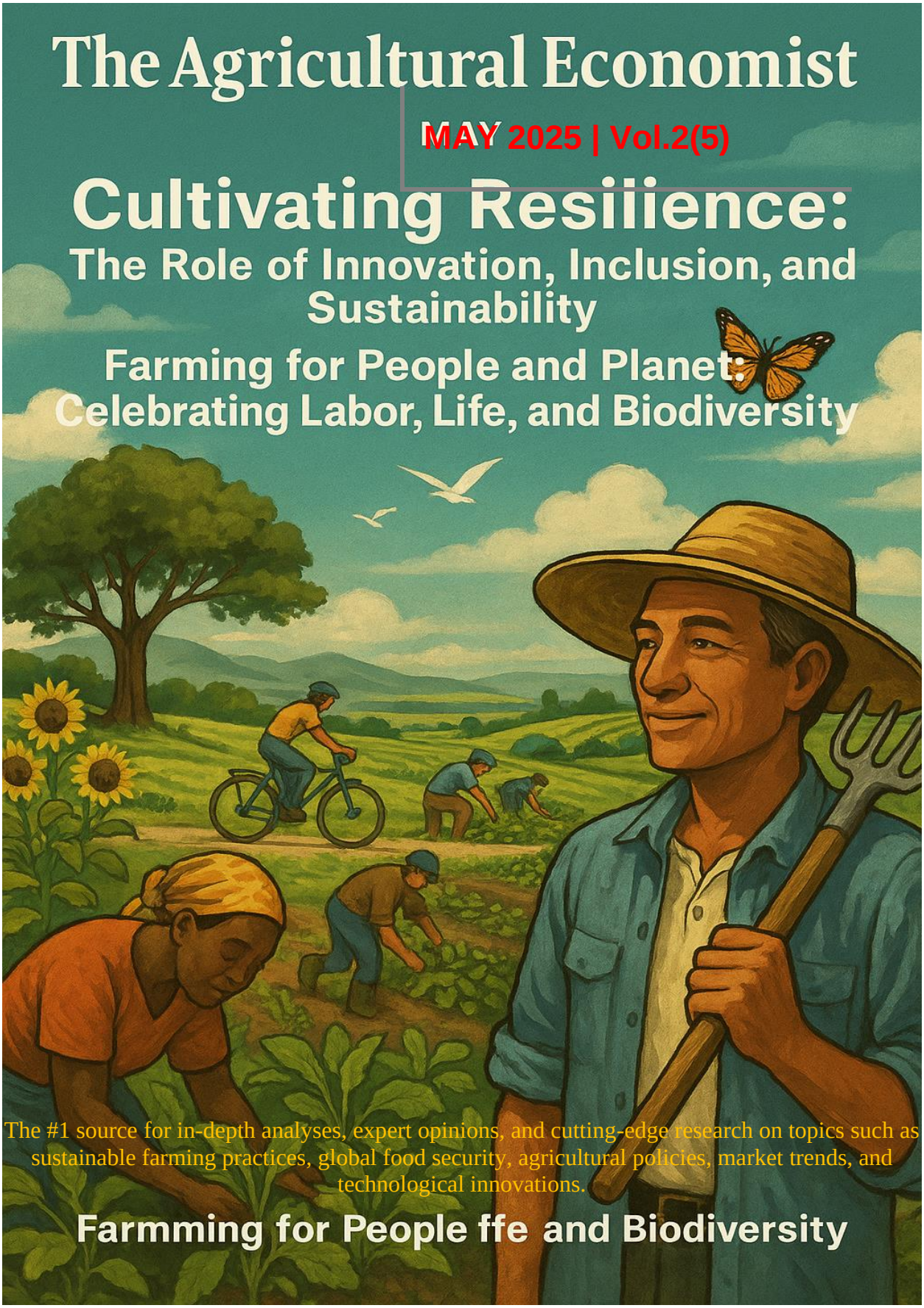
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Cultivating Resiiience:
The Role of Innovation, Inclusion, and Sustainability
Farming for People and Planet:
Celebrating Labor, Life, and Biodiversity
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Farmming for People ffe and Biodiversity

Table of Contents


Editorial

May Focus: Farming for People and Planet

Explore the importance of sustainable agriculture that nourishes and uplifts communities. Celebrate biodiversity and stand with farmers to protect rural communities and pollinators. Embrace cultural diversity as a strength for a resilient agriculture, farming for people and planet.

Muhammad Khalid Bashir

5/1/2025

May is a month of some very important global events that resonate deeply with the values and mission of The Agricultural Economist. From honoring the contributions of workers and nurses to celebrating the essential roles of families, bees, biodiversity, and cultural diversity, this month offers a unique opportunity to reflect on agriculture not just as an economic activity, but as a living system that sustains people and the planet.

At the heart of this edition is a recognition of agriculture as a multidimensional enterprise. Farming is not just about producing food; it is about nurturing ecosystems, supporting rural livelihoods, safeguarding biodiversity, and preserving cultural heritage. The theme, "Farming for People and Planet," encapsulates the need for inclusive, sustainable agricultural systems that empower communities, protect natural resources, and ensure that food security goes hand in hand with ecological and social wellbeing.

Celebrating Labor in Agriculture

On May 1, the world marks International Workers' Day, a celebration of labor and a reminder of the rights and dignity of all workers. In agriculture, labor remains a foundational pillar. Farmers, farmhands, harvesters, and agri-workers are the backbone of food systems, often working in difficult conditions with minimal recognition. As we celebrate labor this month, we must spotlight agricultural workers' contributions and advocate for policies that ensure fair wages, safe working conditions, social protection, and access to training.

Globally, and particularly in South Asia and sub-Saharan Africa, smallholder farmers constitute most agricultural producers. Yet, they face disproportionate challenges, from climate shocks to market exclusion. Supporting agricultural labor means empowering these smallholders with land rights, access to credit, cooperative structures, and knowledge sharing. Labor dignity also means recognizing the unpaid labor of rural women and ensuring their inclusion in all aspects of agricultural development.

Honoring Care Workers and Agricultural Health

May 12, International Nurses Day, and May 8, World Red Cross and Red Crescent Day, honor the healthcare workforce and humanitarian responders. Their relevance to agriculture might not be immediately obvious, yet the intersection between health and agriculture is undeniable. Agricultural communities often suffer from limited access to health services, and the well-being of farmers is critical to food security. The rise of zoonotic diseases, occupational hazards, pesticide-related illnesses, and mental health challenges in farming communities further underline the need for integrated health-agriculture policies.

Agri-health interventions, mobile health clinics in rural areas, and occupational health safety standards for pesticide use and equipment handling are essential. Furthermore, building resilience against disasters, whether floods, droughts, or pandemics, requires strong linkages between agricultural resilience and public health infrastructure.

Supporting Rural Families: The Core of Agricultural Sustainability

The International Day of Families on May 15 is a moment to acknowledge the vital role families play in agricultural continuity. Family farms represent over 80% of all farms globally and are central to food production, intergenerational knowledge transfer, and sustainable land management. However, rural families face growing pressures from urban migration, lack of educational opportunities, land fragmentation, and economic vulnerability.

Sustaining family farming requires integrated rural development policies: investment in education, healthcare, rural infrastructure, and digital connectivity. It also demands reforms that support land inheritance for women and youth, mechanisms to reduce generational poverty, and initiatives that recognize unpaid household labor. Families are not just units of production but guardians of tradition, caretakers of biodiversity, and the social fabric of rural life.

Bees and Pollinators: Tiny Workers, Massive Impact

World Bee Day, observed on May 20, draws attention to the indispensable role of pollinators in agriculture. Bees, butterflies, birds, and bats play a crucial role in pollinating crops and maintaining biodiversity. Over 75% of global food crops depend at least in part on pollination. Yet, pollinator populations are in decline due to pesticide use, habitat destruction, monocultures, climate change, and disease.

The decline of pollinators is not just an environmental issue, it is a food security crisis in the making. Agroecological practices such as planting pollinator-friendly crops, reducing pesticide use, maintaining natural habitats, and integrating hedgerows and flower strips can help restore pollinator populations. Protecting these tiny agricultural

laborers must be a priority for all farmers, policymakers, and consumers.

Biodiversity: The Backbone of Resilient Food Systems

May 22 is the International Day for Biological Diversity, a day that compels us to consider the ecological underpinnings of agriculture. Biodiversity in crops, livestock, soil organisms, and surrounding ecosystems is vital for climate resilience, pest management, nutritional diversity, and long-term productivity. Yet, agricultural biodiversity is under threat. Over 90% of crop varieties have been lost in the last century, and industrial monoculture has replaced diversified farming systems.

Reviving agrobiodiversity requires action on multiple fronts. Seed sovereignty for farmers, support for indigenous crops and livestock breeds, conservation of traditional farming knowledge, and incentives for crop diversification are all needed. Schools of agroecology, farmer seed networks, and biodiversity-friendly market certifications can play transformative roles.

Cultural Diversity in Agricultural Landscapes

On May 21, the World Day for Cultural Diversity reminds us that farming is not just about the environment or economics; it is also about culture. Agricultural practices are deeply embedded in local traditions, rituals, cuisines, and worldviews. From terraced rice fields in Asia to pastoralist herding in Africa, cultural diversity shapes land use, resource stewardship, and social organization.

Preserving cultural diversity in agriculture means supporting indigenous knowledge systems, celebrating food heritage, and protecting cultural landscapes. It also means ensuring the inclusion of marginalized ethnic groups in agricultural policies and extension services. Dialogue between diverse farming communities can foster mutual learning, conflict resolution, and social cohesion.

Toward a Just and Sustainable Agricultural Future

As we reflect on these observances, a common thread emerges: the need for an inclusive agricultural paradigm that recognizes human dignity, ecological integrity, and cultural richness. This calls for a rethinking of agricultural development, away from extractive models toward regenerative, participatory, and equitable systems.

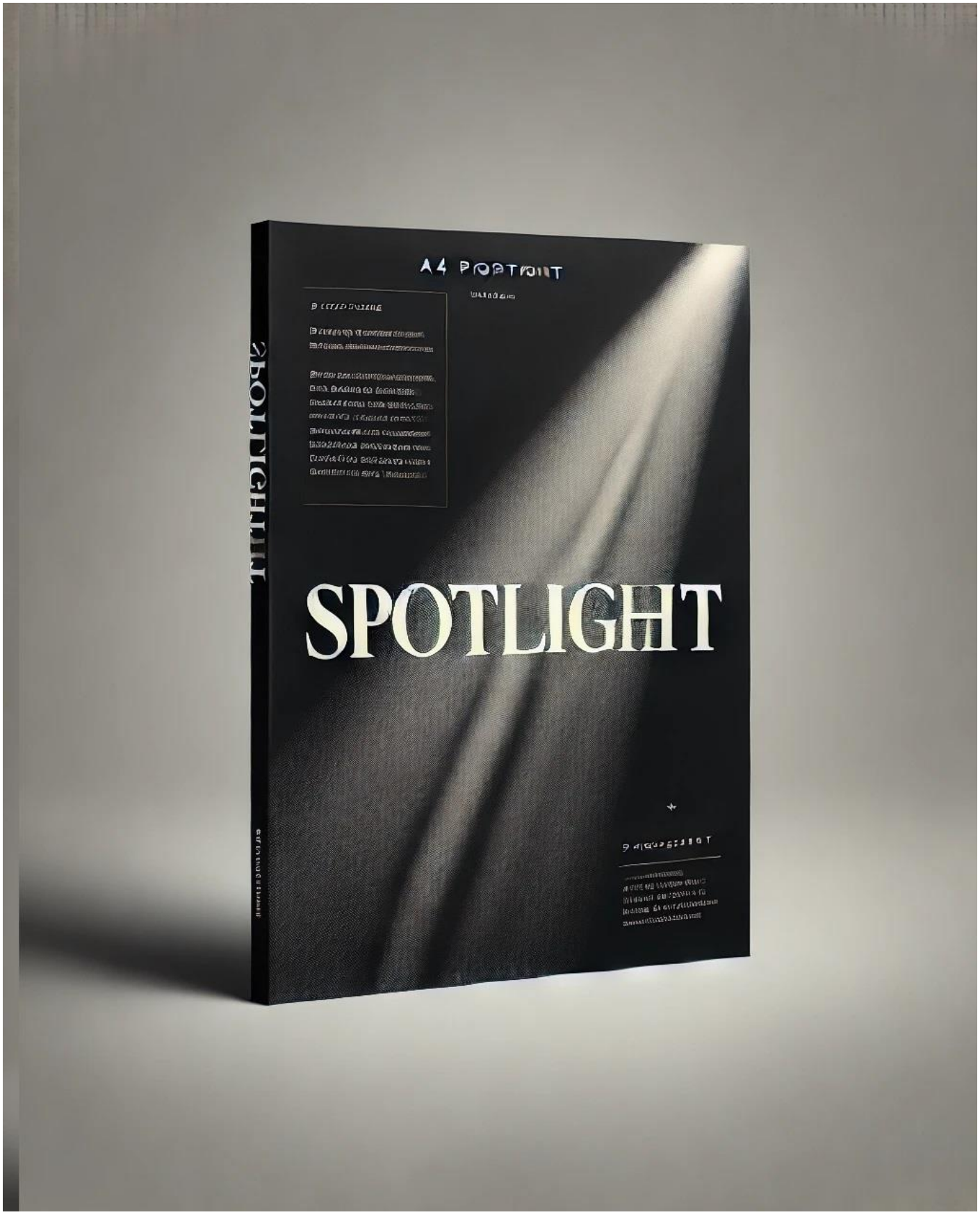
Policymakers must recognize that agricultural productivity and environmental sustainability are not mutually exclusive. Incentives for agroecology, carbon farming, mixed cropping, and ecosystem services can make conservation compatible with profitability. Researchers must prioritize participatory methods that incorporate farmer knowledge and local contexts. Extension workers must move beyond top-down training to co-learning and community empowerment.

Financial institutions should tailor credit and insurance products to the realities of smallholders, especially women and indigenous farmers. Social movements and NGOs must continue to amplify the voices of those most affected by agricultural and environmental policies. Consumers, too, have a role to play, by supporting local producers, reducing food waste, and demanding sustainable food systems.

Technology, if directed wisely, can support this vision. Digital agriculture, remote sensing, climate forecasting, and mobile-based advisory services can help farmers adapt to changing conditions. But technology must be accessible, gender-sensitive, and grounded in real-life user needs.

Together, let us cultivate a future where food is not just a commodity, but a common good; where farming is not just work, but stewardship; and where agriculture serves not just economies, but humanity and the Earth alike.

Warm regards,
Muhammad Khalid Bashir
Managing Editor
The Agricultural Economist


SPOTLIGHT

Sindh's Agricultural Crisis: A Growing Concern

Explore Sindh's agricultural crisis, where environmental degradation, policy inertia, and urbanization threaten food security and rural livelihoods. Understand the impact on crop yields, economic stability, and the urgent need for sustainable solutions.

Faiza Abbasi

5/9/2025

Sindh, long regarded as the breadbasket of Pakistan, is now confronting a deepening farmland crisis that threatens its agricultural legacy and economic stability. The province, responsible for 23% of the national agricultural GDP and home to over 60% of the country's rural population, is undergoing unprecedented land-use change. Urban sprawl, unchecked industrialization, and worsening climate conditions, particularly salinity, waterlogging, and desertification, are collectively eroding its agricultural base. According to recent satellite assessments by the Pakistan Space and Upper Atmosphere Research Commission (SUPARCO, 2024), over 15% of Sindh's cultivable land has been lost to urban and industrial expansion over the past two decades, with hotspots in Karachi, Hyderabad, and Sukkur districts showing the highest conversion rates.

The implications of this transformation are multifaceted. On the food security front, reduced arable land means lower production of staple crops like wheat, rice, and sugarcane, further exacerbating price volatility and food inflation. Economically, as farmland shrinks, thousands of rural laborers are displaced, contributing to rising unemployment and rural-to-urban migration. From 2010 to 2023, Sindh reported a 20% increase in rural outmigration due to declining agricultural viability (PBS, 2023). Environmentally, deforestation and loss of green cover are intensifying local temperature extremes and reducing biodiversity.

