins as a powerful solution for a healthier, more sustainable global food system.

Consumer Acceptance, Market Outlook, and Regulatory Momentum

Consumer acceptance of alternative proteins is gaining momentum, reflecting a broader shift in global eating habits. The rise of the *flexitarian* lifestyle where individuals consciously reduce, rather than eliminate, meat consumption is playing a pivotal role in expanding this market. According to a 2023 report by the Boston Consulting Group (BCG), alternative proteins are projected to capture 11% of the global protein market by 2035, with the potential to reach even higher levels if supported by favorable policies and innovation. Younger generations are driving demand, expressing strong preferences for environmentally responsible and ethically produced foods. However, consumer psychology remains a key factor. For many, the so-called “yuck factor” associated with cultivated meat or insect-based proteins stems from unfamiliarity rather than evidence. In response, companies are prioritizing transparency, clean labeling, sampling campaigns, and educational outreach to build trust, demystify production methods, and emphasize safety and sustainability.

Parallel to rising consumer interest, the regulatory landscape for alternative proteins is evolving rapidly. Singapore became the first nation in the world to approve the commercial sale of cultivated chicken in 2020, signaling a breakthrough for the industry. In 2023, the United States followed suit, granting regulatory clearance for cultivated chicken products from UPSIDE Foods and GOOD Meat (FDA, 2023), marking an important milestone for mainstream

adoption. The European Food Safety Authority (EFSA) is also formulating structured approval pathways under the EU’s Novel Foods Regulation. As more countries move toward clear, science-based frameworks for safety evaluation, labeling, and commercialization, the sector is expected to gain further legitimacy and investor confidence. Ultimately, transparent regulations, coupled with proactive consumer engagement, will be central to accelerating the market trajectory of alternative proteins and ensuring their smooth integration into global food systems.

Persisting Challenges, Remaining Hurdles, and the Road Ahead

Despite remarkable advances, the alternative protein sector continues to face significant scientific, economic, and social challenges that could slow its trajectory. One of the most critical hurdles is the complexity of scaling up production. Cultivated meat requires highly controlled environments that balance cell growth, nutrient delivery, and sterility. Translating successful laboratory experiments into large-scale commercial operations remains a formidable engineering and biological challenge. Although production costs have dropped dramatically since the first lab-grown burger, achieving true price parity with conventional meat, especially poultry and beef depend heavily on reducing the cost of culture media, which still accounts for the largest share of production expenses.

Consumer perception presents another barrier. While awareness is increasing, a portion of the public remains hesitant, influenced by unfamiliarity, cultural traditions, or skepticism toward “synthetic” foods. At the same time, competition from next-generation plant-based products which are becoming more realistic, affordable, and widely available continues to shape market dynamics. Regulatory delays, labeling debates, and intellectual property concerns further complicate the path to widespread adoption.

Looking ahead, however, the long-term outlook remains highly optimistic. Continued investment in biotechnology is expected to deliver breakthroughs in growth media, cell lines, and energy-efficient bioreactors, making production both cheaper and more scalable. Public-private partnerships, government incentives, and international climate policies will also play a crucial role in accelerating commercialization. As climate pressures intensify and demand for sustainable protein grows, cultivated and alternative proteins are well-positioned to become mainstream rather than niche. Wider consumer education, clearer regulations, and strategic collaboration across the food industry will be key to building trust and driving adoption. If these challenges are addressed with foresight and innovation, the sector could help usher in a more resilient, ethical, and low-carbon global food system in the decades ahead.

Conclusion

The global food system is at a historic turning point, and lab-grown meat together with alternative proteins offers

a transformative pathway toward a more resilient, ethical, and sustainable future. As climate change, population growth, and environmental degradation intensify pressure on conventional agriculture, it is increasingly clear that traditional livestock production alone cannot meet the protein needs of future generations. Cultivated meat and next-generation plant-, insect-, and fermentation-based proteins provide a viable solution by dramatically reducing land use, emissions, and resource consumption while addressing animal welfare and public health concerns.

The technological breakthroughs of the past decade combined with rising consumer awareness and a rapidly evolving regulatory landscape suggest that alternative proteins are poised to move from niche innovation to global adoption. While challenges persist in scaling production, reducing costs, and building public trust, the momentum is unmistakable. With continued investment, supportive policies, and transparent communication, the sector

can achieve price parity and mass acceptance.

Ultimately, the future of food will not be defined by a single protein source, but by a diversified and climate-smart system. Lab-grown and alternative proteins will play a central role in that transition, helping nourish a growing world while safeguarding the planet for generations to come.

References: BCG; FAO; GFI; Harvard T.H. Chan School of Public Health; Kang et al; Poore & Nemecek; Sharma et al; Tuomisto & Teixeira de Mattos; United Nations; FDA.

Please note that the views expressed in this article are of the author and do not necessarily reflect the views or policies of any organization.

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The Role of Indigenous Crops in Enhancing Food Security in Pakistan

Explore how indigenous crops can transform Pakistan's food security challenges through sustainable agricultural strategies. These crops not only thrive in local climates but also provide essential nutrients, combating hunger and malnutrition among women and children.

Ariba Sadia

10/24/2025

Pakistan stands at a critical juncture concerning its food security, where rising population pressures and environmental constraints are converging into a national crisis. With more than 240 million people and an annual growth rate of 1.9% (World Bank, 2023), the country's food demand is expanding faster than its production capacity. Climate change impacts such as erratic monsoons, glacier melting, heatwaves, and frequent floods are intensifying vulnerabilities across the agricultural sector. Simultaneously, Pakistan is among the world's most water-stressed nations, severely limiting its ability to sustain crop cultivation.

These stresses are compounded by inflation, shrinking foreign reserves, and poor market governance, which collectively undermine food affordability and availability. Despite being an agrarian economy, the nation faces persistent malnutrition, micronutrient deficiencies, and reduced dietary diversity. Ranking 102 out of 125 countries on the 2023 Global Hunger Index, Pakistan falls into the "serious hunger" category (von der Leyen et al., 2023), underscoring deep structural weaknesses in food policy and agriculture.

One of the core issues is the narrow focus of agricultural policy. Heavy subsidies and procurement programs prioritize wheat, rice, and sugarcane, encouraging monoculture at the expense of diversity. This policy orientation has sidelined Pakistan's rich heritage of indigenous crops. Traditional staples like bajra (pearl millet), jowar (sorghum), mash (black gram), moong (mung bean), chaulai (amaranth), and til (sesame) are naturally aligned with Pakistan's agro-ecological zones. They are drought-tolerant, require minimal water, withstand high temperatures, and often thrive in marginal

soils with limited chemical inputs. Nutritionally, many of these crops are richer in protein, fiber, micronutrients, and essential amino acids compared to wheat or rice. Yet, decades of monocropping have eroded agrobiodiversity, weakened ecological resilience and exposed Pakistan to climate and market shocks. Restoring indigenous crops within mainstream agriculture could therefore play a transformative role in rebuilding a secure, sustainable, and nutrition-rich food system for the country's future.

Defining Food Security and the Indigenous Advantage

The Food and Agriculture Organization (FAO) defines food security as a condition in which all people, always, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs and preferences for an active and healthy life. In the context of Pakistan, this definition underscores the strategic value of reviving indigenous crops to strengthen food security. By diversifying agricultural production beyond wheat, rice, and sugarcane, indigenous crops can play a vital role in ensuring a more reliable and resilient food supply. Their cultivation broadens the national food basket and reduces the risks associated with over-reliance on a few staples that are highly vulnerable to climate change. Since many indigenous crops are naturally drought-tolerant and require fewer inputs, they can be produced at a lower cost, making nutritious food more affordable for low-income households. This characteristic is particularly important in rural Pakistan, where a large share of the population struggles with food inflation and limited purchasing power.

Nutritionally, indigenous crops offer immense and often overlooked value. They are rich in essential vitamins, proteins, minerals, and dietary fiber, making them a powerful tool for addressing widespread malnutrition and micronutrient deficiencies. By encouraging greater consumption of traditional foods such as millet, sorghum, lentils, amaranth, and sesame, Pakistan can improve dietary diversity and public health outcomes. At the same time, the climate resilience of these crops provides long-term stability to the food system. Their ability to withstand heat, drought, pests, and poor soils make them reliable even in adverse conditions, reducing the likelihood of production shocks and supply disruptions. In an era of growing climate uncertainty, integrating indigenous crops into mainstream agriculture offers Pakistan not only a pathway to nutritional well-being but also a sustainable and more self-reliant food future.