This crisis is rooted in both policy and planning failures. Historical neglect of land zoning regulations, the absence of urban growth boundaries, and limited investment in sustainable land management have allowed this conversion trend to accelerate. Yet, solutions are within reach. Integrated land-use planning, enforcement of agricultural land protection laws, promotion of vertical urban development, and investment in land rehabilitation, such as salt-tolerant crops and bio-drainage, could reverse some of these trends. Drawing from insights by FAO, IWMI, and PBS, this article explores both the historical roots and forward-looking policy actions required to safeguard Sindh's remaining agricultural landscape and ensure food and livelihood security for future generations.

Historical Legacy: Sindh's Agrarian Roots

Sindh's agrarian identity is deeply embedded in its history, stretching back over 5,000 years to the Indus Valley Civilization. Archaeological findings from Mohenjo-Daro and surrounding sites reveal evidence of advanced canal-based irrigation systems that sustained staple crops such as wheat, barley, and cotton, laying the foundations of one of the world's earliest organized agricultural economies (UNESCO, 2022). This legacy continued through successive civilizations and peaked during the British colonial era with the construction of the Sukkur Barrage in 1932. This massive infrastructure project transformed over five million acres of desert and semi-arid land into irrigated farmland, turning Sindh into a major producer of food and fiber for the subcontinent (PBS, 2021).

Following independence in 1947, Sindh retained its status as Pakistan's leading agricultural province well into the late 20th century. Between 1947 and 2000, it remained a top producer of wheat and cotton, contributing significantly to national food security and textile exports. However, the past two decades have marked a dramatic reversal. Driven by urban expansion, poor water governance, and systemic policy neglect, the province has seen a 30% reduction in cultivable land since 2000 (FAO, 2023).

Multiple forces are responsible for this erosion. Urban encroachment, particularly the rapid expansion of Karachi, has consumed over 150,000 acres of farmland. Similar patterns are seen in Hyderabad and Sukkur, where housing societies are proliferating on fertile lands (SUPARCO, 2024). Meanwhile, water scarcity, exacerbated by upstream diversions, has reduced the Indus River's flow by 27% since 1960, and 35% of Sindh's soils are now saline and unproductive (IWMI, 2023; PCRWR, 2024). Land fragmentation due to inheritance laws has halved average farm sizes, pushing many smallholders below the poverty line (PBS, 2023). The failure to enforce land protection policies, particularly the Sindh Land Use Act of 2013, has enabled illegal conversions and speculative real estate development, further accelerating agricultural decline.

Economic Fallout: From Breadbasket to Food Importer

Sindh's agricultural decline is no longer a distant concern, it is an economic crisis with national consequences. Once a vital breadbasket, the province has seen its agricultural GDP contribution plummet from 28% in 1990 to just 18% in 2024, reflecting a broader erosion of productivity and policy focus (PBS, 2024). Wheat production in Sindh has fallen sharply from 4.2 million metric tons in 1990 to 2.8 million in 2024, a staggering 33% drop. This contraction has contributed to Pakistan's growing

dependency on imported staples, with the country now spending over $3 billion annually on wheat imports to bridge domestic shortfalls (FAO, 2024). At the same time, the rural poverty rate has surged from 32% to 45% during the same period, underscoring the social costs of declining agricultural livelihoods (World Bank, 2024).

The textile sector, which depends on local cotton, has also suffered. With a 40% drop in cotton production since 2015, the industry faces rising input costs and shrinking global competitiveness (APTMA, 2024). If left unaddressed, Sindh's farmland crisis could further weaken national food security, rural employment, and export earnings.

Yet recovery is possible. Enforcing the Sindh Agricultural Land Protection Act through satellite monitoring and imposing taxes on farmland conversions could slow urban encroachment (ADB, 2023). Water use can be optimized through drip irrigation subsidies and the rehabilitation of over 1,000 silted canals, improving irrigation coverage (IWMI, 2024; SIDA, 2024). Promoting climate-smart agriculture, such as salt-tolerant wheat varieties and solar-powered cold storage, could enhance resilience and reduce post-harvest losses. Urban farming initiatives, including rooftop gardens in Karachi, could supply up to 20% of the city's vegetables, easing pressure on rural production (UNDP, 2024). Finally, interest-free loans and land consolidation programs can empower smallholders to scale up operations and reinvest in productivity. These combined efforts are vital to reversing Sindh's agricultural decline and restoring its role in national food security.

Conclusion

Sindh's agricultural crisis stands at the intersection of environmental degradation, policy inertia, and unchecked urbanization. Once revered as Pakistan's breadbasket, the province now teeters on the brink of food insecurity, rural disempowerment, and economic fragility. The loss of cultivable land, driven by rapid urban encroachment, water mismanagement, and climate-induced salinization, has not only slashed crop output and increased reliance on costly imports but also displaced countless rural livelihoods. From the collapse in wheat and cotton yields to the rising rural poverty rate, the economic and social fallout is undeniable.

However, this trajectory is not irreversible. With strategic reforms, ranging from strict enforcement of land use policies and investment in water-efficient technologies, to adoption of climate-smart farming and revitalization of urban agriculture, Sindh can reclaim its role as a food-secure and agriculturally vibrant province. Empowering smallholders through financial inclusion and consolidating fragmented plots will further unlock latent productivity. Ultimately, saving Sindh's farmland is not just about preserving its agrarian heritage, it is about securing the future of Pakistan's food system, climate resilience, and rural economy. Time is running out, but with coordinated action and political will, a turnaround is within reach.

References: World Bank; SUPARCO; IWMI; FAO; ADB; PCRWR; APTMA; SIDA; UNDP

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 Agricultural Crisis: Water Insecurity & Tensions

Pakistan's agrarian future is at risk due to water insecurity and regional tensions. The suspension of the Indus Waters Treaty and military strikes are disrupting irrigation and threatening food security, risking millions with rising inflation and displacement.

Aisha Ghouri

5/12/2025

The suspension of the 1960 Indus Waters Treaty (IWT) and India's unprecedented missile strikes on Pakistani territory in May 2025 have sent shockwaves through the core of Pakistan's agrarian economy. Punjab and Sindh, the country's breadbasket regions, rely heavily on the Indus River System for irrigation, accounting for over 80% of Pakistan's food production. The sudden halt of upstream water flows from India has already triggered a 40% drop in river discharge into Pakistan, according to remote sensing data from SUPARCO and NASA (2025). Coupled with damage to irrigation infrastructure from military strikes in Bahawalpur and Jacobabad, the situation poses an acute risk to national food security.

Agriculture, which employs 38.5% of Pakistan's labor force and contributes 23.7% to GDP (Pakistan Economic Survey, 2025), cannot absorb such simultaneous shocks without severe consequences. Initial projections by the Planning Commission estimate that wheat and cotton output may fall by 30% and 45%, respectively, in the upcoming Kharif season. This could escalate inflation, increase rural unemployment, and force an additional 12 million people below the poverty line.

The weaponization of water, a clear violation of international norms, underscores Pakistan's strategic vulnerability and lack of water resilience. Without emergency mitigation measures such as aggressive groundwater mobilization, canal desilting, and high-efficiency irrigation (e.g., drip systems), large-scale crop failures are imminent. Moreover, the crisis amplifies the need for diplomatic recalibration, regional water treaties enforcement, and investment in hydrological independence through dam expansions and transboundary water monitoring. As the specter of water wars grows more real, Pakistan must act swiftly to defend both its sovereignty and food security.

The Indus Waters Treaty: A Lifeline Under Siege

The Indus Waters Treaty (IWT), signed in 1960 with World Bank mediation, has long been a cornerstone of water diplomacy in South Asia. It granted Pakistan rights to 80% of the Indus Basin's total flow via the western rivers, Indus, Jhelum, and Chenab, while India retained control over the eastern rivers, Ravi, Beas, and Sutlej. Despite enduring the turbulence of three Indo-Pakistani wars and ongoing diplomatic hostilities, the treaty has remained largely intact for over six decades. However, India's unilateral suspension of the IWT on April 24, 2025, following the Pahalgam tourist attack and accusations against Pakistan, marks a dangerous precedent. This move immediately terminated real-time hydrological data sharing, undermining Pakistan's ability to manage irrigation cycles, prepare for flood events, and maintain reservoir efficiency.

The fallout has already hit the grassroots. Ali Haider Dogar, a wheat farmer in Bhakkar District, previously lost PKR 1.2 million due to a surprise water surge from India's Sutlej River in 2023. Now, with the suspension in place, he fears India could weaponize sediment flushing from upstream dams, disrupting irrigation infrastructure during critical sowing windows. "Without flood warnings, we're blind," he told *The Guardian* in May 2025.

Experts echo these concerns. Dr. Usman Mustafa of IFPRI cautions that new Indian hydropower projects, such as the Ratle Dam on the Chenab River, could decrease Pakistan's water availability by 15–20% during dry periods. Himanshu Thakkar, coordinator of the South Asia Network on Dams, Rivers and People (SANDRP), adds: "India's refusal to share upstream discharge data is a silent weapon, Pakistan's canal scheduling and flood risk management rely on this predictability" (*Al Jazeera*, 2025). In the absence of real-time data, Pakistan's food systems face a mounting threat, one not from drought alone, but from engineered uncertainty.

Military Escalation and Agricultural Disruption

The geopolitical crisis intensified in early May 2025 with India's aggression (May 6–10), aimed at dismantling suspected militant infrastructure in Pakistan-administered Kashmir. However, the campaign's spillover effects on civilian infrastructure have had devastating consequences for agriculture. Cross-border shelling and aerial strikes damaged irrigation canals, flattened fields, and displaced thousands. According to the UNHCR, over 25,000 farming families have been forced to abandon their homes, while Dawn (May 2025) reported that 40% of Kotli District's apple orchards, valued at $50 million, were destroyed. The resulting instability disrupted wheat supply chains across Punjab and northern Sindh, placing the national food system under immense strain. The FAO estimates a shortfall of 1.5 million metric tons in wheat, compounding food inflation and worsening food insecurity across Pakistan.

The fallout spans key crops. Wheat, Pakistan's staple, is projected to see a 20% yield decline due to erratic canal flows, translating to a PKR 300 billion economic loss. Rice, one of Pakistan's top exports, is under threat due to water unpredictability, placing $2.2 billion in

annual exports at risk and already contributing to a 30% surge in global rice prices. Sugarcane farmers, heavily reliant on groundwater, face a 15% production drop as 60% of Sindh and Punjab's aquifers are now overexploited.

Globally, the ramifications are sobering. India and Pakistan jointly account for 36% of the world's rice exports (UN Comtrade, 2024). A prolonged conflict could destabilize food security in major importers like Malaysia, Indonesia, and Singapore. Simultaneously, China's dam construction along the Tibetan Plateau, the Indus River's source, has sparked fears of a regional precedent for water weaponization. Khalid Khokhar, head of Pakistan Kissan Ittehad, starkly noted: "If India stops water, it's war. Our farmers cannot survive without canal systems" (Reuters, May 2025). The weaponization of water risks turning agrarian vulnerability into geopolitical catastrophe.

Pathways to Mitigation

In the face of escalating water insecurity and geopolitical tensions, Pakistan must urgently pursue a multi-track strategy to safeguard its agricultural future. First, international arbitration remains a critical tool. Article IX of the Indus Waters Treaty (IWT) provides for a neutral dispute resolution mechanism through the World Bank. Pakistan must invoke this clause to demand third-party mediation and restoration of real-time hydrological data sharing. The European Union and the United States, both with vested interests in regional stability and food security, must pressure India diplomatically to de-escalate and uphold treaty obligations.

Second, Pakistan's chronic lack of water storage infrastructure has left it dangerously exposed. The country currently stores less than 10% of its annual Indus River flows, compared to the global average of 40%. Investing in small-scale, climate-resilient water infrastructure such as farm ponds, community reservoirs, and solar-powered drip irrigation systems can dramatically reduce wastage and buffer against supply shocks. These decentralized systems are particularly critical for tail-end farmers in Sindh and southern Punjab who are often the first to suffer from upstream disruptions.

Third, Pakistan must reimagine its crop portfolio. With rice and sugarcane consuming over 60% of irrigation water, a gradual transition to less water-intensive crops is essential. Millets, sorghum, and pulses, already adapted to arid conditions, can reduce agricultural water use by 25%, according to ICARDA (2024). These crops not only require less water but also improve soil health and offer nutritional benefits, aligning with both sustainability and food security goals.

Together, these mitigation pathways, leveraging diplomatic pressure, expanding climate-resilient infrastructure, and shifting to smarter crop choices, can help Pakistan counter the dual threats of water weaponization and climate volatility. Long-term resilience will require coordinated action across foreign policy, agriculture, and water governance to secure the future of the country's 38 million-strong rural farming population.

Conclusion

Pakistan's agrarian future hangs in the balance as water insecurity and regional tensions converge into a perfect storm. The suspension of the Indus Waters Treaty and military strikes on civilian farming zones have not only disrupted irrigation and destroyed crops but also exposed the fragility of Pakistan's food system. With agricultural production expected to plummet, inflation to rise, and millions at risk of poverty and displacement, this crisis is no longer hypothetical, it is unfolding in real time. The weaponization of water, once considered an abstract threat, is now a lived reality for millions of farmers in Punjab and Sindh.

However, Pakistan still has agency. Through strategic diplomacy, climate-resilient investments, and crop diversification, it can begin to insulate its agricultural backbone from external shocks. International arbitration under Article IX of the IWT must be pursued immediately, while urgent funding is needed for local water storage, irrigation efficiency, and alternative cropping systems. This is not merely about preserving crop yields, it is about safeguarding national sovereignty, food security, and the livelihoods of nearly 40% of the labor force. The time for action is now. Failure to adapt swiftly could turn this water crisis into a prolonged national catastrophe.

References: World Bank; FAO; Reuters; Al Jazeera; Stimson Center; Pakistan Economic Survey; *Guardian;* UN Comtrade; ICARDA

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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War Damage to Agriculture and Food Security

War inflicts extensive damage on agricultural systems, undermining food security and leading to humanitarian crises. From destroyed fields to displaced farmers, conflict disrupts food production and exacerbates hunger, poverty, and instability, delaying recovery and weakening rural resilience.

Safia Rind

5/20/2025

Agriculture serves as the backbone of many economies, particularly in developing nations where over 60% of the population depends on farming for their livelihoods (World Bank, 2023). In rural communities, agriculture is not merely an economic activity, it is a lifeline. It sustains household incomes, ensures food security, supports local markets, and preserves cultural traditions passed down through generations. Fields, livestock, and harvests are central not only to nutrition and survival but to the social fabric of entire communities. However, when conflict or war erupts, agricultural systems are among the first and most deeply affected sectors, often suffering immediate devastation and long-term collapse.

Armed conflict disrupts every stage of food production. Crops go unplanted or unharvested due to displacement and insecurity. Supply chains break down, leaving markets empty and prices unstable. Farm infrastructures such as irrigation systems, storage facilities, and roads are frequently damaged or destroyed. Farmers lose access to seeds, fertilizers, and fuel, while the risk of land mines or contamination makes working the land dangerous or impossible. In many conflict zones, livestock are looted, fields are scorched, and water sources are polluted, compounding food shortages and rural poverty.

The impacts are not only physical but psychological and economic. Generations of agricultural knowledge can be lost when families flee. Rural youth are often forced to abandon farming for survival work in urban areas or refugee camps, leading to a breakdown in the continuity of rural life. Recovery is slow and fragile, often requiring not just reconstruction but reconciliation and rebuilding trust within fractured communities. Protecting agriculture in times of conflict is therefore not just about food, it's about safeguarding livelihoods, restoring dignity, and planting the seeds of peace in the most disrupted regions of the world.

The Immediate Toll: How Conflict Ravages Agriculture

Conflict takes a devastating toll on agriculture, disrupting every stage of the food production system from planting and harvesting to storage, transport, and distribution. In regions like Ukraine, a key global breadbasket, an estimated 30% of agricultural land has been rendered inaccessible or contaminated by military activity (FAO, 2023). Similarly, in Sudan, escalating violence has forced 40% of farmers to abandon their fields (UN OCHA, 2024), leading to a dramatic drop in food production and rural income.

One of the most immediate impacts of war is the widespread destruction of agricultural infrastructure. Farmlands often become battlefields, riddled with bomb craters, landmines, and heavy machinery that degrade as much as 25% of arable land in conflict zones (ICRC, 2023). In Yemen, the collapse of irrigation systems 70% of which have been damaged that crippled the country's ability to grow food (World Food Program, 2024). In Syria, the destruction of 50% of grain silos has led to post-harvest losses reaching 40% (FAO, 2023), while energy shortages leave farms unable to operate essential machinery.