Reviving Indigenous Crops: Nutrition, Livelihoods, and Climate Resilience for Pakistan

Indigenous crops hold tremendous potential to address Pakistan's multidimensional food crisis by simultaneously combating hidden hunger, empowering rural economies, and restoring ecological balance. These crops are exceptionally rich in nutrients, making them a powerful weapon against the widespread micronutrient deficiencies that persist in Pakistan despite an agriculture-based economy. In a country where diets are dominated by wheat and rice, pulses such as mash and moong offer a critical source of plant-based protein that can substantially improve dietary balance. The Bambara groundnut, for example, contains up to 24 percent protein

significantly higher than maize and products made from it can help reduce protein-energy malnutrition among vulnerable communities. Likewise, amaranth leaves, which contain up to 40 mg of iron per 100 grams and are also rich in vitamin A, offer a strategic solution to anemia and weakened immunity, especially among women and children. Pearl millet (bajra) further contributes to improved nutrition through its high iron and zinc content, far exceeding that of modern refined wheat flour, making it an ideal crop for tackling Pakistan's silent malnutrition crisis.

Beyond health benefits, indigenous crops have the power to strengthen rural livelihoods and stimulate local economies. Their cultivation creates new income streams for smallholder farmers who are otherwise trapped in low-margin, high-input staple crop cycles. Since many indigenous crops are now considered niche or premium products, farmers can earn more by supplying growing urban and export markets that value traditional and organic foods. Examples from other regions also demonstrate the financial promise of indigenous agriculture. Studies from Africa show that cultivating indigenous vegetables can increase farm income by more than 25 percent, and similar opportunities exist in Pakistan through crops like quinoa, heritage rice, and traditional millets. The potential is even greater when supported by value-addition industries such as millet flour, amaranth snacks, mixed pulse products, and ready-to-eat foods. These activities generate employment for women and youth in rural areas, reduce post-harvest losses, and keep wealth circulating within local communities instead of flowing to costly imported inputs.

Environmentally, indigenous crops offer resilience against Pakistan's escalating climate threats. Their natural drought tolerance and ability to thrive in poor soils make them ideal for regions such as Tharparkar, Cholistan, Balochistan, and upland Khyber Pakhtunkhwa. Legume crops like moong and mash also enrich soil fertility by fixing nitrogen, which reduces dependence on chemical

fertilizers, lowers production costs, and protects soil health over the long term. Because these crops co-evolved with local ecosystems and pests, they typically require fewer pesticides, promoting safer food and reducing environmental contamination. By diversifying fields with multiple indigenous crops, farmers can create more stable agro-ecosystems that are less vulnerable to total crop failure, thereby increasing national food system resilience.

Taken together, the nutritional, economic, and environmental advantages of indigenous crops present a compelling case for their revival in Pakistan. Reintegrating them into mainstream agriculture can transform the food system from one characterized by vulnerability to one rooted in resilience, health, and self-reliance.

Strategic Recommendations for Reviving Indigenous Crops in Pakistan

Indigenous crops remain an underexplored yet powerful pathway to overcoming Pakistan's chronic food insecurity and rising malnutrition. Their superior nutritional profile, adaptability to harsh local conditions, and potential to uplift rural economies make them a strategic asset in shaping a resilient and self-reliant food system. To unlock this potential, Pakistan must adopt a comprehensive and coordinated strategy that spans policy reform, institutional innovation, market incentives, and consumer awareness.

A reorientation of agricultural policy is essential. For decades, subsidies and support mechanisms have disproportionately favored wheat, rice, and sugarcane, resulting in monocultures and depleted agro-biodiversity. Redirecting a portion of these subsidies toward climate-resilient crops such as millet, mung bean, amaranth, and sesame will encourage farmers to diversify production. Programs like the government's Horticulture Support Initiative should be expanded to explicitly prioritize nutrient-dense indigenous varieties, ensuring institutional backing

from federal and provincial agricultural departments.

Simultaneously, investment in research and development is critical. Public and private research institutions must initiate breeding programs that enhance yield, shelf life, and processing potential of indigenous crops without eroding their natural strengths. Farmer training, demonstration plots, and university-industry linkages can accelerate the adoption of improved varieties. Parallel to research, market development is needed to create profitable value chains. Branding initiatives such as "Pakistani Heritage Grains" and dedicated supermarket shelves for indigenous products can stimulate demand. Strengthening cold chains, processing facilities, and certification systems will connect rural producers with urban and international markets, offering farmers premium prices.

Finally, public awareness is vital for behavioral change. National campaigns through schools, media, and nutrition programs can promote the health benefits of traditional grains, vegetables, and pulses, increasing their acceptance in household diets. By mainstreaming indigenous crops from farm to table, Pakistan can enhance food sovereignty, improve public health, and build long-term resilience against climate and market shocks.

Conclusion

Pakistan's food security challenges demand a paradigm shift in both agricultural strategy and dietary behavior. The evidence presented in this article clearly shows that indigenous crops offer a practical, sustainable, and nutrition-focused solution to the country's growing crisis of hunger and malnutrition. Naturally suited to local climates, these crops can withstand drought, heat, and poor soil, making them far more dependable than water-intensive staples in an era of climate uncertainty. At the same time, their superior nutritional value rich in proteins, iron, zinc, vitamins, and dietary fiber positions them as a powerful tool in combating "hidden hunger," which

continues to affect millions of Pakistani women and children.

Beyond nutrition, indigenous crops also hold promise for poverty reduction and rural development. By cultivating high-value traditional crops and participating in emerging niche markets, smallholder farmers can diversify incomes, reduce input costs, and gain greater financial stability. Environmentally, reintroducing these crops can restore soil fertility, conserve biodiversity, and reduce

chemical dependency, ultimately leading to healthier agro-ecosystems.

To realize these benefits, however, Pakistan must commit to reform—through supportive policies, targeted research, market incentives, and public awareness. If integrated thoughtfully into mainstream agriculture and national diets, indigenous crops can strengthen food sovereignty, enhance climate resilience, and secure a healthier future for generations to come.

References: Altieri; Chivenge et al; FAO; Giller; Mkandawire; National Institute of Nutrition, India; Soofi et al; Hassan; von der Leyen et al; World Bank.

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Asthma in the Walls: How Housing Conditions and Cockroach Allergens Harm Children

Asthma prevention starts in the walls. Explore how cockroach allergens, housing inequality, and climate change shape children's health globally.

Muhammad Hamid Bashir & Muhammad Huzaifa Jamil

10/1/2025

In megacities from Karachi to New York, a significant but often overlooked driver of pediatric asthma exacerbations lies not in the haze of outdoor air pollution but within the walls of aging apartments and crowded homes: the cockroach allergen. Unlike the visible irritants of smog and smoke, this threat hides in kitchens, cupboards, and cracks in the plaster. The solution is not another can of fogger or surface spray. Instead, the answer lies in building-level prevention, integrated pest management with targeted baits, and public policies that recognize pest control as an essential public health intervention rather than a cosmetic household chore.

On a humid Karachi night, Ayesha listens anxiously as her son coughs through his sleep. She has tried everything the corner shopkeeper suggested: a fogger that left a chemical haze, chalk lines behind the stove, and lemon-scented sprays that promised freshness more than protection. For a few days, the kitchen seemed quiet. Then, in the dim early morning, a cupboard door shifted, and a pair of brown antennae probed the darkness. By the next night, the cough returned, harsher than before.

The true culprit is not only the insects themselves but the microscopic allergens they leave behind. Proteins found in cockroach droppings, saliva, and shed body parts mix with household dust and persist in the air long after the pests are gone (Pomés et al., 2017). In crowded households where maintenance lags and children share sleeping spaces, these allergens act like invisible smoke, constantly priming the immune system. For a sensitized child, this means inflamed airways, chronic vulnerability, and a heightened risk of severe asthma attacks (Do et al., 2016). Addressing this

hidden hazard demands more than household remedies, it requires systemic, preventive action that places healthy housing at the center of urban health strategies.

What Roach Allergens Do to Young Lungs

Cockroaches are brilliantly adapted to urban life. Their proteins, best known to allergists as Bla g 1 (German cockroach) and per a 1 (American cockroach), accumulate where warmth, moisture, and food traces persist. Everyday activity resuspends these particles into the breathable air.

For children with asthma, this exposure is predictive. A seminal study found that children who were both sensitized to cockroach allergens and exposed to high levels in their homes had significantly more hospitalizations, more unscheduled medical visits, and more days of wheezing compared to other children (Rosenstreich et al., 1997). The combination that does the most harm is sensitization plus exposure: a child's immune system is primed to react, and their housing environment delivers a constant dose.

Two realities make this a population-level problem. First, a home does not need a visible infestation to reach clinically relevant allergen levels; a handful of insects colonizing wall voids can be enough (DeLuca & Kessler). Second, exposure maps neatly onto building conditions and socioeconomic status. Crowding, water leaks, and unsealed penetrations mean more habitat and more residue.

"If the walls keep feeding allergens back into the air, medicines are always playing catch-up."

Karachi's Lens on a Global Story

Karachi's urban fabric, where glittering glass towers rise alongside sprawling informal settlements, captures the profound stakes of the cockroach-asthma connection. In these dense neighborhoods, cracked walls, leaky pipes, and warm service shafts create year-round reservoirs where cockroaches thrive, largely immune to household sprays. Pediatric clinics in the city already shoulder a heavy asthma burden, with studies showing that childhood asthma prevalence in urban Pakistan ranges between 10% and 20% or higher, with cockroach exposure consistently identified as a major risk factor (Zahid & Aslam, 2021; Khan et al., 2019). For many families, each asthma attack is not just a health crisis but also an economic strain, as repeated hospital visits, missed school days, and reduced parental productivity deepen household vulnerabilities.

Yet Karachi is not an isolated case; it is a lens onto a global story. Swap in Lahore, Lagos, Dhaka, Cairo, or even the aging rental stock of New York, and the picture is remarkably similar. Wherever apartment blocks share infrastructure, where maintenance is deferred and ventilation shafts link families together, pests and their allergens move easily through invisible channels. The biology of cockroaches does not respect walls or tenancy agreements.

This is why family-by-family approaches so often fail. A can of insect spray in one apartment may kill a handful of visible insects, but the allergenic proteins embedded in dust, and the breeding sites hidden in building plumbing, remain untouched. Pest biology is inherently collective, and so too must be the

response. Effective control requires building-wide strategies, community-based programs, and public health policies that elevate integrated pest management to the same level of seriousness as water sanitation or vaccination. In a warm, urbanizing world, Karachi's story illustrates an urgent global lesson: asthma prevention begins not only in clinics, but also in the shared walls of our cities.

Why “Just Spray” Disappoints

If over-the-counter sprays worked as advertised, Ayesha's kitchen would have been quiet long ago. Yet experience in homes and findings from controlled trials show otherwise. Most consumer aerosols rely on pyrethroids, and urban cockroach populations have developed widespread resistance to them (Fardisi et al., 2019). The outcome is predictable: a brief knockdown effect without eliminating colonies, while leaving behind chemical residues on kitchen counters, children's toys, and bedding. Families are left with the illusion of control while allergens continue to accumulate in dust.

The point is not that chemicals should never be used, but that they must be used intelligently and in sequence. Spraying first only drives cockroaches deeper into wall voids, dispersing them to new hiding sites and making subsequent control harder. By contrast, when structural interventions come first sealing, drying, and limiting access to food targeted baits can work effectively, acting almost like medicine for the building itself.

Integrated Pest Management (IPM) takes this holistic view, treating a building as an interconnected living system. The strategy begins with physics, not poisons sealing wall-floor gaps, packing copper mesh or sealant around plumbing penetrations, and installing door sweeps. This halts the free movement of cockroaches between flats and eliminates hidden harborage. Water management is equally critical, since drips and damp sink basins provide essential lifelines for colonies. Food hygiene using tight-lidded bins, wiping grease trails, and storing dry

goods in sealed containers further weakens the infestation.

Once these foundations are in place, targeted use of insecticidal gel baits along travel routes delivers the decisive blow. Unlike sprays, baits are ingested and shared within colonies, leading to systemic collapse without scattering insects (Wang & Bennett, 2019). Monitoring with sticky traps then confirms progress and guides follow-up action.

Evidence consistently shows that building-wide IPM programs achieve steep reductions in cockroach counts and allergen levels. Studies report declines of 70–90% in *Bla g 1* concentrations within months, often while using far less pesticide overall than conventional spray contracts (Miller & Smith, 2021; Nalyanya et al., 2020). The lesson is clear: in multifamily housing, pests do not respect apartment lines. Unless every leak, crack, and shaft is addressed collectively, roaches will inevitably return.

Health Care Can Prescribe Repairs

Modern asthma care is no longer confined to inhalers and nebulizers; it now pairs medical treatment with environmental risk-factor control. Increasingly, pediatric clinics are asking about pests as part of routine health assessments, recognizing that cockroach allergens are as relevant as pollen or dust mites. In pioneering programs in Boston and New York, physicians have gone further literally prescribing home repairs. Partner agencies deliver interventions such as installing door sweeps, sealing cracks, fixing leaks, and applying targeted baits (Sandel et al., 2020). The economics strongly favor this approach: a coordinated Integrated Pest Management (IPM) cycle across an apartment block often costs less than repeated emergency visits for asthma exacerbations. In this way, pest management becomes preventive medicine.

This shift is also about equity. Families most exposed to cockroach allergens are often those with the least leverage to demand timely repairs. When cockroach

control is framed as a public health imperative rather than a private housekeeping failure, responsibility shifts where it belongs to landlords, municipalities, and housing authorities. Such framing ensures that children's health is not compromised by neglected infrastructure or inadequate policies.

In Pakistan, where urban populations are growing rapidly, the same model could be transformative. The most effective anti-cockroach program begins not with another can of spray but with a plumbing wrench, a tube of sealant, and a policy framework that enables scale. Rental codes and public housing contracts can incorporate IPM standards with verification and follow-ups. Municipalities can procure gel baits, door sweeps, and sealants in bulk, training maintenance teams in IPM basics. Pediatric clinics could be empowered to trigger housing work orders when a child's asthma control is compromised by documented allergen exposure. Community-led “seal-and-clean” blitzes, where entire stairwells or neighborhoods participate in coordinated sealing, cleaning, and bait placement, can yield rapid and visible improvements.

Cockroach exposure is a systems problem at the intersection of housing, infrastructure, climate, and health equity. Warmer, more humid conditions linked to climate change are already lengthening breeding seasons and boosting allergen production (Chapman & Wünschmann, 2021). Continued reliance on sprays alone risks not only failure but also pesticide resistance and unnecessary chemical exposure. The encouraging reality, however, is that this problem is solvable. Building-wide IPM is a proven, cost-effective intervention. For Pakistan and other fast-growing cities, the path forward lies in tying housing quality directly to public health outcomes and investing in the unglamorous but decisive fixes that clean the air where children live. That, at its core, is respiratory medicine by other means.

Conclusion

The story of cockroach allergens and childhood asthma is not merely about insects in the walls it is about the intersection of biology, infrastructure, and inequality. From Karachi to New York, the evidence is clear: where housing is crowded, poorly maintained, and under-regulated, children bear a disproportionate burden of asthma morbidity. The microscopic proteins shed by cockroaches transform ordinary homes into hidden reservoirs of respiratory risk, leaving medicines to play perpetual catch-up against an unaddressed source.

Yet this challenge is neither inevitable nor insurmountable. Research and practice have demonstrated that Integrated Pest Management (IPM), when implemented at the building or block level, can dramatically reduce both pest populations and allergen loads, achieving what sprays

and foggers cannot. The success of programs that link healthcare with housing repair underscores a vital truth: asthma prevention must extend beyond the clinic to the built environment itself.

For Pakistan and other rapidly urbanizing nations, the implications are profound. By embedding IPM standards into rental codes, municipal contracts, and public health policy, and by empowering communities through coordinated interventions, it is possible to turn the tide on both asthma morbidity and pesticide overuse. Climate change may exacerbate the problem, but it also sharpens the urgency for systemic solutions.

Ultimately, healthy lungs begin with healthy housing. Recognizing cockroach control as a matter of public health, rather than private housekeeping, reframes the issue in terms of equity, sustainability, and children's right to breathe clean air.

The pathway forward demands coordination, investment, and persistence but it offers the promise of breaking a cycle where walls feed allergens into the air, and young lungs pay the price.

References: Pomés et al; Do et al; Rosenstreich et al; DeLuca & Kessler; Zahid & Aslam; Khan et al; Fardisi et al; Wang & Bennett; Miller & Smith; Nalyanya et al; Sandel et al; Chapman & Wünschmann.

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Urban Malaria in Pakistan: Rising Threat

Pakistan faces a new malaria crisis as *Anopheles stephensi* spreads in cities. Explore risks, failures of fogging, and sustainable solutions.

Muhammad Hamid Bashir & Muhammad Huzaifa Jamil

10/3/2025

A dangerous shift is underway in Pakistan's battle against malaria, one that challenges long-held assumptions about where the disease thrives. Traditionally associated with rural areas and stagnant irrigation channels, malaria is now finding a new foothold in the very heart of Pakistan's cities. The culprit is *Anopheles stephensi*, a highly adaptive mosquito species that has evolved to exploit urban environments. Unlike rural mosquito species, which rely on open water bodies, *An. stephensi* breeds in man-made structures—rooftop water tanks, uncovered storage drums, clogged drains, and even cracks in densely packed housing. This adaptation is transforming Karachi, Lahore, and other metropolitan centers into year-round malaria risk zones.