Conflict also triggers mass displacement, leading to labor shortages in rural areas. With over 100 million people forcibly displaced worldwide (UNHCR, 2023), farming communities lose not only their workforce but also generations of agroecological knowledge. In Myanmar, 60% of farming households report severe labor shortages due to conflict-driven migration (IFPRI, 2024).

Environmental degradation adds another layer of crisis. In Iraq, oil spills and chemical warfare have left 20% of farmland unusable (UNEP, 2023). In Colombia, armed groups have cleared forests to grow illicit crops, accelerating soil erosion and desertification (Global Witness, 2024). Conflict zones also experience dramatic biodiversity loss, pollinators and native species vanish, cutting yields by up to 30% (IPBES, 2023). War, in short, unravels the very foundations of food security.

The Ripple Effects: Hunger, Poverty, and Instability

When agriculture collapses under the weight of conflict, the effects extend far beyond the farm. Food prices in conflict zones surge by an average of 50%, severely reducing access to basic staples and driving millions into food insecurity (World Bank, 2024). In 2024 alone, an estimated 44 million people faced acute hunger due to the combined impacts of violence and disrupted food systems (Global Report on Food Crises, 2024). In South Sudan, for example, local food production has nearly ceased, forcing the country to import 90% of its food, making it highly vulnerable to global price shocks and supply chain disruptions (WFP, 2023). Meanwhile, 75% of Syrian farmers report falling into debt after losing their crops, livestock, and access to markets, creating cycles of poverty that persist long after the fighting stops (FAO, 2024). Countries like Ethiopia, Somalia, and Afghanistan are now facing emergency hunger levels, with famine risks compounded by climate extremes and prolonged instability (IPC, 2024).

Recovery, where it begins at all, is painfully slow. In countries like

Cambodia and Laos, 40% of agricultural land remains unusable decades after conflict due to landmines and unexploded ordnance (MAG, 2023). Even when peace returns, farmers often lack the seeds, tools, and financial capital needed to restart production. In Mozambique, only 10% of farmers had regained pre-war productivity after five years of recovery (IFAD, 2023). Legal barriers and unresolved land disputes further hinder recovery, 30% of displaced Colombian farmers have been unable to reclaim their land (Human Rights Watch, 2024). Climate change adds another layer of difficulty: droughts, floods, and erratic weather reduce yields by an additional 20% in fragile states, making recovery even more precarious (IPCC, 2024). The road from war to food security is long, uncertain, and urgently in need of coordinated global support.

Pathways to Rehabilitation

Rebuilding agriculture in conflict-affected regions requires more than short-term humanitarian aid. While emergency food relief is essential in times of crisis, sustainable recovery depends on long-term investment in agroecology, rural infrastructure, and farmer capacity-building. Humanitarian responses often lack the scope to address systemic damage caused by war, such as degraded land, destroyed irrigation systems, and shattered market networks. According to the World Bank (2024), without strategic investments, farming communities risk remaining locked in cycles of dependency and underdevelopment.

In Ukraine, where vast tracts of farmland were rendered unusable by mines and shelling, the "Grain from Ruins" initiative offers a promising example of coordinated recovery. With support from the European Union, the program has successfully determined and rehabilitated 15% of damaged agricultural land, enabling farmers to resume production in previously inaccessible areas (EU Commission, 2024). Such initiatives not only restore food systems but also create jobs and strengthen national economies recovering from war.

Technology also plays a pivotal role in post-conflict agricultural recovery. In Iraq and Syria, digital tools like satellite mapping and drone imaging are being used to assess damage, identify safe zones, and prioritize land for rehabilitation (UNDP, 2023). These tools help guide efficient resource allocation and reduce the risks associated with working in post-war environments.

Moreover, investing in farmer training and climate-resilient practices ensures that recovery efforts are both effective and sustainable. Programs focused on agroecology, water conservation, and local seed systems empower communities to rebuild in ways that are environmentally sound and economically viable. Rehabilitation must be holistic, linking physical reconstruction with social, environmental, and economic renewal. Only then can war-torn agricultural systems transform from zones of crisis into pillars of resilience and peace.

Conclusion

War inflicts far-reaching damage on agricultural systems, eroding not only physical infrastructure but also the social, economic, and environmental foundations of food security. From scorched fields and contaminated water sources to displaced farmers and decimated rural livelihoods, conflict disrupts every aspect of food production. As agricultural systems collapse, hunger, poverty, and instability intensify, fueling humanitarian crises and perpetuating cycles of underdevelopment. The psychological toll and loss of generational farming knowledge further delay recovery, weakening rural resilience long after hostilities end.

Recovery is possible but complex. It requires more than emergency aid; it demands sustained investment in rebuilding agricultural infrastructure, restoring land, and empowering communities through education, technology, and inclusive policies. Success stories like Ukraine's "Grain from Ruins" initiative show that with coordinated support, even severely damaged farming systems can recover. Tools like satellite mapping, drone technology, and climate-resilient farming practices can guide efficient and safe rehabilitation efforts.

Ultimately, protecting agriculture during conflict and prioritizing its restoration in peacebuilding agendas is critical. Reviving agriculture is not just about feeding people, it is about restoring dignity, economic stability, and hope. In a world increasingly shaped by conflict and climate change, resilient agricultural systems are essential pillars for lasting peace and sustainable development.

References: FAO; World Bank; UN OCHA; ICRC; Global Report on Food Crises; UNDP; UNHCR; IFPRI; UNEP; Global Witness; IPBES; WFP; MAG; IPC; Human Rights Watch; IFAD; EU Commission

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POLICY BRIEFS
THE AGRICULTURAL ECONOMIST
AGRICULTURAL ECONOMIST

Agricultural Production Transformation in Türkiye's Central Anatolia

Explore the transformation of agricultural production in Türkiye's Central Anatolian closed basin, highlighting the shift from traditional practices to corn-cattle farming. Understand the ecological collapse in Konya.

Mithat Direk

5/2/2025

Türkiye's agricultural sector remains a cornerstone of its economy, contributing 6.5% to national GDP and employing 18.4% of the workforce, according to the Turkish Statistical Institute (TÜİK, 2023). Within this landscape, the Central Anatolian Closed Basin, especially Konya Province, plays a pivotal role as the country's breadbasket. Traditionally dominated by dryland wheat and sheep farming, this region has experienced a substantial transformation in recent decades. Driven by state subsidies, market incentives, and a push for higher yields, many farmers have shifted toward water-intensive corn cultivation paired with large-scale cattle farming.

While this transition has increased short-term productivity and income for some producers, it has also introduced a host of environmental and economic challenges, particularly considering Türkiye's growing vulnerability to climate change. The shift from drought-resilient wheat to irrigation-dependent corn has placed immense pressure on the region's fragile water resources. The Central Anatolian Closed Basin, which lacks natural outflows, is highly sensitive to over-extraction. Intensive groundwater pumping for irrigation has led to a dramatic drop in water tables and the appearance of sinkholes, particularly in Konya. Studies by WWF-Türkiye (2023) warn that current extraction rates are unsustainable and could lead to irreversible damage to aquifers, endangering the region's long-term agricultural viability. In addition, cattle farming generates more greenhouse gas emissions and accelerates land degradation, further undermining climate resilience.

Economically, the corn-cattle system has increased input dependency on imported feed, fertilizers, and machinery, which exposes farmers to global price shocks and erodes local self-sufficiency. Moreover, the focus on high-yield monocultures reduces biodiversity and increases susceptibility to pests and diseases. Addressing these issues requires a reorientation of agricultural policy towards climate-smart farming, improved water governance, and support for sustainable crop-livestock integration. Promoting rotational grazing, dryland wheat varieties, and drip irrigation could help restore ecological balance while sustaining livelihoods in the region.

The Changing Agricultural Landscape in Central Anatolia

The agricultural landscape of Central Anatolia, particularly in Konya Province, has undergone a significant transformation over the past four decades. Historically known as Türkiye's breadbasket, the region was dominated by rain-fed wheat cultivation and extensive sheep farming throughout the pre-1980s period. These traditional systems were well-adapted to the region's semi-arid climate and relied on natural rainfall and low-input practices that preserved ecological balance. However, major shifts in agricultural policy during the 1980s and beyond catalyzed a profound change in land use and resource consumption. To modernize agriculture and boost productivity, government policies began incentivizing irrigated crops, particularly corn, and expanding support for dairy and cattle farming. As a result, groundwater extraction in the Central Anatolian Closed Basin increased by 70%, creating mounting pressure on already fragile water systems (DSI, 2023).

Today, Konya's water table is reportedly dropping by approximately 2.5 meters annually, a trend that threatens the long-term sustainability of the region's agricultural sector (TÜBİTAK, 2023). Several interrelated factors have driven this transition. Globalization has played a major role, as Türkiye increasingly supplies corn-based animal feed and dairy products to European and Middle Eastern markets, making these commodities economically attractive for producers (ITC, 2023). Simultaneously, government subsidies and irrigation development programs have favored water-intensive crops, inadvertently accelerating aquifer depletion and environmental degradation (World Bank, 2023).

Climate change has further compounded these challenges. Annual rainfall in Konya has declined by 15% since 2000, reducing the reliability of rain-fed systems and making wheat farming more vulnerable to seasonal droughts and crop failures (MGM, 2023). As a result, farmers are increasingly opting for crops and systems perceived as more profitable or secure, despite their unsustainable water demands. This transformation underscores the urgent need for a policy realignment toward climate-resilient and water-efficient agricultural practices.

Ecological & Economic Consequences

The rapid agricultural transition in Central Anatolia, particularly in Konya Province, has triggered serious ecological and economic consequences, threatening the region's long-term sustainability. Over-irrigation and unsustainable farming practices have led to widespread soil degradation. According to the Food and Agriculture Organization (FAO, 2023), salinization now affects approximately 28% of Konya's arable land, rendering it less productive and more vulnerable to

erosion. Simultaneously, intensive groundwater extraction to support water-intensive crops like corn have dramatically depleted aquifers. In 1990, most wells in Konya reached depths of 50 meters; today, over 90% are deeper than 150 meters, reflecting a drastic drop in water tables (DSI, 2023). The situation has also affected key natural ecosystems, Lake Tuz, one of Türkiye's largest saline lakes and a biodiversity hotspot, has lost 60% of its volume since 2000 due to shrinking inflows and agricultural withdrawals (WWF-Türkiye, 2023).

Economically, these environmental shifts have created vulnerabilities. Türkiye's heavy reliance on livestock and corn-based feed has led to increased dependence on imports. As of 2023, 60% of corn used in livestock feed is imported, escalating production costs and undermining national food security (TOBB, 2023). Meanwhile, wheat, a strategic crop for national self-sufficiency, has suffered due to declining cultivation and shifting policy priorities. Wheat imports rose from 3.8 million tons in 2010 to 5.2 million tons in 2023 (USDA, 2023), indicating an erosion of food sovereignty.

A case study from the Konya Agricultural Master Plan (2023) highlights these structural challenges. While Konya accounts for 63.8% of Türkiye's cultivated area, only 17% of its farmland is irrigated, and just 20.7% of that is effectively watered due to infrastructure limitations. Over 82% of the land is under continuous cultivation, often through monocropping systems that deplete soil nutrients. Simultaneously, pastures and forests, essential for ecosystem balance, are in decline. Together, these trends expose the fragility of the current agricultural model and the urgent need for reform.

Policy Failures & Unsustainable Practices

Türkiye's agricultural challenges in regions like Central Anatolia are rooted not only in environmental pressures but also in critical policy failures and unsustainable practices. Government subsidies have disproportionately favored water-intensive crops such as corn and sugar beet, with ₺4.5 billion allocated annually (Ministry of Treasury, 2023). In contrast, wheat, traditionally a drought-resilient staple, is supported with only ₺1.2 billion, despite being more suitable for the arid climate of provinces like Konya (TZOB, 2023). These subsidy imbalances have incentivized a shift away from climate-resilient crops, accelerating groundwater depletion and soil degradation.

Moreover, agricultural policymaking remains overly centralized, neglecting Türkiye's diverse climatic zones. For instance, Konya receives just 300 mm of annual rainfall compared to over 1,200 mm in the Black Sea region (MGM, 2023). Yet, nationwide subsidies are applied uniformly, failing to account for local resource constraints and crop suitability. This one-size-fits-all approach promotes inefficiencies and undermines regional sustainability.

Groundwater overuse further exacerbates the crisis. Nearly 40% of Konya's water is extracted illegally through unauthorized wells, with weak enforcement and minimal penalties allowing this trend to persist unchecked (DSI, 2023).

Addressing these issues requires a comprehensive policy overhaul. Shifting back to drought-resilient crops like wheat and barley through targeted subsidies and agroecological methods, such as crop rotation and conservation tillage, can help restore soil health. Expanding drip irrigation, currently used by only 8% of farmers (TÜİK, 2023), should be prioritized with tax incentives and technical support to reach 30% adoption by 2030. Additionally, traditional rainwater harvesting systems like *karez* should be rehabilitated to replenish groundwater reserves.

Policies must be decentralized and tailored to basin-level conditions. For instance, arid zones like Konya should receive support for dryland farming and sheep pastoralism, while wetter regions can focus on crops like tea, hazelnuts, and corn. Farmer education, including mobile advisory services and women-led cooperatives, can drive the adoption of climate-smart practices. Lastly, institutional reforms are vital, banning new wells in critical zones and introducing water pricing mechanisms will promote sustainable water use and ensure long-term agricultural viability.

Conclusion

The transformation of agricultural production in Türkiye's Central Anatolian Closed Basin represents both a cautionary tale and a call to action. While the shift from traditional wheat-sheep systems to corn-cattle farming brought short-term economic gains, it has imposed heavy ecological costs and heightened long-term vulnerabilities. Groundwater levels are plunging, salinization is spreading, and biodiversity is eroding, threatening not only the environmental stability of the region but also its capacity to sustain livelihoods. Konya, once hailed as Türkiye's breadbasket, now teeters on the edge of ecological collapse due to policy decisions that favored high-yield but water-intensive crops in one of the most arid parts of the country.

This crisis reveals the urgent need for policy realignment rooted in climate resilience, regional differentiation, and ecological stewardship. Uniform subsidy models that ignore local rainfall patterns and resource limits are no longer tenable. Sustainable alternatives, such as incentivizing drought-resistant wheat and barley, expanding water-efficient irrigation, reviving traditional groundwater recharge systems, and integrating rotational livestock systems, must be prioritized.

Empowering farmers with localized knowledge, affordable technology, and market incentives for climate-smart practices will be crucial. With decisive action and regionally tailored solutions, Türkiye can reclaim its agricultural sustainability and secure the future of food production in its heartland, before the costs become truly irreversible.

References: DSI: FAO; TÜİK; WWF-Türkiye; World Bank; TÜBİTAK; ITC; MGM; TOBB; USDA; Konya Agricultural Master Plan; Ministry of Treasury; TZOB

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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Circular Economy in Pakistan: A Path to Sustainability

Discover how Pakistan can transform its economy by embracing the circular economy principles. By adopting the 3Rs (reduce, reuse, and recycle) Pakistan can address waste management challenges and promote sustainable development, enhancing efficiency and improving working conditions.

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The circular economy (CE) is a transformative approach that emphasizes the efficient and regenerative use of natural resources by reducing the reliance on virgin materials, minimizing waste generation, and extending the life cycle of products and materials. It shifts the focus from the conventional linear model of "take, make, dispose" to a more sustainable and cyclical system where products are designed for durability, reuse, remanufacturing, and recycling. This model not only reduces the environmental burden associated with resource extraction and waste disposal but also contributes to economic resilience and innovation (Ellen MacArthur Foundation, 2023).

In the context of escalating environmental challenges such as climate change, biodiversity loss, and resource depletion, the transition toward a circular economy is increasingly recognized as essential for achieving sustainable development. For developing countries like Pakistan, where rapid urbanization, industrial expansion, and population growth are putting immense pressure on natural ecosystems, adopting circular economy principles is both an opportunity and a necessity.

Pakistan generates approximately 49.6 million tons of solid waste annually, yet only 50-60% of this waste is collected, and less than 10% is recycled (Pakistan Environmental Protection Agency, 2022). This alarming gap not only contributes to environmental degradation, such as land and water pollution, but also represents a significant loss of valuable materials and economic potential. Implementing the core strategies of the 3Rs—Reduce, Reuse, and Recycle—can help address these challenges by minimizing waste at the source, promoting material recovery, and creating green jobs and circular business opportunities.

A national commitment to circular economy practices can enhance resource efficiency, reduce carbon emissions, and stimulate innovation in sectors ranging from agriculture to manufacturing. As such, fostering a culture of circularity is critical for Pakistan's long-term sustainability and economic competitiveness in the global green transition.

The 3Rs Framework and Its Socioeconomic Impact

The 3Rs framework, Reduce, Reuse, and Recycle, offers a practical and impactful pathway for managing waste while fostering socioeconomic development in Pakistan. Reducing waste generation at its source is the most effective strategy, targeting both consumer habits and production processes. For instance, minimizing the use of single-use plastics, which constitute 15-20% of urban waste in Pakistan, can significantly curb environmental pollution (UNDP Pakistan, 2023). Promoting the consumption of durable, energy-efficient products, such as household appliances that reduce energy use by up to 30%, not only conserves resources but also lowers utility costs for consumers (National Energy Efficiency & Conservation Authority, 2022). Encouraging repair culture, particularly in sectors like electronics and textiles, further extends product life and reduces demand for new materials. Industrial efficiency is also crucial, as seen in the Green Industrial Policy (2021), which targets a 30% reduction in industrial emissions by 2030 (Ministry of Climate Change, 2021).

Reuse practices are already embedded within Pakistan's informal economy, with second-hand markets serving 40–50% of urban households (World Bank, 2023). Everyday examples include refillable glass bottles in beverage industries, refurbished electronics sold in markets like Karachi's Sadar and upcycled garments that sustain over one million informal workers (Pakistan Textile Council, 2022). These reuse activities not only reduce waste but also support livelihoods and foster entrepreneurial opportunities in low-income communities.

Recycling plays an equally important role in transforming waste into valuable resources. Pakistan's recycling efforts are mostly informal but expanding steadily. Plastic recycling recovers 14-18% of PET bottles, paper and cardboard recycling meets 35% of local demand, and while e-waste recycling remains underdeveloped, processing only 5% of the 435,000 tons generated annually, it presents a significant area for growth and formal sector engagement (Sustainable Development Policy Institute, 2023).

Economic Impact of 3Rs in Pakistan vs. Other Countries

The economic impact of the 3Rs, Reduce, Reuse, Recycle, varies considerably across countries based on infrastructure, policy enforcement, and the role of the informal sector. In Pakistan, over 70% of recycling activities are driven by the informal sector, where more than 1.5 million individuals earn a livelihood through waste picking and resale, often under unsafe and exploitative conditions. In contrast, developed countries such as Germany and Japan rely heavily on advanced, formal recycling systems that achieve over 90% recycling rates through regulated, technology-driven frameworks. These systems contribute 2–3% to GDP and generate high-skilled

green jobs. Meanwhile, in developing countries like India and Bangladesh, recycling is similarly dominated by informal workers, though recent policies, like India's Plastic Waste Management Rules (2022), are shifting towards formalization and improved recycling rates.

In Pakistan, the formal waste management infrastructure remains underdeveloped, with less than 10% of solid waste recycled formally. The draft National Waste Management Policy (2023) signals a move toward formalization, yet enforcement and funding remain weak. Current annual investment in waste management is just $50 million, far below the $500 million needed to modernize the sector (Asian Development Bank, 2022). Public participation is also limited, with only 25% of households practicing waste segregation at source (Gallup Pakistan, 2023). The quality of recycled material suffers due to manual sorting and inconsistent processing, unlike standardized systems in developed economies. However, opportunities exist integrating informal workers into formal frameworks can improve efficiency, boost job quality, and enhance material recovery. Technological upgrades, such as mechanized sorting and AI-based systems used internationally, could also improve outcomes. For Pakistan, the 3Rs represent not only an environmental necessity but a socio-economic opportunity to build a circular economy that is inclusive, sustainable, and economically transformative.

Conclusion

Pakistan stands at a pivotal juncture where embracing the principles of the circular economy is not just an environmental imperative but a strategic pathway toward sustainable development and economic transformation. The current linear model of resource extraction, consumption, and disposal is no longer viable in the face of escalating waste generation, resource scarcity, and environmental degradation. By adopting the 3Rs framework, Reduce, Reuse, and Recycle, Pakistan can shift toward a more regenerative, inclusive, and resilient economic model. While informal systems currently dominate waste management, formalizing and integrating these efforts presents an opportunity to enhance efficiency, improve working conditions, and elevate the quality of recovered materials.

Learning from global best practices, investing in infrastructure, and enforcing progressive waste policies can further accelerate this transition. Additionally, public awareness, technological innovation, and private sector engagement are essential to mainstream circular economy practices across sectors. Ultimately, a robust circular economy in Pakistan can create green jobs, reduce emissions, conserve natural resources, and position the country competitively in the global shift toward sustainability. The challenge now lies in translating vision into action, through policy coherence, stakeholder collaboration, and a national commitment to circularity that benefits people, the planet, and prosperity. The time to act is now, before the cost of inaction becomes irreversible.

References: Asian Development Bank; Ellen MacArthur Foundation; Ministry of Climate Change, Pakistan; Pakistan Environmental Protection Agency; World Bank; UNDP Pakistan; National Energy Efficiency & Conservation Authority; Pakistan Textile Council; Sustainable Development Policy Institute

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Reviving Agriculture in Pakistan for a Resilient Future

Agriculture in Pakistan must evolve into a climate-resilient and export-oriented powerhouse to secure its economic future. With strategic investments in value-added horticulture and smart technologies, the country can overcome current challenges and tap into high-value global markets.

Alina Arain

5/8/2025

Pakistan's agricultural sector is the cornerstone of its economy, contributing 24% to the national GDP and employing 38% of the labor force (World Bank, 2024). Despite this foundational role, the sector's export performance remains underwhelming, with agricultural exports plateauing at approximately $5 billion per year, well below the country's potential, especially in the context of rising global demand for food, fiber, and high-value agro-products (FAO, 2023). The sector is increasingly constrained by interlocking challenges including climate volatility, water scarcity, outdated farming technologies, limited value addition, and fragmented institutional support systems. These constraints significantly reduce productivity and make Pakistani agriculture less competitive on the global stage.

The devastating 2022 super floods, which inundated 4.4 million acres of cropland and caused an estimated $30 billion in economic damage, exemplify the acute risks posed by climate change (World Bank, 2023). However, even before this catastrophic event, Pakistan's agricultural productivity was growing at a modest 1.8% per year, far below the 3.5% seen in India and 4.2% in Bangladesh, highlighting deep-rooted structural inefficiencies (FAO, 2023). Without bold reforms, Pakistan risks falling further behind as neighboring economies aggressively pursue export-led agricultural growth.

This article delves into specific bottlenecks within Pakistan's key agricultural sub-sectors, rice, cotton, and horticulture, while analyzing policy gaps, institutional weaknesses, and climate vulnerabilities. Drawing on recent field research in Punjab and Sindh, and supported by data from the World Bank, FAO, and ADB, we explore practical pathways for transforming agriculture into a driver of sustainable export growth. We argue that strategic crop diversification, investment in climate-resilient technologies, better access to export markets, and institutional modernization could raise annual agricultural export earnings to $8 billion. At the same time, these interventions would enhance food security, boost rural incomes, and position Pakistan as a competitive player in global agro-trade.

Sectoral Dynamics: From Stagnation to Strategic Export Diversification

Pakistan's agricultural export landscape reflects a paradox of potential versus performance. Despite being the 4th-largest exporter of rice globally, producing 7.4 million tons of Basmati annually (FAO, 2022), Pakistan captures only 15% of the global branded Basmati market. This underperformance, termed the "Basmati Paradox," stems largely from quality control issues. In 2023 alone, 23% of rice shipments to the EU were rejected due to pesticide residue violations (ITC, 2024). However, initiatives such as Punjab's 2023 Smart Basmati Program, which combined drip irrigation with blockchain-based traceability, have shown promise. This program improved yields by 25% and reduced EU rejections by 12%, demonstrating the potential of technology-driven interventions (Punjab Agriculture Department, 2024). Still, Pakistan lacks enforceable food safety regulations and international branding comparable to India's.

In cotton, once dubbed "white gold," Pakistan has witnessed a 40% production decline since 2015, costing the textile sector $2 billion in export revenues (Hussain et al., 2025). This collapse is driven by pest outbreaks, deteriorating water access, and poor seed quality. Innovation trials such as BT Cotton V3 hybrids in Multan showed 35% higher yields, but scaling is hindered by monopolized seed distribution and the fragmented nature of smallholder farms. Corporate models like Engro's IoT-enabled farm in Sindh, achieving 900 kg/acre, suggest viable models for revitalization—if backed by inclusive investment (ADB, 2023).

In horticulture, Pakistan's position as the 6th-largest mango producer offers untapped potential, yet 35% of mangoes are lost post-harvest due to inadequate cold storage (FAO, 2021). ADB-supported solar-powered pack houses in Multan extended shelf life by 10 days and increased mango exports to Iran by 50% (ADB, 2023). However, only 12% of farmers currently benefit from cold chain infrastructure. Bridging this infrastructure gap through targeted investment and public-private partnerships could transform Pakistan's horticulture into a high-value export engine.

Climate Resilience and Structural Reforms: Securing Pakistan's Agri-Export Future

As climate change intensifies, Pakistan's agricultural export pipeline faces growing volatility. Extreme weather events, heatwaves, floods, and pest outbreaks are causing significant economic disruption. In recent years, wheat yields have dropped by 30% during intense heat spells, while the 2022 floods alone resulted in $1.5 billion in rice export losses (Ministry of Climate Change, 2024). Cotton, already in structural decline, suffered 40% crop

damage from pest outbreaks. Yet, climate-resilient innovations are emerging. Drought-tolerant wheat varieties such as *Uqaab-2025*, satellite-based flood early warning systems, and biocontrol agents like *Trichogramma* have demonstrated potential for stabilizing output. Climate insurance pilots in Thar have reduced farmer loan defaults by 60% (World Bank, 2024), proving the viability of risk-transfer mechanisms. Additionally, scaling up drip irrigation remains crucial for countering chronic water stress, especially in Sindh and southern Punjab.

However, resilience must be paired with systemic reforms. Pakistan's agro-export competitiveness is hampered by regulatory and financial inefficiencies. Trade policy remains fragmented, with 137 overlapping tariff codes that restrict market access (ITC, 2023). Aligning trade infrastructure with China-Pakistan Economic Corridor (CPEC) routes could cut export logistics costs and unlock new regional markets. Financially, a redirection of Rs. 200 billion in subsidies from water-intensive staples like wheat and rice toward high-value horticulture and climate-smart technologies is essential. Introducing Green Credit Lines at concessional rates (5%) for renewable energy-powered cold storage will also expand marketable surpluses.

Institutionally, technology adoption and land consolidation are critical. Punjab's Kisan App, now used by over 1.2 million farmers, provides real-time pricing and input access, an innovation ready for national scaling. Likewise, consolidating land parcels below five acres will improve mechanization and traceability.

To future-proof Pakistan's agricultural exports, we recommend the formation of a National Agri-Trade Council to unify provincial and federal policies, the establishment of 50 agri-tech incubators to support blockchain traceability, and a complete reorientation of subsidies toward climate-resilient agriculture. These reforms are not only necessary to withstand climate shocks but also to reposition Pakistan as a competitive force in global agro-markets.

Conclusion

Pakistan stands at a critical juncture where agriculture, once a steady economic mainstay, must now evolve into a climate-resilient and export-oriented sector to secure its future. Despite contributing 24% to GDP and employing nearly two-fifths of the workforce, the sector's export stagnation at $5 billion underscores deep inefficiencies and missed opportunities. Climate change, outdated practices, and fragmented policy frameworks have eroded competitiveness, even as regional peers surge ahead. However, the roadmap to revival is within reach. Strategic investments in value-added horticulture, smart technologies like drip irrigation and blockchain traceability, and adoption of climate-resilient seed varieties can stabilize yields and open high-value global markets.

Simultaneously, structural reforms, such as rationalizing tariff codes, consolidating landholdings, and digitizing farmer services, can unlock economies of scale and foster innovation. With proper alignment of trade, financial, and institutional reforms, Pakistan's agriculture can shift from survival to surplus, from volatility to value. Raising annual agri-exports to $8 billion is not just aspirational, it is attainable, if bold, coordinated action is taken now.

References: FAO; World Bank; Hussain, et al.; ADB; ITC; Punjab Agriculture Department; Ministry of Climate Change

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Impact of Globalization on Türkiye's Agricultural Trade

Globalization has transformed agricultural trade, presenting both challenges and opportunities for Türkiye. While export growth has surged, disparities in subsidies and productivity pose risks. Explore how Türkiye navigates these complexities in a competitive global market.

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The scarcity of natural resources continues to grow as a critical global issue, exacerbating inequality and food insecurity across regions. In 2023, an estimated 828 million people suffered from hunger, while almost 30% of the global population endured some form of food insecurity when malnutrition is included (FAO & WHO, 2023). These alarming figures reflect not only resource shortages but also deep structural imbalances in the global food system. Unequal access to water, land, and agricultural inputs disproportionately affect populations in developing and least-developed countries, where rising temperatures, erratic rainfall, and soil degradation have reduced crop productivity and undermined food sovereignty.

To level the playing field, the World Trade Organization (WTO) introduced trade reforms through the Uruguay Round Agreement on Agriculture (1994), which called for phased reductions in agricultural subsidies. Developed countries were required to reduce subsidies within five years, developing countries within ten, and least developed countries within fifteen. The goal was to reduce trade-distorting support and allow developing economies fairer access to global markets. However, the agreement's impact has been limited. Major agricultural exporters like the United States and the European Union continue to provide an estimated $600 billion annually in subsidies, using mechanisms like direct payments, insurance schemes, and export incentives that circumvent WTO rules (OECD, 2023).

These persistent subsidies allow developed countries to flood global markets with artificially cheap food, undermining farmers in poorer nations and perpetuating cycles of dependency. As a result, many developing countries are unable to compete, invest in sustainable agriculture, or protect their own food security. The global imbalance in agricultural trade and support systems not only distorts markets but also exacerbates poverty, rural underdevelopment, and ecological strain. Addressing this inequity requires renewed international commitment to transparent trade, fair subsidy reforms, and sustainable investment in food systems for all.

Türkiye's Agricultural Dilemma in a Globalized Economy

Türkiye, recognized as one of the top ten global agricultural producers, is grappling with significant structural challenges in adapting to the competitive pressures of a globalized economy, particularly under the regulatory frameworks of the World Trade Organization (WTO). A central issue lies in Türkiye's subsidy structure, where most of the its agricultural support mechanisms are categorized under the WTO's "Red Box", defined as trade-distorting subsidies. In contrast, the European Union (EU) effectively utilizes "Green Box" supports, which include non-trade-distorting assistance such as environmental programs and rural development funding. This disparity places Türkiye at a competitive disadvantage in global markets where WTO compliance is increasingly critical (WTO, 2023).

Productivity gaps further underscore Türkiye's agricultural dilemma. In the livestock sector, the average number of animals per farm is only 3.9 in Türkiye, compared to 38.7 in the EU (TÜİK, 2023). Similarly, milk yields are significantly lower, 2,000 kg per cow annually in Türkiye versus 5,500 kg in the EU (Eurostat, 2023). Meat production also lags, with average carcass weights of 170 kg in Türkiye compared to 281 kg in the EU (TÜİK, 2023). These figures reveal inefficiencies that hinder Türkiye's competitiveness and economic returns in international trade.

Additionally, trade imbalances persist despite the sector's export potential. Agriculture comprises about 11% of Türkiye's total exports, yet the country is highly reliant on imports for value-added and processed agricultural goods, with 90% sourced from the EU (TIM, 2023). This dependence on imported agro-products not only undermines domestic food processing industries but also widens the trade deficit. Addressing these structural shortcomings requires reforming Türkiye's subsidy system, investing in productivity-enhancing technologies, and supporting local agro-industrial capacity to ensure competitiveness and sustainability in the global agricultural market.