The consequences of this urban shift are alarming. Cities, already struggling with dengue outbreaks, now face the double burden of two major mosquito-borne diseases. Public health systems, designed with seasonal and rural malaria patterns in mind, are ill-prepared for continuous urban transmission. Traditional responses such as fogging or spraying provide only temporary relief, often failing to reach hidden breeding sites within homes and buildings.

Buy vitamins and supplements

Containing this threat requires more than reactive measures; it demands structural change. Urban planning must integrate vector control, with building codes that mandate covered water storage, proper drainage, and mosquito-proof designs. Water supply systems need upgrading to reduce the reliance on rooftop tanks, while municipal waste and sewage management must be prioritized to eliminate breeding grounds. At the same time, public awareness campaigns should encourage households to adopt preventive practices,

such as covering containers and maintaining sanitation.

Ultimately, the rise of *An. stephensi* underscores a harsh truth: malaria in Pakistan is no longer just a rural disease. Without urgent reforms in urban governance and infrastructure, the nation risks an entrenched public health crisis at the core of its economic hubs.

A New Kind of Malaria Threat

In Pakistan's urban clinics, a troubling new pattern is emerging. Children and adults alike are increasingly being misdiagnosed with dengue when, in fact, they are suffering from malaria. What was once a rural disease has firmly established itself in the cities. The shift is stark: in 2022 alone, Pakistan recorded 1.6 million confirmed malaria cases, with a large share originating from urban and peri-urban areas (Pakistan National Malaria Control Program, 2023). This urban resurgence signals not just a health crisis but also a transformation in how malaria spreads and sustains itself.

At the center of this shift is *Anopheles stephensi*, a mosquito uniquely adapted to urban life. Unlike traditional malaria vectors that thrive in fields, ponds, or rice paddies, *An. stephensi* prefers artificial containers. In cities like Karachi, where water supply is irregular, millions of households rely on rooftop tanks and underground "tankas" for storage. These water reservoirs have become ideal breeding grounds. In Lahore, a recent survey revealed that over 40% of sampled water storage containers harbored *An. stephensi* larvae (Khan et al., 2024). Because these structures are used year-round, the mosquito enjoys a continuous breeding cycle, ensuring that malaria never fully subsides, even in cooler months.

The international experience offers a sobering warning. When *An.*

stephensi invaded Djibouti City, malaria cases skyrocketed from just 27 in 2012 to more than 70,000 within a decade. The World Health Organization (WHO, 2023) has since flagged its spread as a severe threat to elimination of malaria across Africa, where it endangers decades of progress. For Pakistan, the message is clear: the presence of *An. stephensi* in urban centers is not a seasonal nuisance but a structural, long-term challenge that demands urgent public health and urban planning reforms before the country risks a full-scale urban malaria crisis.

Why Fogging is a Failing Strategy: Toward Integrated Urban Malaria Control

The widespread reliance on fogging as Pakistan's first line of defense against malaria, particularly in urban centers, is proving dangerously inadequate against the advance of *Anopheles stephensi*. While fogging offers a visible and politically convenient response, its practical effectiveness is severely compromised. As one public health entomologist observed, "Fogging a street for a night is easy; keeping mosquitoes out of water tanks and homes is the real work." The persistence of malaria transmission in Karachi, Lahore, and other major cities underscores the shortcomings of this reactive approach.

There are two central reasons for its failure. First, insecticide resistance has eroded the power of chemical interventions. A 2023 study in Punjab revealed that more than 78% of *An. stephensi* tested were resistant to pyrethroids, the most widely used class of insecticides for fogging and bed nets (Ali et al., 2023). This resistance dramatically reduces kill rates and renders repeated fogging campaigns increasingly futile. Second, fogging cannot penetrate the hidden breeding sites unique to this urban vector. *An. stephensi* thrives in rooftop tanks, underground tankas, and

domestic water container's locations shielded from outdoor sprays. Larvae continue developing undisturbed, and adult mosquitoes retreat indoors, where fogging trucks cannot reach.

Relying on fogging alone is thus not only wasteful but also misleading, creating a false sense of security while the vector silently entrenches itself deeper into urban systems. A reimagined defense must integrate health policy, housing standards, and municipal infrastructure into a coordinated strategy.

The first step is to seal the water sources that serve as breeding hubs. Mandatory mosquito-proof lids for rooftop tanks and underground reservoirs, enforced through building codes, could dramatically reduce infestation. Evidence from Rajasthan, India, showed that replacing leaky lids with sealed covers eliminated tank breeding and reduced local mosquito densities by 70% (Singh et al., 2021).

Second, homes must be redesigned with mosquito-proofing in mind. Simple measures such as screened windows, sealed vents, and closed eaves create physical barriers. A 2023 meta-analysis found that house screening reduced malaria infection odds by nearly half (Tusting et al., 2023), underscoring its preventive power.

Third, urban governance must integrate mosquito control into core sanitation duties. Fixing water pooling points, lining open drains, and embedding larval surveillance into municipal routines can reduce habitats.

Finally, insecticides should be deployed intelligently. Next-generation tools, such as piperonyl butoxide (PBO)-treated nets, have proven more effective against resistant vectors. Rotating insecticide classes for Indoor Residual Spraying (IRS), guided by local resistance data, ensures sustainability.

Conclusion

The emergence of *Anopheles stephensi* in Pakistan's cities signals a profound shift in the country's malaria landscape. Once regarded as a rural and seasonal disease, malaria has now entrenched itself as a year-round urban threat, exploiting man-made water storage systems, poor drainage, and fragile municipal infrastructure. The alarming rise in cases, coupled with the mosquito's proven resistance to commonly used insecticides, demonstrates that conventional measures such as fogging are inadequate and unsustainable.

This evolving challenge calls for a paradigm shift in both public health policy and urban governance. Malaria control

must move beyond short-term chemical interventions to long-term structural reforms that integrate housing standards, water management, and sanitation into disease prevention. Building codes that mandate mosquito-proof tanks, urban planning that prioritizes drainage, and municipal services that embed larval surveillance are no longer optional, they are essential. At the same time, households must be mobilized through awareness campaigns to adopt preventive measures within their own environments.

Pakistan's cities stand at a crossroads. By embracing integrated, evidence-based strategies, the country can prevent a full-scale urban malaria crisis. Failure to act decisively risks not only overwhelming public health systems but also undermining economic stability in the nation's urban hubs.

References: Ali et al; Khan et al; NMCP; Singh et al; Tusting et al; WHO.

Please note that the views expressed in this article are of the author and do not necessarily reflect the views or policies of any organization.

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The Hidden Costs of Antibiotic Dependence in Animal Farming

Explore how antibiotic overuse in animal farming disrupts physiology, fuels antimicrobial resistance, and threatens global food and public health.

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Antibiotics have revolutionized animal agriculture by reducing mortality, promoting faster growth, and improving feed efficiency. However, their widespread use, accounting for nearly 73% of all global antimicrobial sales in food-producing animals (Mulchandani et al., 2023) has come with unintended and far-reaching consequences. In many livestock systems, antibiotics are not limited to therapeutic purposes; instead, they are routinely administered at subtherapeutic doses for disease prevention and growth promotion. While this practice initially appears economically efficient, it masks deep physiological and ecological costs that threaten long-term sustainability.

At the animal level, continuous antibiotic exposure disrupts the natural microbiome, leading to gut dysbiosis an imbalance in microbial populations essential for digestion, immunity, and nutrient absorption. This disturbance weakens the immune system, making animals more dependent on further antibiotic interventions. Moreover, physiological stress caused by antibiotic-induced metabolic shifts can impair liver function, reproductive performance, and overall growth quality. These biological disruptions reduce the efficiency of livestock production over time, undermining the very gains antibiotics were meant to secure.

The ripple effects extend beyond the farm. Antibiotic residues in meat, milk, and eggs pose significant health risks to consumers, potentially triggering allergic reactions and contributing to antimicrobial resistance (AMR) in human pathogens. Contaminated manure and wastewater further disseminate resistant bacteria into soil and water systems, perpetuating a cycle of environmental exposure. In this interconnected “One Health” framework where animal, human, and environmental

health are inseparable, indiscriminate antibiotic use emerges as a critical hazard.

Recognizing these physiological and ecological costs, the urgent priority is to transition toward responsible antibiotic stewardship, emphasizing vaccination, probiotics, improved hygiene, and precision nutrition. Sustainable livestock production must rest not on chemical dependence, but on healthier systems that protect both animal welfare and public health.