Global Agricultural Trade Trends

The global agricultural trade landscape has experienced notable changes over the past few decades. Between 1985 and 2004, the value of agro-exports surged dramatically, increasing from $123 billion to $393 billion. However, despite this impressive growth in the absolute value of agricultural exports, their share of global trade decreased from 12% to 7%, highlighting the growing diversification of global trade beyond agriculture (World Bank, 2023). A closer look at the distribution of these exports reveals a concentration in the hands of a few nations. In fact, just 20 countries account for a staggering 73%

of global agricultural exports, demonstrating the dominance of key players in the agricultural export market (WTO, 2023). One significant trend within this shift is the growing importance of processed foods. Processed food exports have been growing at an annual rate of 8.5%, underscoring the increasing focus on value-added agricultural products as opposed to raw commodities. This growth is indicative of a broader value chain disparity, where countries that can process agricultural products add more value and capture higher returns compared to those that only export raw materials (ITC, 2023). These trends suggest that to stay competitive in the global market, countries must increasingly focus on both expanding their export base and enhancing the value added to their agricultural products. As demand for processed foods rises and agricultural markets become more concentrated, nations that can innovate and improve their production processes will be best positioned to succeed in the evolving global agricultural trade environment. However, this growth is not without challenges, as it also requires significant shifts in policy, infrastructure, and production methods to support a sustainable and competitive agricultural sector that can meet the changing demands of the global market.

Conclusion

Globalization has redefined the landscape of agricultural trade, creating both opportunities and obstacles for countries like Türkiye. While global market integration has encouraged export growth and innovation, it has also exposed deep disparities in subsidy structures, productivity levels, and value chain competitiveness. Türkiye's reliance on trade-distorting subsidies, low farm-level efficiency, and dependence on imported processed foods leaves it vulnerable in a system dominated by well-subsidized and technologically advanced economies.

The WTO's reforms have not fully addressed these global imbalances, as developed nations continue to use loopholes to maintain their dominance, undermining the competitiveness of developing economies. Moreover, global trade is increasingly driven by processed and value-added products, where Türkiye lags due to insufficient investment in agri-processing infrastructure and policy support. To remain competitive, Türkiye must realign its agricultural strategy through structural reforms, including transitioning toward "Green Box" compliant subsidies, improving productivity through technology adoption, and supporting domestic agri-business value chains. These changes must also address environmental sustainability and social equity to ensure long-term resilience. The pathway forward lies in crafting policies that not only respond to global trade rules but also enhance national food security, rural livelihoods, and ecological balance. Only through such a comprehensive and forward-looking approach can Türkiye thrive in the increasingly complex and competitive global agricultural economy.

References: FAO; WTO; TÜİK; OECD; EC; WHO; TIM; ITC

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Pakistan's Water Conflict: Indus Treaty Crisis

Pakistan faces a critical agricultural crisis as the suspension of the Indus Waters Treaty exacerbates water conflict with India. With projected drops in wheat and rice yields of 30-40%, mass farmer indebtedness, and potential food insecurity, signals a national emergency.

Alina Arain

5/12/2025

The suspension of the 1960 Indus Waters Treaty (IWT) has plunged Pakistan's agriculture sector into unprecedented threat. As agriculture accounts for 24% of Pakistan's GDP and employs 38% of the labor force, its fate is intricately tied to the Indus River System, which provides irrigation for 90% of all cultivated land. The abrupt halt in real-time hydrological data sharing from India and the looming threat of reduced river flows have created a crisis of planning, productivity, and food security. According to the Pakistan Council of Research in Water Resources (PCRWR, 2025), wheat and rice yields could decline by 30–40% by 2030 if the disruption persists. This translates into potential economic losses of up to $50 billion annually, with 65 million acres of farmland under threat and food insecurity looming over 245 million citizens (World Bank, 2025).

Recent data from provincial and federal sources paints a grim picture. Wheat yields in Punjab are projected to decline from 2.8 tons to 1.9 tons per hectare, resulting in losses of $12 billion per year. Sindh's rice exports, already strained by water unpredictability, may fall by $1.5 billion, causing widespread farmer defaults, estimated at 40%. Cotton cultivation has also collapsed, with acreage in Punjab down 40% since 2015, endangering the $4 billion textile industry.

The cumulative impact of water scarcity, agricultural contraction, and export decline threatens to destabilize Pakistan's rural economy and national balance of payments. Without immediate investment in water storage, precision irrigation, and climate-resilient crop diversification, Pakistan risks a systemic agrarian breakdown with global food security implications. The current crisis underscores the urgent need for both diplomatic resolution and domestic reforms to build agricultural resilience in the face of geopolitical and climatic shocks.

Water Wars Escalate

The intensification of transboundary tensions over water between India and Pakistan has evolved into a strategic challenge now commonly described as a "water war." India's 2023 National Water Strategy, which prioritizes domestic hydropower and irrigation, has resulted in the diversion of an estimated 15–30% of Chenab and Jhelum River flows, according to the Pakistan Council of Research in Water Resources (PCRWR, 2025). These diversions undermine the core tenets of the Indus Waters Treaty and have begun to reshape Pakistan's hydrological security landscape. The consequences are already manifesting across sectors and regions, with Pakistan's urban and rural systems equally exposed.

In the urban context, Karachi, a city of over 20 million, faces a growing crisis as its water supplies from the Indus system have dwindled. Current shortages affect nearly 50% of the city's demand, forcing lower-income neighborhoods to rely on expensive tanker mafias or unsafe groundwater extraction. The Sindh Environmental Protection Agency (2025) projects that water scarcity could displace over 1 million climate migrants into urban slums by 2030, exacerbating public health challenges and infrastructure strain.

In the rural belt, water insecurity is driving mass agricultural distress. Field surveys conducted in Muzaffargarh and Ghotki in 2024 revealed that 70% of smallholder farmers lack the capital to install or maintain groundwater pumps. The situation is particularly dire in canal-dependent zones, where reduced inflows and poor maintenance have crippled irrigation reliability. A rice farmer from Ghotki, interviewed by *Dawn* (2024), lamented: "My rice seedlings died waiting 40 days for canal water. I had no money for diesel to run the tube well."

Such testimonies reflect the growing desperation across the farming community, where loss of crop viability directly translates into income shocks, debt spirals, and forced migration. As India tightens upstream control and Pakistan struggles with adaptive capacity, the mounting water stress threatens to rupture both food production systems and rural livelihoods. Without coordinated hydro diplomacy, investment in water-saving technologies, and expanded credit access for farmers, Pakistan risks escalating from ecological vulnerability to agrarian collapse.

Policy Solutions: The Indus Resilience Accord

To address Pakistan's mounting water insecurity and agricultural vulnerability, a multi-pronged policy framework, proposed as the *Indus Resilience Accord*, offers a strategic roadmap for national and regional stabilization. The first pillar is infrastructure transformation. With over 60% of irrigation sourced from declining groundwater tables, the government proposes the installation of 30,000 solar-powered tubewells at a cost of Rs. 150 billion. These would reduce diesel dependency and expand access to clean, affordable irrigation, particularly in tail-end regions of Sindh and southern Punjab. In parallel, the Punjab Irrigation Department has initiated a pilot to digitize canal operations using IoT sensors at the Trimmu Barrage. These real-time

monitoring systems aim to improve water flow regulation, curb theft, and enhance distribution equity.

The second pillar focuses on diplomacy. With the Indus Waters Treaty (IWT) in jeopardy, Pakistan must escalate its case to the International Court of Justice (ICJ) under Article IX, which allows for arbitration in the event of treaty violation. Complementing legal avenues, a proposal for joint satellite-based monitoring of Indus River flows could restore trust, transparency, and predictive capacity for both countries, mitigating accidental escalation and ensuring real-time data access for irrigation and disaster planning.

Domestically, the Accord calls for bold but necessary reforms. One recommendation is to phase out sugarcane cultivation in chronically water-stressed districts such as Bahawalpur, where the crop's high-water demands are no longer sustainable. Replacing it with climate-resilient alternatives like millet and pulses could reduce irrigation pressure by up to 40%. Finally, scaling up climate insurance schemes for smallholders would protect vulnerable farmers against yield losses from droughts, floods, and erratic rainfall. These policies, when enacted together, would build long-term hydrological resilience, reduce geopolitical exposure, and secure the livelihoods of Pakistan's 38 million rural agricultural workers.

Conclusion

Pakistan stands at a critical crossroads as the suspension of the Indus Waters Treaty and the growing water conflict with India expose deep vulnerabilities in its agrarian economy. The looming specter of agricultural collapse, marked by a projected 30–40% drop in wheat and rice yields, mass farmer indebtedness, and potential food insecurity for over 245 million people, signals a national emergency. With water diversions and canal disruptions already taking a toll on critical crops and rural livelihoods, the threat is no longer abstract. It is tangible, immediate, and escalating.

Yet, the crisis also presents a pivotal opportunity for reform. The proposed Indus Resilience Accord provides a coherent, strategic response that blends infrastructure modernization, legal diplomacy, and domestic policy overhaul. Solar-powered tubewells, IoT-enabled canal systems, international arbitration, and a transition to climate-smart crops such as millet and pulses represent practical, scalable solutions. Critically, these interventions must be paired with expanded farmer credit, crop insurance, and region-specific bans on unsustainable crops like sugarcane.

Ultimately, Pakistan's path forward lies in transforming vulnerability into resilience. By investing in water governance, diplomatic engagement, and agricultural innovation, the country can not only safeguard its food systems but also reclaim agency in an increasingly water-insecure region. Water must not become a weapon, but a shared resource for peace and prosperity.

References: PCRWR; World Bank; Sindh EPA; Dawn; Sindh Environmental Protection Agency

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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Addressing Land Inequality in Pakistan's Rural Economy

Land inequality and landlessness pose serious challenges in Pakistan's rural economy, marginalizing smallholders and tenant farmers. Explore the impacts on agricultural productivity, rural poverty, food insecurity, and perpetuates social conflict.

Duaa Laghari

5/21/2025

Land is a critical asset in Pakistan's rural economy, not only as a means of production but also as a determinant of social identity, power, and opportunity. Yet, land distribution remains starkly unequal, with significant consequences for economic development and rural livelihoods. The top 5% of landowners in Pakistan control nearly 62% of the country's agricultural land, while the vast majority, around 64% of rural households, own less than 2 hectares or no land at all (World Bank, 2023; FAO, 2022). This extreme concentration of landownership entrenches rural poverty, limits upward mobility, and exacerbates food insecurity. For millions of landless farmers and sharecroppers, lack of secure tenure means limited access to credit, weak bargaining power, and little incentive to invest in sustainable farming practices.

This inequality has historical roots that continue to shape present realities. During British colonial rule, land was concentrated through the Zamindari and Jagirdari systems, which rewarded loyalty with large estates and institutionalized a class of absentee landlords (Lodhi, 2007). These systems laid the groundwork for Pakistan's enduring feudal structure. Post-independence land reform efforts in the 1950s, 1970s, and 1980s aimed to redistribute land to smallholders and tenants, but they were largely unsuccessful. Powerful elites often used legal loopholes, political influence, and bureaucratic manipulation to subvert the reforms. For example, landowners would divide large holdings among family members or forge records to remain within redistribution limits (Gazdar & Mallah, 2021).

The persistence of land inequality undermines rural development and fuels discontent, particularly among youth and marginalized communities. Without meaningful land reform, the cycle of poverty and exclusion will continue. Addressing this issue requires bold political will, transparent land governance, and policies that support equitable access to land for small farmers, women, and landless workers who form the backbone of Pakistan's rural economy.

Quantifying Land Inequality and Landlessness in Pakistan

Land inequality in Pakistan reflects not only disparities in ownership but also entrenched structural exclusion. A key tool used to assess this inequality is the Gini coefficient, where a score of 0 signifies perfect equality and 1 indicates total inequality. For landowners alone, Pakistan's Gini coefficient stands at 0.67, underscoring the high concentration of land among a small elite (Pakistan Bureau of Statistics, 2023). However, this measure becomes even more alarming when landless rural workers are included. Factoring in the millions without any landholding, the coefficient spikes to 0.84 (PIDE, 2024), signaling one of the highest levels of land inequality globally.

Recent data reveals a worsening trend. Between 2015 and 2023, landlessness increased by 8%, and inequality among landowners rose by another 2% (Pakistan Economic Survey, 2023). These changes are not marginally point to deepening rural disparities that threaten social cohesion, food security, and economic resilience.

Landlessness now affects 42% of rural households (HRCP, 2023). Those without land typically work as tenant farmers, sharecroppers, or daily-wage agricultural laborers. Their livelihoods are precarious, often governed by informal arrangements with little legal protection. Many faces exploitative conditions, including verbal tenancy agreements, sudden eviction, and debt cycles that verge on bondage (Amnesty International, 2022). Without ownership or secure tenure, landless workers are excluded from government support programs, agricultural credit, and the ability to make long-term investments in productivity or sustainability.

This structural exclusion reinforces intergenerational poverty and denies millions of Pakistanis the right to dignified livelihoods. Accurately measuring and acknowledging both land inequality and landlessness is critical for crafting policies that promote equitable development. Without addressing the vast rural land divide, efforts to improve agricultural productivity, reduce poverty, or foster inclusive growth will remain fundamentally incomplete.

Regional Disparities and Social Impacts of Land Inequality in Pakistan

Land inequality in Pakistan is shaped not only by historical and legal frameworks but also by stark regional and ecological variations. Across the country, land access and ownership patterns are deeply uneven, reflecting differences in geography, governance, and agrarian structures. In Punjab, particularly in the irrigated regions, the landlessness rate stands at 35%, with large landholdings concentrated among political and economic elites (PBS, 2023). Sindh presents an even grimmer picture, landlessness reaches 66% in many zamindari-dominated districts, where feudal structures persist and tenant rights remain weak (World Bank, 2022).

In Balochistan, an arid and sparsely populated province, the landlessness rate

is 45%. While large landholdings are less common, productivity is extremely low, and access to land and water is tightly controlled by tribal elites. Khyber Pakhtunkhwa, particularly in tribal and mountainous areas, shows a lower landlessness rate of 20%, largely due to customary and communal land ownership patterns that offer broader, albeit informal, access to land.

The consequences of these disparities are profound. Landless households are three times more likely to live in poverty compared to those with secure landholdings (UNDP, 2023). Food insecurity is widespread, 58% of landless families report chronic shortages and poor nutrition (WFP, 2023). Gender inequality further compounds the issue: although women contribute approximately 70% of agricultural labor, only 4% hold land titles (FAO, 2023), leaving them excluded from decision-making and economic empowerment.

The lack of secure land rights also fuels social conflict. Land disputes account for nearly 30% of all court cases in rural Pakistan (HRCP, 2023), creating legal bottlenecks and community-level tensions. Addressing regional variations and their socioeconomic fallout is essential for building a more inclusive, resilient, and equitable rural economy. Without tackling these structural divides, broader development goals will remain out of reach.

Addressing Land Inequality through Policy Reform in Pakistan

Land inequality in Pakistan persists largely due to entrenched policy gaps, institutional inertia, and elite capture of agrarian reforms. Despite multiple waves of land reform since independence, implementation has remained weak and inconsistent. Redistribution laws, though present on paper, are rarely enforced due to a lack of political will and strong resistance from powerful landholding elites. Many large landowners continue to exert significant influence over policymaking, effectively blocking reform efforts and preserving existing inequalities.

Administrative challenges further compound the problem. Land records across the country are outdated, fragmented, and often manipulated. As of 2023, only 30% of land records have been digitized (World Bank, 2023), leaving ample room for corruption and disputes. Tenants and sharecroppers face particularly precarious conditions, often working under informal arrangements without legal protections or security of tenure. Arbitrary avoidances, exploitative contracts, and lack of grievance mechanisms remain widespread.

To address these challenges, a comprehensive and multi-pronged approach is essential. Legal and tenancy reforms must be prioritized, strengthening protections for tenants, ensuring enforcement of inheritance laws, and safeguarding women's rights to own and inherit land. Redistributive measures, such as enforcing land ceilings and allocating surplus land transparently to landless farmers, are also crucial for equity and productivity.

Technology offers promising tools for reform. Full digitization of land records by 2025 and the use of GIS and satellite mapping can help curb land grabbing and increase transparency. Additionally, targeted support for landless workers, through microcredit, vocational training, and cooperative farming initiatives, can create alternative pathways to economic security.

Gender inclusion must also be a cornerstone of reform. Joint land titles for married couples and public awareness campaigns can empower women in rural communities. Only through bold, inclusive, and enforceable policies can Pakistan close its rural land gap and foster a more just and resilient agricultural future.

Conclusion

Land inequality and landlessness remain among the most pressing structural challenges in Pakistan's rural economy. Despite decades of reform attempts, the entrenched concentration of land ownership continues to marginalize smallholders, tenant farmers, women, and millions of landless workers. This persistent disparity undermines agricultural productivity, deepens rural poverty, fuels food insecurity, and perpetuates social conflict. The situation is further exacerbated by regional disparities, outdated land governance systems, and a lack of political will to implement meaningful change.

Addressing these challenges requires a transformative and sustained policy effort that goes beyond rhetoric. Legal and institutional reforms must be enforced to secure land rights, protect tenants, and ensure women's access to land. Redistribution of surplus land, technological modernization of land records, and targeted support for landless communities are essential steps toward building an equitable agrarian structure. Without these reforms, Pakistan risks continuing a cycle of exclusion, inefficiency, and rural discontent.

Equitable land access is not merely a matter of justice, it is a prerequisite for sustainable development, food security, and inclusive economic growth. The time has come for Pakistan to move from symbolic gestures to substantive action. Bridging the land divide is not only possible, but also necessary for the prosperity and stability of the nation's rural heartland.

References: Amnesty International; FAO; Gazdar & Mallah; Government of Pakistan; HRCP; PIDE; UNDP; World Bank; Lodhi; Pakistan Bureau of Statistics; WFP

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One Health Framework: Preventing Zoonotic Diseases

Explore the One Health framework highlighting the interconnectedness of human, animal, and environmental health. Discover how investing in livestock vaccination and preventive measures can yield significant health and economic benefits.

Khadija Iqbal

5/26/2025

The intersection of livestock disease control and human health represents a vital, multidisciplinary field that unites epidemiology, veterinary science, public health, and economics. Central to this collaboration is the One Health approach, which acknowledges that the well-being of humans, animals, and ecosystems is interdependent. With zoonotic diseases accounting for roughly 60% of known infectious diseases and 75% of emerging pathogens (WHO, 2023), integrated strategies are no longer optional but essential to global health security.

Economically, unchecked livestock diseases can devastate both agricultural productivity and human health systems. For instance, outbreaks such as avian influenza or foot-and-mouth disease trigger mass culling, trade embargoes, and lost income for farmers, while human infections strain medical resources and reduce labor productivity. Cost-benefit analyses consistently show that preventive investments, such as routine vaccination campaigns, biosecurity measures on farms, and early detection systems, yield far greater returns than reactive responses to widespread outbreaks. For every dollar spent on prevention, studies suggest returns can range from $5 to $15 by avoiding production losses and controlling human healthcare costs.

Effective surveillance systems play a pivotal role in economically sound disease management. Integrated animal-human surveillance networks enable rapid identification of novel pathogens at the animal reservoir stage, limiting spread to human populations. Digital reporting platforms and community-based animal health workers help track disease incidence in remote or resource-poor regions, reducing delays that exacerbate both animal mortality and human risk. In turn, policymakers can use surveillance data to prioritize resource allocation, targeting high-risk zones, optimizing vaccination rollouts, and enforcing movement controls that minimize economic disruption.

Policy interventions must reinforce these technical measures. Subsidized vaccination programs for smallholder farmers, combined with financial incentives for reporting suspected cases, strengthen early detection and control. Regulatory frameworks mandating farm biosecurity standards, paired with technical assistance and credit access, encourage adoption without imposing unsustainable costs. At the national level, integrating veterinary and public health budgets can streamline response teams and avoid redundant expenditures. International collaboration on research, funding, and information sharing further amplifies the economic benefits of One Health, ensuring that investments in livestock disease control safeguard both agricultural livelihoods and human well-being.

The Economic Benefits of One Health Approach

The One Health approach delivers substantial economic benefits by preventing zoonotic diseases, protecting livelihoods, and stabilizing trade. Zoonotic diseases, such as avian influenza, rabies, and brucellosis, impose a global economic burden exceeding $20 billion annually through healthcare costs and lost productivity (World Bank, 2023). By prioritizing early detection and vaccination in animal populations, One Health initiatives can cut the human disease burden almost in half, as evidenced by FAO estimates showing a 50% reduction in human cases when animal vaccination programs are implemented (FAO, 2023). For example, mass dog vaccination campaigns against rabies not only avert an estimated 59,000 human deaths each year but also save approximately $8.6 billion in treatment and post-exposure prophylaxis costs (OIE, 2022). These preventive investments therefore offer clear returns by reducing expensive hospitalizations, prolonged labor absenteeism, and long-term healthcare expenditures.

Beyond direct human health savings, One Health safeguards agricultural livelihoods and food security. Outbreaks such as African Swine Fever have inflicted cumulative global losses of $130 billion since 2018, decimating hog populations and destabilizing pork markets (FAO, 2023). Similarly, Foot-and-Mouth Disease diminishes livestock productivity by 20–50%, disproportionately affecting smallholder farmers who depend on cattle, sheep, and goats for income and nutrition (ILRI, 2022). By integrating improved biosecurity measures, routine vaccination, and coordinated surveillance under a One Health framework, developing nations can increase livestock gross domestic product by 5–15% (World Bank, 2023). Healthier herds translate directly into higher milk yields, weight gains, and reproductive success, strengthening rural economies and reducing the risk of household food insecurity.

Moreover, controlling animal diseases enhances trade opportunities and market stability. Zoonotic or epizootic outbreaks often prompt importing countries to impose trade restrictions, leading to losses of $1–5 billion per outbreak for major exporters such as Brazil and India (WTO, 2023). By achieving and demonstrating

disease-free status through rigorous surveillance and certification, countries can boost their meat and dairy exports by 30–40% (OIE, 2023). This uplift not only augments national export revenues but also stabilizes domestic markets by preventing price collapses triggered by sudden import bans. Through these interlinked mechanisms, healthcare cost reduction, livelihood protection, and trade enhancement, the One Health approach emerges as an economically compelling model for sustainable development.

Economic Impact of Zoonoses and Integrated Surveillance

Zoonotic diseases impose both direct and indirect economic burdens that ripple through human health systems and agricultural sectors. For instance, avian influenza alone accounts for an estimated $10 billion in annual losses by collapsing the poultry industry and triggering costly trade bans. Brucellosis generates roughly $3.4 billion each year, as chronic human illness reduces workforce productivity while infected livestock succumb to the disease or are culled. Similarly, Rift Valley fever incurs around $1.2 billion annually in costs related to human outbreaks, livestock mortality, and disrupted trade (WHO, OIE, World Bank, 2023). These figures understate additional downstream impacts: families drained by medical expenses may withdraw children from school, and communities reliant on livestock for income face heightened food insecurity. Moreover, indirect costs, lost wages, caregiving duties, and long-term sequelae, amplifying the fiscal toll, tethering vulnerable rural economies to cycles of poverty.

Integrated surveillance systems that bridge human and animal health data streams have demonstrated superior cost-effectiveness compared to siloed approaches. According to the CDC (2023), coordinated One Health surveillance is approximately 30 percent more cost-efficient than separate human-only or veterinary-only systems. By pooling laboratory networks, training shared field officers, and harmonizing reporting protocols, jurisdictions detect zoonotic threats earlier and allocate resources more judiciously. In pastoral or remote regions, mobile and drone-based monitoring have slashed outbreak response times by as much as 60 percent (Gates Foundation, 2023). Faster detection reduces the need for large-scale culling or mass vaccination drives, preserving both livestock value and public confidence.

Quantifying the human health benefits of these interventions often uses metrics such as Disability-Adjusted Life Years (DALYs) and Quality-Adjusted Life Years (QALYs). One Health programs, by preventing cross-species spillover and expediting treatment, averts an estimated 5 million DALYs each year (WHO, 2023). From a purely economic perspective, the cost per DALY averted through integrated zoonotic control ranges between $50 and $200, whereas human-only interventions often cost $500 to $1,000 per DALY averted (World Bank, 2023). These comparative figures underscore the value proposition of One Health: collaborative investments not only safeguard human lives but also fortify agricultural productivity, stabilize trade, and generate sustainable economic returns.

Economic Strategies for Disease Control in Livestock

Investing in vaccination and biosecurity measures represents one of the most cost-effective strategies for controlling livestock diseases and safeguarding economic stability. According to FAO estimates, every dollar invested in livestock vaccination can yield between five and thirty dollars in economic benefits, as healthy herds translate directly into increased production, reduced treatment costs, and fewer trade restrictions (FAO, 2023). Complementing vaccination with rigorous biosecurity protocols, such as disinfecting vehicles, controlling farm access, and isolating new or sick animals, can reduce disease transmission by up to 70 percent in intensive farming systems (OIE, 2023). When farmers implement these combined measures, they not only protect animal health but also strengthen market confidence, allowing better prices for disease-free produce.

For pastoralists and smallholder farmers operating in low-resource settings, specialized support mechanisms are equally vital. Community-based surveillance networks, which involve training local animal health workers and incentivizing farmers to report unusual signs promptly, have demonstrated earlier outbreak detection and containment in regions lacking formal veterinary infrastructure (ILRI, 2023). These grassroots systems complement national surveillance and reduce the economic shock of disease spread by enabling rapid, localized responses. Index-based livestock insurance provides another layer of protection, compensating farmers based on predefined triggers, such as regional mortality rates, rather than case-by-case assessments. This type of insurance mitigates financial risks from sudden disease outbreaks, encouraging farmers to invest in preventive measures knowing that catastrophic losses will not permanently undermine their livelihoods (IFAD, 2023).

At the policy level, cross-sector collaboration is essential to scale up these interventions. Despite the clear benefits of integrated approaches, only around 30 percent of countries have formalized One Health policies that coordinate human, animal, and environmental health sectors (WHO, 2023). When national governments develop and enforce these policies, they facilitate data sharing, resource pooling, and coordinate outbreak responses. Public-private partnerships, such as those supported by the Global Alliance for Vaccines and Immunization (GAVI), play a critical role in expanding vaccine access, subsidizing costs for low-income farmers, and ensuring reliable cold-chain logistics (GAVI, 2023). By combining vaccination, biosecurity, community surveillance, livestock insurance, and robust policy frameworks, governments can build a resilient livestock economy that not only reduces the direct costs of disease but also promotes sustainable growth and rural prosperity.

Overcoming Challenges and Charting Future Directions in Livestock Disease Control

Securing sustainable funding for zoonotic disease prevention remains a significant hurdle: only about 5% of global health budgets are allocated to this critical area, leaving many high-risk regions under-resourced (WHO, 2023). To address this, governments and international agencies can establish dedicated One Health funding pools that blend public resources, philanthropic grants, and private-sector contributions. For example, creating matching-grant schemes could incentivize local governments to allocate national budget lines for zoonotic surveillance. Likewise, agricultural cooperatives and producer associations might contribute small levies toward a regional animal health trust, ensuring a reliable stream of finance for vaccine procurement and outbreak response teams.

Data limitations also weaken control efforts, as roughly 60% of low- and middle-income countries lack real-time disease surveillance (World Bank, 2023). Leveraging mobile technology and cloud-based platforms can bridge this gap at low cost. Training community animal health workers to report disease symptoms via smartphone apps or SMS-based systems empowers early warning networks. Governments should partner with digital health startups to co-develop user-friendly surveillance dashboards, while universities and NGOs can support capacity-building workshops on data analysis. Pilot programs in which veterinary students deploy open-source GPS mapping tools during field visits have shown promise; scaling these initiatives through formal partnerships can turn fragmented data into actionable intelligence.

Climate change further complicates disease control by expanding the geographic range of zoonotic pathogens, Lyme disease risk areas in Europe, for instance, have grown by 20% as temperatures rise (IPCC, 2023). Mitigating this trend requires integrating climate-smart interventions into livestock management. Restoring wetlands and reforesting buffer zones can interrupt vector habitats, while adjusting grazing schedules and relocating herds away from new high-risk zones can reduce exposure. Early alert systems that combine meteorological forecasts with epidemiological models allow authorities to anticipate disease surge periods. Finally, cross-border collaboration on climate-resilient disease modeling and regional vaccination campaigns will prove indispensable as shifting environmental conditions continue to reshape zoonotic threats.

By mobilizing multi-source funding, harnessing digital surveillance innovations, and adapting livestock practices to a changing climate, stakeholders can strengthen the resilience of livestock disease control efforts, ultimately protecting both animal and human health while safeguarding rural economies.

Conclusion

The One Health framework underscores that human, animal, and environmental health are inseparable, with significant economic consequences when zoonotic diseases are left unchecked. By investing in preventive measures, such as livestock vaccination campaigns, biosecurity protocols, and integrated surveillance, stakeholders can avert costly outbreaks that impair both agricultural productivity and public health systems. Economic analyses consistently demonstrate high returns on these investments: every dollar spent on prevention can yield $5–$15 by avoiding treatment expenses, productivity losses, and trade disruptions. Community-based surveillance and index-based insurance further protect smallholders and pastoralist livelihoods by facilitating early outbreak detection and mitigating financial shocks.

To realize these benefits, sustainable funding mechanisms must be established, leveraging public-private partnerships, dedicated One Health budgets, and regional animal health trusts. Overcoming data gaps through mobile and cloud-based reporting empowers rapid response, while climate-smart interventions, restoring wetlands and adjusting grazing practices, reduce emerging disease risks. Policy alignment across veterinary and public health sectors, coupled with subsidized vaccines and portable insurance for migrant workers, ensures that rural economies remain resilient.

Ultimately, a robust, economically sound approach to livestock disease control fosters healthier herds, safer food supplies, and stable trade markets. Prioritizing One Health is not just a scientific imperative but a strategic investment in long-term economic growth and global health security.

References: WHO; World Bank; FAO; OIE; ILRI; CDC; Gates Foundation; IFAD; GAVI; IPCC

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Strengthening Pakistan's Agriculture Through Local Governments

Explore the vital role of local governments in enhancing Pakistan's agricultural sector. Despite decentralization reforms, challenges like limited fiscal autonomy and weak farmer engagement hinder decision-making.

Amna Mushtaq

5/27/2025

Local governments (LGs) play an indispensable role in transforming Pakistan's agriculture by ensuring policies are responsive to local needs, delivering essential services, and directly engaging farmers. Decentralization reforms, such as the 2010 Local Government Ordinance in many provinces, aimed to transfer authority and resources from provincial capitals to district and tehsil administrations. In theory, this empowers LGs to tailor irrigation projects, extension services, and credit schemes to regional agronomic conditions. For example, in Punjab's Faisalabad district, the local council coordinated canal maintenance schedules with crop calendars, reducing waterlogging and improving yields by an estimated 8% in three years (Punjab LG Department, 2021).

Yet persistent centralization undermines these gains. Key decisions on fertilizer subsidies, large-scale irrigation infrastructure, and crop insurance remain controlled by provincial bureaucracies, leaving LGs with limited autonomy. Political interference further distorts resource allocation: when influential groups lobby for projects in politically significant areas, water allocation and road maintenance often bypass high-need farming zones. In Khyber Pakhtunkhwa, districts with lower political clout experience 20% less spending on rural infrastructure compared to more influential districts (KP Finance Commission, 2022).

Fiscal constraints add another layer of complexity. Only 12% of LG budgets are earmarked for agricultural services, despite agriculture accounting for over one-third of employment. Extension officers are frequently understaffed; the recommended ratio of one officer per 1,000 farm households is often reversed, with one officer serving up to 5,000 households in remote areas. This staffing shortfall means timely advice on climate-resilient practices, such as crop rotation, drip irrigation, and drought-tolerant seed varieties, rarely reaches smallholders.

To address these gaps, LGs should receive increased fiscal transfers linked to performance metrics, such as improvements in per-hectare yield and irrigation efficiency. Establishing district-level agricultural boards that include farmer representatives can enhance accountability and ensure resource allocation aligns with local priorities. Leveraging digital platforms, mobile apps for weather forecasts and pest alerts, can overcome extension constraints by delivering real-time guidance. Finally, granting LGs authority over small-scale irrigation works and local seed distribution can expedite climate-resilient interventions, ensuring that Pakistan's farmers receive the support they need to thrive.