Physiological and Ecological Consequences of Antibiotic Overuse in Livestock

The widespread, prolonged, and often indiscriminate use of antibiotics in livestock farming has deeply altered the physiology of farm animals, with cascading implications for animal health, productivity, and public safety. While antibiotics are administered to control infections and enhance growth rates, their subtherapeutic and prophylactic use has triggered a series of biological disturbances that undermine the very systems they were designed to protect. Central to these disruptions is the alteration of gut microbiota, immune imbalance, metabolic strain on vital organs, and the contamination of food and ecosystems through persistent antibiotic residues.

The gut microbiota plays a vital role in maintaining digestive health, nutrient metabolism, and immune function. When antibiotics are administered at low or continuous doses, they target not only harmful bacteria but also beneficial commensal microorganisms, leading to gut dysbiosis, a breakdown in microbial diversity and equilibrium. This microbial imbalance weakens the fermentation of dietary fibers, reduces the synthesis of short-chain fatty acids such as butyrate (essential for intestinal health), and

damages the gut’s epithelial barrier. The result is a condition often termed “leaky gut,” where toxins and pathogens can cross into the bloodstream, leading to systemic inflammation and reduced nutrient absorption. This compromised digestive function ultimately manifests in lower feed efficiency, poorer growth performance, and increased vulnerability to gastrointestinal infections such as *Salmonella* and *Clostridium perfringens*. Ironically, the preventive use of antibiotics to avoid disease can create the very conditions that perpetuate infection cycles, trapping farmers in a continuous loop of drug dependency.

Beyond the digestive system, antibiotics disrupt the immune system’s natural development and regulation. The gut microbiota serves as a crucial educator of the immune system, providing antigenic stimulation that helps develop balanced immune responses. When this dialogue is disrupted, the immune system becomes under-stimulated and dysregulated. Studies indicate that continuous antibiotic exposure reduces populations of regulatory T-cells and disturbs the Th1/Th2 cytokine balance, leaving animals more immunologically fragile. Such animals become overly dependent on medical interventions for disease resistance, leading to higher production costs and weaker herd immunity. At the same time, the selective pressure exerted by antibiotics accelerates the evolution of antimicrobial resistance (AMR) one of the most severe global health crises of the 21st century. Resistant strains of bacteria, such as those carrying the *mcr-1* gene for colistin resistance, can spread from animals to humans via contaminated meat, direct contact, or the environment, rendering formerly treatable infections potentially fatal.

The metabolic burden imposed by antibiotics further strains animal physiology. The liver and kidneys, responsible for detoxification and excretion, must metabolize and eliminate antibiotic compounds, a process that leads to oxidative stress and tissue damage with prolonged exposure. Elevated liver enzyme levels (ALT and AST) and histological signs of hepatocellular degeneration are frequently observed in animals subjected to repeated antibiotic treatments. Similarly, the kidneys experience glomerular and tubular damage, impairing filtration efficiency and causing electrolyte imbalances. These subclinical conditions divert metabolic energy away from productive processes like growth, milk synthesis, and reproduction, eroding the efficiency gains antibiotics were meant to deliver.

Finally, antibiotic residues and environmental contamination extend the physiological consequences beyond the farm gate. Inadequate observance of withdrawal periods results in residues persisting in meat, milk, and eggs, posing chronic exposure risks to consumers. Even when administered properly, up to 90% of antibiotic compounds can be excreted unchanged through feces and urine, contaminating manure that is later used as fertilizer. This introduces active antibiotic molecules and resistance genes into soil and water systems, where they can persist for months, affecting crops, aquatic organisms, and eventually human health.

The cumulative evidence underscores that the overreliance on antibiotics in livestock production is not a sustainable pathway for agricultural development. What began as a tool for improving productivity has evolved into a biological and ecological liability. A paradigm shifts toward antibiotic stewardship, improved biosecurity, and sustainable alternatives, such as probiotics, prebiotics, vaccination, and precision nutrition, is essential to restore balance in animal physiology and safeguard human and environmental health alike.

Future Perspectives

The future of livestock farming depends on a decisive transition from antibiotic dependency to sustainable, science-driven health management. The early economic gains achieved through antibiotic use have been eroded by mounting evidence of their long-term damage to both animal physiology and human health. Continuous exposure to antibiotics disrupts the delicate balance of gut microbiota, weakens immune responses, and strains metabolic organs such as the liver and kidneys. Simultaneously, the spillover effects, antibiotic residues in food, the rise of antimicrobial resistance (AMR), and environmental contamination, have created a global health challenge that transcends the boundaries of agriculture.

To reverse this trajectory, the livestock sector must embrace a paradigm shift grounded in One Health principles, recognizing the interconnectedness of human, animal, and environmental well-being. Future strategies should focus on prevention rather than cure. Strengthening farm biosecurity through improved hygiene, waste management, and controlled animal movement can dramatically reduce infection risks. Precision vaccination programs tailored to local disease profiles can replace prophylactic antibiotic use, while optimized nutrition, especially the inclusion of trace minerals, amino acids, and immune-boosting supplements, can enhance natural disease resistance.

Equally promising are antibiotic alternatives such as probiotics, prebiotics, phytogetic feed additives (plant extracts with antimicrobial properties), and organic acids, which support gut health and reduce pathogen load without fostering resistance. Furthermore, genomic selection and digital monitoring tools can identify and breed disease-resilient livestock, paving the way for precision farming systems that prioritize welfare and productivity.

Globally, policy frameworks must reinforce this transformation through stricter regulation of antibiotic sales, incentives for sustainable practices, and farmer education on responsible drug use. In essence, the future of animal agriculture lies not in pharmaceutical dependence but in intelligent, preventive, and ecologically balanced

systems that secure both productivity and planetary health.

Conclusion

The widespread use of antibiotics in animal farming has delivered undeniable short-term economic benefits but at immense physiological, ecological, and public health costs. What began as a strategy for disease prevention and growth promotion has evolved into a structural dependency that disrupts gut microbiota, weakens immunity, strains liver and kidney function, and diminishes long-term productivity. Beyond animal physiology, this overuse has contributed to the alarming global spread of antimicrobial resistance (AMR), contaminating food chains, water systems, and the broader environment. The consequences are no longer confined to farms, they now threaten human health and the sustainability of agricultural ecosystems.

A shift toward responsible antibiotic stewardship is, therefore, not optional but imperative. The livestock sector must prioritize prevention through enhanced biosecurity, vaccination, and the use of scientifically validated alternatives such as probiotics, prebiotics, and phyto-genics. Policymakers and industry leaders must strengthen regulatory oversight, enforce withdrawal periods, and promote education on rational antibiotic use. Embracing the One Health approach linking animal, human, and environmental health offers a holistic framework for sustainable progress.

Ultimately, the future of livestock production depends on restoring biological balance rather than relying on pharmaceutical shortcuts. Only by reducing antibiotic dependence can we safeguard animal welfare, ensure food safety, and protect public health for generations to come.

References: Cycoń & Piotrowska-Seget; Ferrario et al; Gadde et al; Kumar et al; Manyi-Loh et al; Mulchandani et al; WHO.

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Brucellosis in Livestock: A One Health Challenge for Rural Economies

Explore how brucellosis threatens livestock productivity, public health, and rural economies and why a One Health approach is key to sustainable control.

Ehsanullah, Muhammad Qasim Anjum & Iqra Ishaq

10/13/2025

Brucellosis remains one of the world's most persistent zoonotic diseases, exerting a heavy toll on animal health, public health, and economic stability, particularly in agrarian economies. Caused by bacteria of the *Brucella* genus, the disease affects a wide range of domestic animals (cattle, goats, sheep, and buffaloes) causing reproductive disorders such as abortions, retained placentas, infertility, and decreased milk production. These outcomes severely diminish farm productivity, leading to significant economic losses for smallholders and commercial farmers alike. In regions where livestock serve as the backbone of rural livelihoods, brucellosis erodes household income, compromises food availability, and undermines long-term development efforts.

For humans, the disease commonly known as undulant or Malta fever is transmitted through direct contact with infected animals, contaminated environments, or the consumption of unpasteurized dairy products. Symptoms such as recurrent fever, joint pain, and fatigue can become chronic if untreated, reducing labor productivity and straining rural healthcare systems. In countries where animal vaccination and milk pasteurization programs are inconsistently implemented, the risk of human infection remains particularly high.

The complex epidemiology of brucellosis highlights the need for a One Health approach, integrating veterinary, medical, and environmental interventions. Strengthening animal vaccination coverage, improving farm biosecurity, enforcing dairy hygiene standards, and conducting community education campaigns are essential steps toward control. Simultaneously, enhanced surveillance and diagnostic capacity can

help identify outbreaks early and prevent cross-species transmission.