Decentralization Reforms and Agricultural Governance

Pakistan's journey toward decentralizing agricultural governance has been marked by ambitious reforms that often fell short of their goals. The 2001 Devolution Plan and subsequent 2013 Local Government Acts aimed to devolve authority from provincial capitals to district and tehsil administrations. In Punjab, for example, the 2013 Local Government Act formally delegated irrigation management and agricultural extension services to district councils. Despite these provisions, 70% of local government budgets remain reliant on provincial transfers, severely limiting true autonomy (World Bank, 2023). Without stable, locally generated revenues, districts struggle to prioritize timely maintenance of canal networks or staffing of extension officers. In Sindh and Khyber Pakhtunkhwa, experiences have been uneven: while some districts successfully expanded farmer training programs and community seed banks, others face chronic delays in fund disbursement that stall service delivery (ADB, 2023).

Several core challenges undermine decentralization's promise. Politically, provincial interference and elite capture persist, as influential figures shape resource allocation in ways that often favor urban interests over rural agricultural needs. This dynamic means that irrigation projects and subsidy schemes rarely target smallholders in marginalized areas. Administratively, extension services are under-resourced and understaffed; many districts have only a fraction of the recommended number of agricultural officers, leading to delays in disseminating modern farming techniques like precision irrigation or integrated pest management. This bureaucratic inertia discourages farmers from adopting climate-smart practices. From a fiscal perspective, local governments generate only about 5% of their budgets through local taxes, leaving them dependent on unstable provincial transfers. As a result, critical investments in rural roads, water storage, and agricultural research remain underfunded.

To transform agricultural governance, Pakistan must strengthen revenue-generation mechanisms at the local level, such as nominal land-use fees or market levies, while ensuring that provincial transfers are predictable and tied to performance indicators. Building transparent accountability structures, such as district agricultural boards with

farmer representation, can mitigate elite capture. Finally, investing in the recruitment and training of extension officers, coupled with streamlined administrative workflows, will enable LGs to deliver timely, context-specific support, ultimately boosting productivity and resilience across the agricultural landscape.

Local Government's Role in Agricultural Service Delivery and Farmer Participation

Local governments (LGs) are pivotal in providing agricultural services, yet coverage remains limited. Only 15% of farmers receive regular extension support, leaving most smallholders without critical guidance on modern farming practices, pest management, or climate-resilient techniques (FAO, 2023). In Punjab, the "Kissan Card" scheme aimed to digitize input subsidies, but with only 28% rural internet penetration, many eligible farmers cannot fully benefit (PTA, 2023). Strengthening LG outreach, through mobile-based advisory units and incentivized village extension agents, could bridge this gap, ensuring tailored support reaches remote areas.

In irrigation and water management, LGs oversee minor canals and distribution networks. However, underfunded maintenance regimes allow up to 60% of irrigation water to be lost before it reaches fields, exacerbating scarcity and fueling inequitable distribution (PCRWR, 2023). Water theft and unauthorized diversions further disadvantage smallholders downstream. Empowering LGs with dedicated canal repair funds and community-led water user associations can improve accountability. Implementing transparent water-tracking systems, such as simple flow meters and local monitoring committees, would help ensure that scarce water resources are equitably shared.

Rural infrastructure and market access also depend heavily on LG investments. Only 40% of Pakistani villages have paved roads, making it difficult for farmers to transport produce to markets or access inputs (PSLM, 2023). In Khyber Pakhtunkhwa, the "Agro-Based Rural Development Program" upgraded 45% of targeted rural roads, resulting in significant increases in farm incomes by reducing transit times and spoilage (KP Govt., 2023). Scaling similar road rehabilitation projects nationwide would enable farmers to reach buyers more efficiently and secure better prices.

Despite these service provisions, farmer's participation in LG decision-making remains minimal. Less than 10% of smallholders engage in local planning processes, and women, who comprise 70% of the rural agricultural labor force, are largely excluded from policy discussions (IFPRI, 2023; UN Women, 2023). The absence of formal feedback mechanisms leaves issues like seed quality or subsidy delays unaddressed; for instance, Punjab's "e-Khidmat" complaint portal exists but has low farmer awareness and utilization (PARC, 2023; PITB, 2023). Establishing village-level farmer councils, ensuring gender-balanced representation, and promoting awareness of grievance platforms can provide farmers with real influence over LG policies. By strengthening extension outreach, improving water and road infrastructure, and incorporating farmer voices, LGs can more effectively support sustainable agricultural development.

Policy Gaps & Recommendations

Several policy gaps hinder local governments (LGs) from fully supporting agricultural development. First, weak fiscal decentralization limits LGs' ability to generate and allocate resources for farming services. Allowing LGs to levy modest agricultural taxes, such as market fees, input levies, or land-use charges, would strengthen local budgets. India's Panchayati Raj model demonstrates this approach: nearly 25% of panchayat revenues come from local taxes, enabling tailored investments in rural infrastructure and agro-services.

Second, poor extension services leave many farmers without timely advice on modern practices. To address this, LGs should deploy mobile-agriculture clinics staffed with agro-technicians who travel to remote villages. Complementing these clinics with AI-based advisory apps, offering personalized recommendations on crop varieties, pest control, and weather forecasts, can expand outreach. Kenya's DigiFarm platform, with over one million registered users, exemplifies how digital tools can empower smallholders with real-time agronomic guidance.

Third, gender exclusion remains pervasive: women own less land and have limited access to LG decision-making. Reserving at least 30% of LG seats for women ensures their perspectives shape agricultural policies. Additionally, offering gender-sensitive subsidies, such as discounted inputs for female-headed households or grants for women-led cooperatives, can boost women's productivity. In Bangladesh, Female Farmer Cooperatives have successfully increased women's participation in value chains by providing shared equipment and market linkages.

Finally, LGs often lack capacity for climate resilience, leaving farmers vulnerable to droughts, floods, and erratic weather. Integrating LG-led early warning systems, combining local weather stations, community monitoring, and SMS alerts, can help farmers prepare. Ethiopia's Climate-Smart Villages program showcases this model: local committees use climate data to adjust planting schedules and water management, reducing crop losses and stabilizing incomes.

By addressing these policy gaps, enhancing fiscal autonomy, modernizing extension services, promoting gender inclusion, and bolstering climate resilience, LGs can more effectively support sustainable agriculture and improve rural livelihoods.

Conclusion

Local governments are central to strengthening Pakistan's agricultural sector, yet persistent challenges, such as

limited fiscal autonomy, under-resourced extension services, and weak farmer engagement, undermine their impact. While decentralization reforms have theoretically delegated responsibilities for irrigation, extension, and credit, reliance on provincial transfers (over 70% of LG budgets) and political interference continue to constrain district-level decision-making. Understaffed extension offices and low digital connectivity mean that fewer than 15% of farmers receive regular advisory support, slowing adoption of modern, climate-resilient practices. Similarly, water management remains inefficient: minor canals overseen by LGs lose up to 60% of flow due to underfunding and theft, deepening scarcity for smallholders downstream.

Addressing these gaps requires targeted reforms: granting LGs authority to levy modest local taxes can bolster agricultural budgets, while performance-linked fiscal transfers, tied to metrics like yield improvements, would incentivize efficient service delivery. Mobile agri-clinics and AI-driven advisory apps can expand extension reach and mandating at least 30% women's representation in LG bodies will ensure gender-responsive policies. Investing in rural road rehabilitation and transparent water-tracking systems will improve market access and equitable irrigation. Finally, integrating LG-led climate early-warning systems, drawing on local weather stations and community monitoring, can help farmers anticipate and adapt to droughts or floods.

By enhancing fiscal autonomy, modernizing extension services, promoting gender inclusion, and embedding climate resilience, local governments can more effectively support smallholders, boost productivity, and foster sustainable rural livelihoods across Pakistan.

References: Pakistan Economic Survey; World Bank; FAO; UN Women; Punjab LG Department; KP Finance Commission; ADB; PTA; PCRWR; PSLM; KP Govt; IFPRI; PARC; PITB

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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Land Reforms in Pakistan: Boosting Agriculture & Poverty

Explore the impact of land reforms in Pakistan aimed at dismantling feudal structures, enhancing agricultural productivity, and alleviating rural poverty. Despite initial policies, challenges like weak implementation and limited access to credit continue to hinder progress.

Sakeena Ihsan

5/28/2025

Land reforms have played a pivotal role in shaping economic trajectories across developing nations, and Pakistan is no exception. As one of the most critical productive resources, land is deeply tied to the livelihoods of rural populations, with agriculture accounting for 22.7% of Pakistan's GDP and employing 37.4% of the labor force (Pakistan Economic Survey 2022–23). Yet, decades of skewed landownership patterns have entrenched inequalities, restricted smallholder productivity, and fueled social tensions.

Since the 1950s, Pakistan has embarked on several waves of land reform to address these issues, aiming to redistribute surplus holdings, dismantle feudal structures, and boost agricultural yields. The first major attempt came in the 1959–1960 Land Reform Ordinance, which imposed acreage ceilings and sought to transfer excess land to tenants. However, loopholes in the legislation, such as allowing landlords to divide estates among family members, meant that only about 5% of land changed hands. Subsequent reforms in the 1970s under Prime Minister Zulfikar Ali Bhutto raised ceiling limits and attempted to consolidate small farms, yet elite resistance and protracted legal battles once again blunted the intended impact.

By the 1980s and 1990s, further adjustments, like revising ceiling laws and expanding tenancy rights, sought to strengthen the rights of sharecroppers and smallholders. Despite these efforts, weak implementation mechanisms, inadequate agricultural extension services, and limited access to credit undermined potential gains in productivity. In regions like Punjab and Sindh, the presence of large landlords continued to influence local politics, often blocking effective enforcement of land reform measures. Consequently, landlessness and underemployment persisted in many rural pockets, curbing the growth of rural incomes and perpetuating poverty cycles.

Nonetheless, pockets of success have emerged. Where redistributed plots were coupled with improved access to irrigation, credit, and market linkages, smallholders have demonstrated significant yield improvements, sometimes up to 20% higher than before the reform. Additionally, land reforms have contributed to a modest reduction in rural inequality, as Gini coefficients for land distribution in some districts fell by 3-5 percentage points following reform implementation. Political stability has also seen incremental gains: despite lingering frustrations, regions with clearer landownership records and legally protected tenancy agreements have experienced fewer rural uprisings and more participatory local governance.

However, the overarching challenge remains without comprehensive, well-resourced support systems, such as credit facilities, modern agronomic training, and rural infrastructure, land reforms alone cannot unlock the full agricultural potential of Pakistan's smallholders. For land redistribution to catalyze broader economic transformation, policy makers must ensure that legal changes are reinforced by on-the-ground investments in irrigation, mechanization, and rural extension services. Only then can equitable land access translate into sustained productivity gains, poverty reduction, and long-term political stability across Pakistan's agrarian landscape.

Objectives of Land Reforms in Pakistan

Land reforms in Pakistan have been driven by multifaceted objectives aimed at transforming the agrarian economy, reducing poverty, promoting social justice, and fostering political stability. One central goal has been to dismantle entrenched feudal structures and enhance economic efficiency and growth. Historically, large landowners, known as zamindars, controlled vast estates, while small farmers toiled as tenants under exploitative conditions. The 1959 Land Reforms under Ayub Khan and the more extensive 1972 reforms under Zulfikar Ali Bhutto imposed ceilings on landholdings, initially 500 acres, later reduced to 150 acres for irrigated land, to transfer surplus land to landless peasants (Khan, 2004). Although loopholes such as benami transfers (holding land in proxy names) allowed many zamindars to retain de facto control, redistributed plots nonetheless demonstrated higher per-acre productivity as smallholders invested intensive labor, adopted improved crop management, and applied traditional knowledge more effectively than absentee landlords (Hussain, 2018). Secure land tenure became recognized as crucial for incentivizing farmers to invest in irrigation systems, high-yield seed varieties, and mechanization, factors essential for modernizing Pakistan's agricultural sector.

A second objective has been poverty alleviation. Rural poverty remains pervasive: 39.5% of rural households still fall below the poverty line (World Bank, 2021). By granting land to landless peasants, reforms sought to promote self-sufficiency and create stable income sources. Between 1959

and 1977, approximately 4.5 million acres were redistributed, benefiting a fraction of the rural poor and creating modest improvements in household welfare for those beneficiaries (Gazdar & Mallah, 2013). Access to land also enhances credit availability, as land can serve as collateral for loans. Yet only 27% of small farmers currently have formal credit access (State Bank of Pakistan, 2022), constraining their ability to acquire productivity-enhancing inputs such as fertilizers and tractors, and thereby limiting the broader impact of redistributive policies on poverty reduction.

Promoting social equity and justice constitutes a third objective. Land inequality remains stark: 5% of landowners control nearly 64% of agricultural land (Pakistan Bureau of Statistics, 2020). By aiming to redistribute land, reforms sought to empower marginalized groups, including women, who own less than 3% of agricultural land despite constituting a significant portion of farm labor (FAO, 2021). The 2019 Punjab Protection of Women's Property Rights Act represented an important step toward securing women's inheritance rights, yet cultural norms, legal ambiguities, and weak enforcement continue to undermine its effectiveness. Greater land access for women could strengthen their economic independence, reduce gender disparities, and improve household nutrition and education outcomes.

Finally, land reforms have aimed to foster political stability and reinforce democratic governance. Land inequality has historically fueled rural unrest, evident in movements such as the Haris Committee protests of 1949 and the Anjuman-e-Mazareen Punjab agitation in the early 2000s, both of which demanded tenant rights and equitable land distribution. In theory, successful land reforms would diffuse feudal power, broaden economic participation, and reduce social tensions. However, persistent political resistance from landed elites has often stalled reform implementation, as reflected in the 2018 agricultural census that revealed continued land concentration and limited disruption of feudal structures. Ensuring lasting political stability requires not only legislative changes but also robust enforcement mechanisms and sustained political will to overcome elite capture.

In summary, the objectives of land reforms in Pakistan, enhancing economic efficiency, alleviating poverty, promoting social justice, and ensuring political stability, underscore the complex interplay between agrarian structures and national development. While progress has been uneven, these goals remain central to policy debates as Pakistan seeks to transform its agricultural landscape and improve rural livelihoods.

Impact on Agricultural Productivity

Land reforms in Pakistan have the potential to significantly boost agricultural productivity by aligning landownership with those most motivated to cultivate. Data from IFPRI (2020) show that small farms, those under five acres, produce yields per acre that are approximately 30% higher than larger estates. This productivity premium arises from labor-intensive practices, careful land stewardship, and the ability of smallholders to closely monitor their crops. When a farmer holds secure title to even a modest plot, they are more likely to invest in soil improvements, experiment with high-yield seed varieties, and adopt better crop management techniques. However, one unintended consequence of redistributive policies has been land fragmentation: as plots are subdivided across generations, individual holdings may shrink to sizes that are not economically viable. Small parcels can limit the adoption of mechanization and reduce economies of scale, ultimately dampening the productivity gains that land redistribution initially sought to stimulate.

Complementary policies are essential for realizing the full productivity potential of land reforms. Subsidized fertilizers and improved irrigation infrastructure, such as lining canals, rehabilitating watercourses, and introducing drip irrigation in water-scarce areas, can raise yields substantially. For example, the Kisan Card Scheme (2023) aims to digitize subsidy delivery and streamline input procurement via a mobile-enabled card, but its impact is constrained by only 28% rural internet connectivity (PTA, 2023). Digital extension services, when effectively deployed, can bridge this gap by delivering customized agronomic advice directly to farmers' mobile phones. Enhanced access to credits and crop insurance also encourages smallholders to invest confidently, knowing they can borrow for inputs without fear of exploitative interest rates. Without these complementary measures, land reforms alone often fail to translate into sustained productivity gains.

Land Reforms and Rural Development

Redistribution of land can catalyze wider rural development by injecting purchasing power into previously landless households. When new landowners purchase seeds, fertilizers, and basic machinery, local demand for agricultural inputs rises, generating business for seed vendors, agrochemical suppliers, and service providers. This surge in economic activity can spur the growth of agro-based industries, such as dairy processing, cold-storage facilities, and textile production, by creating reliable supply chains of raw materials. As farm incomes rise, families can afford better nutrition, send their children to school, and access primary healthcare services, creating a positive cycle of human capital development.