Ultimately, combating brucellosis requires not only medical and veterinary solutions but also social and institutional coordination. By fostering collaboration between farmers, veterinarians, public health agencies, and policymakers, nations can move toward eliminating this ancient yet still formidable disease, protecting both livelihoods and lives while advancing sustainable rural development.

Brucellosis: Etiology and Epidemiology

Brucellosis is a contagious bacterial zoonosis caused by *Brucella* species, small Gram-negative, non-motile coccobacilli that infect a wide range of domestic and wild animals. These bacteria are facultative intracellular pathogens, capable of surviving and multiplying within host macrophages, which makes eradication particularly difficult. The disease's epidemiology is closely tied to its host preferences: *Brucella*

abortus predominantly infects cattle and buffaloes, *Brucella melitensis*, the most pathogenic species for humans, affects goats and sheep, while *Brucella suis* is commonly associated with pigs and certain wildlife reservoirs (Godfroid et al., 2011). Each species adapts to specific ecological and husbandry conditions, influencing regional disease dynamics.

Transmission among animals primarily occurs through direct contact with infected materials such as aborted fetuses, placental tissues, and genital discharges. Environmental contamination plays a major role, as the bacteria can survive for weeks to months in cool, moist conditions in soil, manure, and water sources. Animals can become infected by ingesting contaminated feed or water or through mucosal exposure during parturition. Vertical transmission through milk or in

utero infection also perpetuates herd-level persistence. Once infected, animals often remain chronic carriers, intermittently shedding bacteria and acting as reservoirs for ongoing transmission.

The global burden of brucellosis is substantial, with an estimated 500,000 new human cases annually (Pappas et al., 2006), though the true number is likely much higher due to widespread underreporting and misdiagnosis. The disease remains endemic across the Mediterranean Basin, the Middle East, South and Central Asia, Latin America, and parts of Africa. In many developing countries, weak surveillance systems, lack of vaccination coverage, and informal livestock trading perpetuate its spread. Understanding the etiology and epidemiology of brucellosis is therefore critical to designing targeted prevention, control, and eradication strategies under a One Health framework that bridges veterinary and human health sectors.

Impact of Brucellosis in Livestock and Humans

Brucellosis exerts a heavy toll on livestock productivity and rural livelihoods worldwide. In animals, the disease primarily targets the reproductive system, leading to abortions, stillbirths, retained placentas, and infertility. Such reproductive failures not only reduce herd size but also compromise genetic improvement programs designed to enhance productivity. In dairy herds, infection with *Brucella* species causes a significant drop in milk yield estimated to be at least 20% in affected animals (McDermott & Arimi, 2002) which severely undermines farm profitability and national milk supply. Moreover, chronic infections reduce fertility rates and animal longevity, while infected males may suffer from orchitis and epididymitis, further hindering breeding potential. In draught

animals, fatigue and reduced work capacity translate into lowered agricultural productivity, exacerbating economic losses, particularly for smallholder farmers who depend on livestock for both income and labor. On a macroeconomic scale, brucellosis can also result in trade restrictions, limiting the export of livestock, dairy products, and genetic material, and imposing costly barriers to international markets.

Beyond livestock, brucellosis represents a serious zoonotic threat to public health. Humans typically contract the infection through direct contact with infected animals or by consuming unpasteurized milk, cheese, or other dairy products. Those most at risk include veterinarians, farmers, slaughterhouse workers, and laboratory technicians. Human brucellosis, commonly known as undulant fever, presents with intermittent fever, weakness, muscle and joint pain, and night sweats, often mimicking other febrile illnesses, leading to delayed diagnosis. Without timely antibiotic treatment, the disease can progress to chronic forms involving arthritis, endocarditis, and neurological complications (Franc et al., 2018). These prolonged illnesses reduce worker productivity and impose heavy medical and social costs. Thus, controlling brucellosis in livestock is not only vital for agricultural sustainability but also essential for protecting human health, food safety, and economic development under the One Health paradigm.

Diagnosis, Control, and Prevention of Brucellosis

Accurate and timely diagnosis forms the foundation of any effective brucellosis control program. Given the disease's complex epidemiology and its ability to establish chronic infections, diagnostic precision is vital for preventing widespread transmission within and between herds. In most field settings, serological testing remains the primary diagnostic tool. The Rose Bengal Plate Test (RBT) is widely used as a rapid and inexpensive screening method, allowing for large-scale herd surveillance. However, because RBT can yield false positives due to cross-reactivity with other bacteria, confirmatory tests are

essential. Advanced assays such as the Competitive Enzyme-Linked Immunosorbent Assay (cELISA) and the Fluorescence Polarization Assay (FPA) offer greater specificity and reliability, especially for international trade certification and disease control programs (Godfroid et al., 2011).

Molecular diagnostic methods, particularly Polymerase Chain Reaction (PCR), have revolutionized disease detection by enabling the identification of *Brucella* DNA with high sensitivity and specificity. PCR techniques can also differentiate between vaccine strains and wild-type infections, an essential capability in regions where vaccination is widely practiced. Despite their accuracy, molecular methods remain underutilized in many developing countries due to high costs and limited laboratory infrastructure. The gold standard for confirmation, bacterial culture, provides definitive identification and strain typing but requires Biosafety Level 3 facilities, specialized personnel, and strict safety protocols to protect laboratory workers. These constraints underscore the urgent need for affordable, portable diagnostic kits and improved biosafety infrastructure, particularly in endemic regions.

Controlling and preventing brucellosis in livestock demands a comprehensive, multifaceted strategy centered on vaccination, sound herd management, and strict biosecurity. Vaccination remains the cornerstone of long-term control, with live attenuated strains such as *B. abortus* S19 for cattle, *B. melitensis* Rev.1 for small ruminants, and *B. abortus* RB51 for differentiation between vaccinated and infected animals (Schurig et al., 2002). In parallel, biosecurity practices, including the quarantine and testing of new stock, prompt culling of infected animals, and safe disposal of aborted materials are essential to prevent disease spread. The pasteurization of milk and use of personal protective equipment for farm and veterinary workers are equally vital public health measures to break the zoonotic transmission cycle.

Ultimately, the persistent challenge of brucellosis reinforces the importance of the

One Health approach, which recognizes that human, animal, and environmental health are deeply interconnected. Effective control cannot be achieved through veterinary interventions alone; it requires collaboration among medical professionals, agricultural authorities, and environmental agencies. Targeting the infection at its animal source remains the most efficient and cost-effective strategy. Through integrated surveillance, vaccination campaigns, and cross-sectoral education, nations can significantly reduce the burden of brucellosis, safeguarding both rural livelihoods and public health.

Recommendations for the Control and Eradication of Brucellosis

Brucellosis remains a formidable obstacle to sustainable livestock production and rural development, particularly in endemic regions across Asia, Africa, and the Mediterranean. The disease not only undermines animal productivity but also threatens public health and national economies through trade losses and medical expenditures. Despite the availability of effective vaccines and diagnostic tools, the persistence of brucellosis is largely due to weak surveillance systems, fragmented control efforts, and limited community awareness. Therefore, an integrated, long-term, and well-coordinated strategy is essential for its effective control.

Strengthened vaccination programs must form the backbone of disease prevention. Mass immunization of cattle and small ruminants in high-risk areas should be systematically implemented and monitored to ensure coverage and compliance. Alongside vaccination, enhanced surveillance systems using modern diagnostic tools such as PCR and ELISA are crucial for mapping disease prevalence and guiding targeted interventions.

On farms, strict biosecurity measures, including controlled animal movement, proper sanitation, and safe disposal of infected materials must be enforced. Public education campaigns should emphasize the dangers of consuming unpasteurized milk and the importance of safe animal handling practices.

Equally important is the establishment of a functional One Health framework, fostering collaboration between veterinary, human health, and environmental sectors. Joint surveillance, data sharing, and coordinated outbreak responses can ensure early detection and swift containment.

By prioritizing education, vaccination, surveillance, and inter-sectoral coordination, countries can substantially reduce the burden of brucellosis. These actions will not only protect animals and human health but also enhance rural livelihoods, food security, and economic stability paving the way toward sustainable agricultural and public health systems.

Conclusion

Brucellosis remains one of the most enduring and economically devastating zoonotic diseases affecting both livestock and humans worldwide. Its persistence in endemic regions reflects not only biological resilience but also systemic

challenges limited diagnostic capacity, inadequate vaccination coverage, and weak intersectoral coordination. The disease's dual burden on animal productivity and human health continues to undermine rural livelihoods, constrain agricultural trade, and impede progress toward sustainable development.

The path toward brucellosis eradication demands a comprehensive and unified approach anchored in the One Health framework. This includes strengthening vaccination programs for cattle and small ruminants, improving surveillance and reporting systems, and ensuring rapid diagnosis through accessible and reliable testing methods. Farmer education and community engagement are equally critical to enhance compliance with biosecurity measures and promote safe dairy consumption practices.

Governments and international partners must also invest in veterinary infrastructure, research, and policy

enforcement to sustain long-term control efforts. Eradicating brucellosis is not merely a veterinary challenge, it is economic, public health, and social imperative. Through coordinated action, nations can move closer to a future where livestock are healthy, rural communities are resilient, and the threat of zoonotic transmission is effectively contained, ensuring food safety and sustainable rural prosperity.

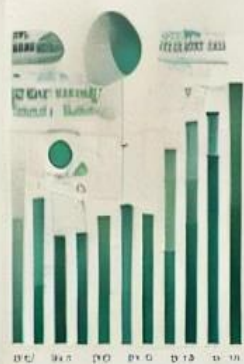
References: Godfroid et al; Pappas et al; McDermott & Arimi; Franc et al; Schurig et al.

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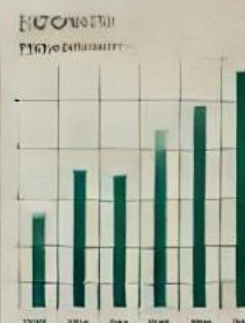
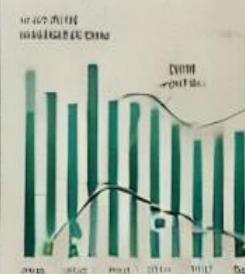
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GROWTH INSIGHTS



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10 High-Demand and Rewarding Careers in Agriculture

Explore 10 high-demand careers in agriculture for 2025 and beyond spanning agritech, sustainability, biotechnology, and climate-smart farming.

Kiran Hameed

10/2/2025

Agriculture, defined as the practice of cultivating plants and raising animals for food, fiber, fuel, and other essential products, remains not only the foundational pillar of human civilization but also a critical driver of the global economy. Over centuries, it has evolved from subsistence farming into a sophisticated sector that now encompasses specialized fields such as aquaculture (fish farming), sericulture (silkworm rearing), apiculture (beekeeping), and agroforestry, reflecting its expanding role in meeting human needs.

Despite its importance, agriculture often suffers from a perception gap that discourages young people and students from considering it as a viable career path. Many view it as labor-intensive, low-tech, and financially unrewarding, largely because of limited exposure during formative years of education. Modern agriculture is a highly dynamic, innovation-driven industry that leverages biotechnology, data science, artificial intelligence, and sustainable practices to address pressing global challenges. Careers in this field are increasingly high-impact and financially competitive, with opportunities spanning research, agribusiness, environmental management, and food technology.

The urgency for innovation is underscored by demographic trends. With the global population projected to reach 8.5 billion by 2030 (UN, 2022), food security, resource efficiency, and climate resilience will require cutting-edge agricultural solutions. The sector's economic potential is equally striking: the global agri-tech market is forecasted to reach \$52.8 billion by 2030, growing at an impressive compound annual growth rate

(CAGR) of 11.3% (Grand View Research, 2023). This growth signals robust demand for skilled professionals capable of merging traditional agricultural knowledge with modern technological expertise.

Looking ahead, the agricultural landscape will be shaped by fields that combine sustainability, innovation, and technology. The following ten areas represent the vanguard of this revolution, offering some of the most promising and impactful career paths in future.

Emerging Careers in Agriculture

Agriculture is undergoing a profound transformation, no longer confined to conventional farming practices but extending into high-tech, sustainable, and entrepreneurial domains. The rise of global challenges such as climate change, food insecurity, and urbanization has accelerated the need for innovation, opening diverse career opportunities for the next generation. Ten fields stand out as the vanguard of this revolution, offering dynamic pathways for 2025 and beyond.

Organic and regenerative farming is gaining momentum as consumers demand healthier food and environmentally responsible practices. Unlike traditional organic farming, regenerative agriculture actively enhances soil health, biodiversity, and water cycles. Careers in this field include organic farm managers who oversee operations and certification compliance, soil health specialists who prescribe regenerative techniques such as cover cropping, and permaculture designers who create self-sustaining landscapes with food forests and water-harvesting systems.

The intersection of agriculture and technology has birthed agritech and precision farming, which deploys artificial intelligence, drones, IoT sensors, and big data analytics. Specialists in this area analyze geospatial data to optimize inputs, drone operators monitor crop health and pest activity from the sky, while sensor technicians ensure the smooth functioning of in-field monitoring systems. Together, they enhance yields while reducing costs and resource waste.

Sustainable livestock management offers another critical frontier. This field integrates environmental and ethical considerations with animal production. Roles include livestock nutritionists who formulate climate-friendly diets, regenerative grazing planners who design rotational systems to boost soil carbon, and animal welfare auditors who ensure humane standards, often linked to certification programs that add value to supply chains.

Vertical and urban farming reflects the growing need for localized food systems in rapidly urbanizing societies. By using hydroponics, aeroponics, and controlled environment agriculture, these systems achieve up to 95% greater water-use efficiency. Careers here range from vertical farm technicians who manage LED lighting and nutrient solutions, to entrepreneurs who supply produce directly to urban markets, and operators who specialize in soil-less cultivation systems.

Agricultural biotechnology continues to push the boundaries of science, producing crops that are more resilient and nutritious. Biotech researchers work on bio-pesticides and genetically improved plants, seed science specialists develop new varieties with higher yields and

climate resistance, while plant geneticists decode the genes that underpin vital agricultural traits. These roles are at the heart of addressing global food challenges.

As agriculture generates more data than ever, agricultural data science and artificial intelligence are reshaping farm management. Data analysts integrate information from sensors, satellites, and drones to create predictive models. Machine learning engineers design algorithms to detect pests or automate harvesting, and climate risk modelers forecast long-term threats, helping farmers prepare for uncertain futures. This field blends agriculture with cutting-edge computer science, offering career opportunities that barely existed a decade ago.

Agri-entrepreneurship and agritourism represent innovative ways of linking farming with business and community engagement. Coordinators design tourism experiences such as farm tours or festivals, CSA managers run subscription models connecting consumers directly with harvests, while value-added product developers transform raw produce into branded goods like jams, cheeses, or organic snacks. These careers expand revenue streams while reconnecting society with farming.

Carbon farming and agroforestry highlight agriculture's role in climate mitigation. Agroforestry planners design landscapes that integrate trees with crops or livestock, carbon farming consultants help farmers access carbon credit markets projected to reach \$50 billion by 2030, while silvopasture specialists manage systems that combine trees, pasture, and grazing animals. These careers position farmers not only as food producers but also as climate stewards.

Sustainable aquaculture and inland fisheries address the need for alternative protein sources as global fish stocks

decline. Aquaculture technicians manage recirculating systems that recycle water, hatchery managers oversee breeding and juvenile fish production, while aquatic health specialists safeguard against diseases and ensure biosecurity. With over half of the fish consumed worldwide now farmed, this field represents one of the fastest-growing career opportunities.

Finally, agri-supply chain and post-harvest management focus on reducing food loss, which currently accounts for 14% of global production. Cold chain logistics managers maintain proper storage and transport conditions for perishables, supply chain analysts optimize coordination between farmers and markets, while food preservation technologists develop innovative methods such as high-pressure processing or modified atmosphere packaging. These roles are critical in ensuring that food reaches consumers safely and efficiently.

Together, these ten fields illustrate that agriculture today is more than cultivation it is a multidisciplinary, innovation-driven sector central to solving humanity's greatest challenges. Careers now extend from soil science to artificial intelligence, from biotechnology labs to urban farms, and from local food systems to global carbon markets. For students and young professionals, agriculture offers not only stable employment but also the opportunity to shape a sustainable and equitable future. The next generation of agricultural professionals will be climate innovators, data scientists, entrepreneurs, and environmental stewards, proving that the future of farming is as dynamic as it is essential.

Conclusion

Agriculture stands at the crossroads of tradition and transformation, offering opportunities that reach far beyond conventional farming. The ten career pathways outlined in this article demonstrate how the sector is becoming a

nexus of sustainability, technology, entrepreneurship, and climate action. From regenerative farming that restores ecosystems to precision agriculture powered by artificial intelligence, each field reflects the urgent need to produce more with fewer resources while protecting the planet.

For young professionals, agriculture is no longer limited to manual labor in rural fields; it is a global arena where science, innovation, and policy converge. The rapid growth of agri-tech, the rise of climate-smart practices like carbon farming, and the expansion of urban agriculture highlight how careers in this sector can deliver both economic rewards and social impact. Moreover, with food security challenges intensifying as the world population approaches 8.5 billion by 2030, skilled professionals in agriculture will be at the forefront of solving humanity's most pressing issues.

Ultimately, agriculture today offers not just jobs but purpose-driven careers. By entering this evolving sector, the next generation can become agents of resilience, sustainability, and innovation proving that the future of farming is the future of humanity itself.

References: FAO; Grand View Research; McKinsey & Company; United Nations; World Economic Forum; Agritecture.

Please note that the views expressed in this article are of the author and do not necessarily reflect the views or policies of any organization.

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Transforming Graduates into Agripreneurs

Agripreneurs become job creators by leveraging agricultural knowledge. This home-based agribusiness movement is redefining Pakistan's agricultural future, promoting food security and sustainability, one rooftop and backyard at a time.

Sana Fareed

10/21/2025

Agriculture remains the backbone of Pakistan's economy, contributing about 22.7% to the national GDP and providing employment to 37.4% of the labor force (Pakistan Economic Survey, 2022–2023). Yet, a growing concern lies beneath these impressive statistics, the widening gap between agricultural education and meaningful employment. Every year, thousands of agriculture graduates enter the job market, only to find limited vacancies, slow hiring cycles, and underemployment. This situation creates frustration among youth; however, it also opens a transformative window of opportunity.

Instead of relying solely on government or corporate jobs, young graduates can reimagine themselves as agripreneurs. With access to scientific knowledge, research-based techniques, and increasingly available digital platforms, students are uniquely positioned to launch profitable, home-based agri-businesses. These ventures require minimal land and modest capital, yet offer strong income potential, scalability, and long-term sustainability.

Spaces such as rooftops, terraces, balconies, and small backyard plots can be converted into productive micro-farms. From organic vegetable cultivation, microgreens production, mushroom farming, composting units, rooftop hydroponics, kitchen gardening kits, nursery plants, to value-added products like dehydrated fruits, herb teas, pickles, or organic fertilizers, the opportunities are vast. These businesses not only promote self-employment and innovation but also support urban food supply chains, reduce household food expenses, and create a circular economy by turning organic waste into productive inputs.

Moreover, this home-based agripreneurship movement aligns national priorities, improved food security, youth empowerment, climate-smart agriculture, and sustainable cities. With proper training, market linkages, and value addition, students can convert their ideas into brands, reaching consumers through e-commerce, farmer markets, and social media.

This article advocates a mindset shift from job seekers to job creators. By combining academic knowledge with entrepreneurship, the next generation can cultivate both plants and prosperity, building resilient livelihoods from the comfort of their homes while contributing meaningfully to Pakistan's agricultural future.

Turning Agricultural Knowledge into Action: The Agripreneurial Mindset

Becoming a successful agripreneur begins with a shift in thinking from viewing agriculture as a subject to be studied, to embracing it as an opportunity for innovation, income generation, and problem-solving. Agriculture students already possess a strong foundation in plant sciences, soil management, pathology, biotechnology, and agricultural economics. The real transformation happens when this academic knowledge is applied through small, practical, home-based projects that can grow into profitable micro-enterprises.

Developing an agripreneurial mindset involves learning to identify opportunities where others see limitations. Common agricultural challenges such as pest infestations, nutrient-deficient soils, or food spoilage are not obstacles, but signals of unmet market needs. For example, the growing demand for organic

food and eco-friendly inputs has created new business openings. Products like neem-based bio-pesticides, compost made from kitchen waste, or organic liquid fertilizers can be produced at home, responding directly to consumer preferences for chemical-free, sustainable solutions (FAO, 2022).

Another pillar of this mindset is starting small and using existing resources. Even a 100-square-foot balcony, rooftop, or spare corner can become a productive unit through container gardening, hydroponics, or vertical farming. The goal is not to begin big, but to begin wisely testing ideas, managing costs, and scaling gradually. Students should also recognize the power of value addition. Often, it is not the raw tomato or herb that earns the highest profit, but the product created from it such as sun-dried tomatoes, herbal teas, or ready-to-cook salad mixes with attractive packaging and branding.

Finally, agripreneurship is a continuous learning process. Hands-on experimentation, record-keeping, and adapting based on results help refine skills and build confidence. By integrating knowledge from horticulture, entomology, and agricultural economics, students can make informed, data-driven decisions. This holistic, action-oriented approach turns academic learning into real-world impact and lays the foundation for sustainable, home-grown agribusiness success.

Home-Based Agri-Business Ideas for Agriculture Students

A wide range of home-based agribusiness opportunities allows agriculture students to convert their academic learning into practical income-generating ventures. One of the most accessible

options is organic vegetable and herb gardening, which aligns with the rapidly growing global demand for chemical-free food, a sector expanding at over 8% annually (IFOAM, 2021). By cultivating leafy greens, tomatoes, chilies, or coriander in pots and grow bags using compost and neem-based pest control, students can supply fresh produce to neighbors, local markets, or restaurants. Even small terraces and balconies can become highly productive under this model.

Another promising idea is organic compost production, which transforms household waste into a valuable agricultural input. With rising awareness about soil health, compost has a steady urban and rural market. By collecting kitchen scraps, leaves, and manure, students can produce nutrient-rich compost in just a few months, creating income while reducing waste.

A seedling nursery (paneri) is also a profitable option. By producing healthy, disease-free seedlings of vegetables and flowers, students can help farmers and gardeners avoid germination losses. This business requires basic propagation knowledge and offers consistent seasonal demand.

Similarly, value-added food products such as pickles, sauces, dried herbs, or jams allow students to tap into the home-based food market. With post-harvest losses for fruits and vegetables reaching up to 40% in Pakistan (World Bank, 2021), value addition not only generates income but also reduces waste.

Students may also launch a fresh-cut salad and microgreens service, catering to health-focused urban consumers through subscription-based weekly deliveries. Lastly, mushroom cultivation offers high returns in a small space, using wheat straw or crop residues as substrate. With short production cycles and strong market demand, mushrooms are an ideal beginner-friendly enterprise.

Challenges and Strategic Solutions

While home-based agri-businesses offer tremendous potential for youth

empowerment and sustainable income generation, aspiring agripreneurs frequently encounter several challenges that can hinder early progress. One major limitation is the lack of startup capital. Many students cannot afford expensive inputs or equipment, which leads to delayed execution of their ideas. The most effective solution is to begin on a micro-scale using recycled containers, locally available materials, and low-cost input. Profits from the first production cycle can be reinvested, allowing the business to grow organically over time.

Another obstacle is the lack of practical, hands-on skills. Although students possess theoretical knowledge, they often struggle with implementation. This gap can be bridged through self-learning using free digital resources such as PARC's Agri-Tech Portal, online training, and YouTube tutorials on urban gardening, composting, or hydroponics. Consistent experimentation builds confidence and competence.

Space constraints are also common, especially in urban households. However, innovative methods like container gardening, hydroponics, rooftop farming, vertical towers, and hanging planters allow maximum productivity in minimal space. Meanwhile, accessing markets can be challenging for beginners. Creating a social media presence on Facebook, Instagram, or WhatsApp Business provides a direct link to customers. Participating in weekend farmers' markets or building partnerships with shopkeepers and mini marts helps scale sales beyond the neighborhood.

Efficient resource management is also essential for sustainability. Students can adopt drip irrigation, moisture-retaining mulches, and drought-resistant crop varieties to reduce water use, especially in hot climates. By embracing these strategic solutions, young agripreneurs can overcome early barriers and turn small home-based projects into profitable and resilient agri-business ventures, ultimately contributing to food security and green entrepreneurship in Pakistan.

Conclusion

Pakistan's growing population and competitive job market demand new thinking from the next generation of agricultural graduates. Home-based agri-businesses offer a practical, affordable, and empowering pathway for youth to transition "from learning to earning." By applying their academic knowledge through small, scalable ventures, students can create sustainable livelihoods without waiting for traditional job openings. These micro-enterprises not only generate income but also strengthen urban food supply chains, reduce waste, and promote climate-smart agriculture aligning personal success with national development goals.

From organic vegetables and microgreens to compost units, nurseries, mushrooms, and value-added foods, the range of opportunities is vast and adaptable to small spaces and limited budgets. The key ingredients for success are mindset, consistency, innovation, and strategic use of digital tools for marketing and customer engagement. Challenges such as lack of capital, limited space, or technical skill can be overcome with gradual scaling, self-learning, and resource-efficient production methods.

Ultimately, agripreneurship transforms graduates from job seekers into job creators. By turning agricultural knowledge into action, students can build profitable brands, support their households, and contribute to food security and environmental sustainability. This home-based agribusiness movement has the potential to redefine Pakistan's agricultural future one rooftop, balcony, and backyard at a time.

References: Government of Pakistan; FAO; IFOAM; World Bank; PARC.

Please note that the views expressed in this article are of the author and do not necessarily reflect the views or policies of any organization.

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