Despite these potential benefits, Pakistan's rural growth remains stunted by inadequate infrastructure, poor market access, and acute climate vulnerabilities. Unpaved roads mean that even productive harvests may perish before reaching markets, and insufficient storage facilities lead to high post-harvest losses. In regions prone to floods or droughts, smallholders typically lack resources to implement climate

adaptation measures. Consequently, to truly electrify rural economies, land reforms must be part of integrated policy packages that invest in rural roads, market linkages, and climate-resilient infrastructure such as flood embankments and rainwater harvesting systems.

Challenges in Implementation

Elite resistance poses the most formidable obstacle to effective land reform. Powerful landowners often exploit legal loopholes, such as benami transfers and complex inheritance regulations, to retain control over surplus holdings. Their political influence further hampers genuine redistribution, as they can sway bureaucratic decisions and delay land title registrations. A weak institutional framework exacerbates these issues: only 67% of land records are digitized as of 2023, leaving significant portions of rural Pakistan reliant on outdated paper records that are prone to forgery and mismanagement. Without transparent and accessible land registries, it is difficult to enforce redistribution mandates or resolve disputes.

A third challenge is the absence of necessary complementary reforms. Even when land is redistributed, beneficiaries frequently lack access to affordable credit, extension services, and rural infrastructure, undermining the productivity and development goals of the reforms. Finally, persistent gender disparities further weaken impact: while women legally have inheritance rights, social norms and family pressures often prevent them from taking up land titles. As a result, female farmers, who comprise 70% of rural agricultural labor, miss out on the benefits of land ownership, perpetuating cycles of poverty and underdevelopment. Addressing these intertwined challenges requires a comprehensive approach that combines legal reform, institutional capacity building, and targeted investments in rural communities.

Conclusion

In Pakistan, land reforms have sought to dismantle feudal structures and equip smallholders with secure tenure, aiming to boost agricultural productivity and alleviate rural poverty. While initial policies in the 1950s and 1970s imposed acreage ceilings, loopholes and elite resistance limited genuine redistribution. Subsequent adjustments strengthened tenancy rights but still fell short due to weak implementation, inadequate extension services, and restricted access to credit. Consequently, landlessness and underemployment persisted, keeping many rural households mired in poverty.

Where land was successfully redistributed, accompanied by improved irrigation, subsidized inputs, and better market linkages, smallholders achieved yield increases of up to 20% and Gini coefficients for land distribution decreased by several percentage points. These pockets of progress also saw more participatory local governance and fewer rural uprisings. Yet, systemic challenges remain only two-thirds of land records are digitized, elite capture continues to distort resource allocation, and just over a quarter of small farmers can access formal credit. Gender disparities further weaken outcomes, as women still hold under 3% of land despite constituting most of the agricultural labor.

For land reforms to catalyze broad-based economic transformation, they must be paired with investments in rural infrastructure, irrigation networks, farm roads, and digital extension platforms, as well as targeted credit and insurance schemes. By reinforcing legal changes with on-the-ground support systems, policymakers can ensure equitable land access translates into sustained productivity gains, poverty reduction, and long-term political stability across Pakistan's agrarian landscape.

References: FAO; Gazdar & Mallah; Hussain; Pakistan Economic Survey; World Bank; Khan; State Bank of Pakistan; Pakistan Bureau of Statistics; IFPRI; PTA

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Climate Change and Agriculture in Pakistan

Explore how climate change threatens agriculture in Pakistan, impacting food security and livelihoods. Discover climate-smart agriculture (CSA) solutions that enhance resilience and improve yields amidst erratic weather patterns.

Aisha Ghouri

5/2/2025

Pakistan's agriculture sector, which contributes approximately 19% to the national GDP and employs nearly 38% of the labor force, is increasingly vulnerable to the escalating impacts of climate change (World Bank, 2024). The frequency and intensity of extreme weather events, such as heatwaves, prolonged droughts, flash floods, and unseasonal rainfall, have surged in recent years, threatening national food security and pushing rural communities toward economic instability. The catastrophic floods of 2022 stand as a grim reminder, having submerged 4.4 million acres of cropland, destroyed critical irrigation infrastructure, and inflicted an estimated $30 billion in losses to the agricultural economy (NDMA, 2023). Simultaneously, droughts in arid regions like Balochistan have slashed wheat yields by 40%, intensifying food shortages and displacing entire communities reliant on rain-fed farming systems (PMD, 2024).

Climate projections indicate a dire future unless adaptation strategies are urgently implemented. Pakistan is expected to face a temperature rise of 2.8°C by 2050, which would exacerbate water scarcity, alter growing seasons, and increase crop vulnerability to pests and diseases. Traditional farming methods are ill-equipped to withstand such pressures, making a shift toward Climate-Smart Agriculture (CSA) not only advisable but essential.

CSA offers a suite of strategies aimed at increasing productivity, enhancing resilience, and reducing greenhouse gas emissions. These include drought-resistant seed varieties, efficient irrigation techniques like drip and sprinkler systems, agroforestry, weather-indexed insurance, and conservation agriculture practices such as minimum tillage and mulching. Despite proven success in localized pilot projects, the large-scale adoption of CSA in Pakistan remains limited due to barriers such as lack of awareness, inadequate financing, and weak institutional coordination.

The Climate Crisis and Pakistan's Agriculture

The climate crisis has emerged as a formidable challenge to Pakistan's agricultural sector, placing both crops and livelihoods at increasing risk. As one of the top ten most water-stressed countries globally, Pakistan is witnessing a troubling rise in drought frequency and severity, particularly in the provinces of Balochistan and Sindh (World Resources Institute, 2023). Rain-fed agricultural systems, which support a significant portion of the rural population in these regions, are becoming increasingly unreliable. The Pakistan Meteorological Department (PMD, 2024) has reported a 35% increase in drought frequency since 2000, with critical crops such as wheat and barley facing major yield reductions. Diminishing water tables, erratic rainfall, and soaring temperatures are leaving farmers unable to plan planting and harvesting schedules with any degree of certainty.

At the same time, the country is vulnerable to devastating floods that cause abrupt and widespread damage. The monsoon season has become increasingly unpredictable, triggering extreme rainfall events that result in flash floods and river overflows. The catastrophic 2022 floods affected over 33 million people, destroyed approximately 2.3 million hectares of agricultural land, and severely disrupted national food supply chains (FAO, 2023). These floods not only wash away crops but also destroy vital infrastructure such as roads, storage facilities, and irrigation systems, making recovery difficult and long drawn.

The dual threats of drought and flooding are placing Pakistan's food security, rural employment, and export earnings under immense strain. Without targeted adaptation strategies, it is projected that agricultural GDP could decline by 8–10% annually by 2030 due to climate-related losses (UNDP, 2023). The increasing unpredictability of weather patterns demands urgent attention to climate-resilient agricultural practices, better water governance, and investment in early warning and disaster response systems to safeguard Pakistan's agrarian economy against these mounting threats.

Climate-Smart Agriculture (CSA) Strategies in Action

Climate-Smart Agriculture (CSA) has become a vital strategy for building resilience in Pakistan's agricultural sector, particularly in the face of growing climate risks such as droughts, floods, and soil degradation. In arid zones like Sindh's Thar Desert, farmers have begun cultivating drought-tolerant crops such as *Thar-2023* millet, which yields up to 2.5 tons per hectare while using 30% less water, according to the Pakistan Agricultural Research Council (PARC, 2023). Similarly, in Balochistan, the heat-resistant Chakwal-50 wheat variety has led to a 25% yield increase even in areas where temperatures regularly exceed 45°C (CIMMYT, 2024). Alongside these crop innovations, precision irrigation methods are gaining traction. In Punjab's barani (rain-fed) areas, drip irrigation systems have helped reduce water usage by 60% and simultaneously doubled vegetable yields (Punjab Agriculture Department, 2024). In Sindh's Umerkot district, the installation of solar-powered tube wells has benefited over 50,000

farmers, lowering diesel fuel costs by an impressive 70% (World Bank, 2024).

Flood-prone regions have also implemented CSA strategies to mitigate damage. In Khyber Pakhtunkhwa, the Swat-1 rice variety, which can withstand up to 14 days of submergence, is now cultivated by more than 12,000 farmers (IRRI, 2023). The flood-tolerant Sarshar sorghum variety has been instrumental in reducing crop losses by 35% in waterlogged areas (PARC, 2024). Infrastructure-based solutions, such as the rehabilitation of Sindh's Left Bank Outfall Drain (LBOD) system, have also been critical. This upgrade shortened floodwater stagnation in Badin district from 30 to just 7 days, thereby saving 50,000 hectares of farmland (Sindh Irrigation Department, 2023).

Agroforestry and soil health improvements are proving to be essential complementary strategies. In Punjab, the planting of native Kikar and Ber trees has decreased wind erosion by 50% and boosted cotton yield by 18% (Punjab Forest Department, 2024). In Balochistan, the use of biochar, carbonized organic matter, has improved soil moisture retention by 40%, increasing drought resilience (ICARDA, 2023).

A comprehensive CSA pilot project launched in 2023 in Punjab's Chakwal and Bhakkar districts illustrates the benefits of integrated approaches. The initiative combined drought-tolerant wheat, laser land leveling, and agroforestry belts. Farmers reported a 22% increase in wheat yield, a 45% reduction in water usage, and a 60% decline in soil erosion. Adoption rates ranged from 42% to 68%, highlighting the tangible benefits of CSA. However, 58% of participating farmers noted that high upfront costs remain a significant barrier, emphasizing the need for financial support and policy incentives to scale up CSA practices nationwide.

Barriers to CSA Adoption

Despite the proven effectiveness of Climate-Smart Agriculture (CSA) in mitigating climate impacts, its widespread adoption in Pakistan remains limited due to several institutional, financial, and infrastructural barriers. Fragmented policy coordination between federal and provincial agriculture departments continues to delay effective CSA implementation. Different provinces follow disjointed strategies without a unified national vision, making it difficult to scale successful practices or ensure continuity in climate adaptation programs. Additionally, Pakistan's investment in agricultural research and development is severely underfunded. The country allocates just 0.3% of its agricultural GDP to R&D, well below the global average of 1.5% (World Bank, 2024), constraining innovation in crop genetics, irrigation technology, and soil management tailored to regional needs.

Moreover, smallholder farmers, who make up the majority of Pakistan's agricultural workforce, face persistent barriers in accessing CSA technologies. High costs of equipment like drip irrigation systems or climate-resilient seeds, combined with limited credit access, prevent these farmers from transitioning to sustainable practices. Meanwhile, weak early warning systems remain a major vulnerability. The Pakistan Meteorological Department (PMD, 2024) reports that only 30% of farmers receive timely weather alerts, leaving many unprepared for floods, droughts, or heatwaves.

To address these challenges, a multi-tiered policy framework is essential. Establishing a National CSA Fund would ensure dedicated financial resources, with at least 5% of provincial agriculture budgets allocated to subsidize technologies such as drip irrigation, flood-resistant seeds, and soil enhancers like biochar. Leveraging international climate finance instruments, including the Green Climate Fund (GCF), could further support smallholders.

Expanding early warning systems through the deployment of IoT-based weather sensors in drought-prone districts and partnerships with space agencies like NASA and ESA for satellite forecasting would improve preparedness. Strengthening farmer cooperatives can foster collective action—enabling group purchasing of CSA inputs and shared access to machinery. Finally, reinforcing research collaborations between national institutions like PARC and international centers such as CIMMYT, and investing in gene-editing for heat-tolerant crops, will help localize solutions for climate resilience in agriculture.

Conclusion

Climate change has emerged as a defining challenge for Pakistan's agricultural future, threatening the livelihoods of millions and undermining the foundations of national food security. As the country grapples with increasingly erratic weather patterns, ranging from prolonged droughts to devastating floods, it is evident that traditional agricultural systems can no longer meet the demands of a rapidly changing climate. The evidence presented in this article underscores both the urgency of the crisis and the promise of solutions. Climate-Smart Agriculture (CSA) has proven to be a viable and impactful response, with successful case studies from across Pakistan demonstrating its ability to improve yields, reduce resource use, and enhance climate resilience.

From drought-tolerant wheat in Balochistan to solar-powered irrigation in Sindh and submergence-resilient rice in Khyber Pakhtunkhwa, CSA offers a pathway to transform vulnerability into opportunity. However, the road to widespread adoption remains fraught with challenges—insufficient funding, fragmented policies, weak research investment, and limited farmer access to climate-resilient tools.

Moving forward, the adoption of a national CSA framework, supported by targeted subsidies, robust extension systems, and access to climate finance, is critical. Building institutional capacity, investing in agricultural R&D, and engaging smallholders through cooperatives and digital tools will ensure that CSA is not just a pilot initiative but a nationwide movement. In doing so, Pakistan can lay the groundwork for a more resilient, equitable, and sustainable

agricultural economy, one that safeguards its people, secures its food systems, and strengthens its ability to withstand the storms ahead.

References: CIMMYT; FAO; ICARDA; NDMA; Punjab Agriculture Department; World Bank; UNDP; PMD; World Resources Institute; PARC; IRRI; Sindh Irrigation Department; Punjab Forest Department

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Bridging the Digital Divide in Pakistani Agriculture

Addressing the digital divide in Pakistani agriculture is essential for tackling climate change and food insecurity. This socio-economic imperative focuses on empowering smallholder farmers through Improving connectivity, digital literacy, lowering technology costs, and removing gender disparities.

Alina Arain

5/2/2025

Agriculture is the backbone of Pakistan's economy, employing 38% of the national workforce and supporting nearly 65% of the rural population (World Bank, 2024). Yet, the sector remains largely underserved by digital technology. Despite the emergence of cutting-edge agri-tech tools, ranging from AI-based crop monitoring and IoT-powered irrigation to blockchain traceability for supply chains, only 12% of smallholder farmers in Pakistan, defined as those cultivating less than five acres, are currently using any form of digital technology (AgriTech Pakistan, 2024). This digital exclusion is deepening rural poverty, stagnating productivity, and reducing farmers' ability to cope with the growing challenges of climate change, pests, and erratic markets.

In 2023, Pakistan introduced its Digital Agriculture Transformation Plan with ambitious goals to digitize farming practices through artificial intelligence, smart devices, and precision agriculture. While promising on paper, the implementation has remained uneven and largely inaccessible to smallholders, who make up over 85% of the country's farmers. The reasons are manifold: limited internet connectivity in rural areas, lack of digital literacy, unaffordable technologies, and weak extension systems. Consequently, farms that are not digitally integrated yield 30-40% less than those using tech-enhanced practices (FAO, 2024), highlighting a growing productivity gap.

This growing digital divide directly fuels rural poverty and food insecurity. Farmers without access to real-time weather updates, disease forecasts, or market prices are more vulnerable to shocks, forced to sell their produce at lower rates or suffer from crop losses. It also affects women disproportionately, who face additional cultural and financial barriers to accessing mobile-based advisory services or online marketplaces. Addressing this divide requires urgent policy interventions such as rural internet infrastructure, subsidized smart tools for smallholders, digital literacy campaigns, and inclusive tech platforms tailored to low-resource environments. Without bridging this gap, the promise of digital transformation risks passing by those who need it most.

The Four Pillars of the Digital Divide

The digital divide in Pakistan's agricultural sector is underpinned by four interconnected pillars: infrastructure gaps, digital illiteracy, affordability barriers, and gender disparities. These challenges significantly hinder the adoption of agricultural technologies, particularly among smallholder farmers, further deepening rural poverty and limiting national food security.

The first barrier is infrastructure. Reliable internet and electricity are prerequisites for any digital transformation, yet only 22% of rural Pakistan has 4G connectivity (PTA, 2024). In regions like Sindh's Thar Desert, 90% of farmers lack internet access altogether. In Balochistan, some communities are completely cut off, with farmers walking several kilometers to find a mobile signal (GSMA, 2024). Electricity access is similarly uneven, 45% of Balochistan's villages have no electricity, and in Punjab, daily power outages lasting 8–10 hours disrupt the functioning of IoT-based irrigation systems (NEPRA, 2023; Punjab Energy Department, 2024).

Secondly, digital illiteracy is a major obstacle. Nearly 78% of farmers over the age of 40 are unable to operate smartphones (Gallup Pakistan, 2024). Additionally, many government agri-apps are in Urdu, leaving speakers of regional languages like Punjabi, Seraiki, and Sindhi at a disadvantage (PARC, 2024). An example is the Punjab Agriculture Department's failed CropCare app (2022), which saw only 12% adoption. Reasons included a mismatch between language and local dialects, lack of SMS-compatible phones, and generic pest alerts that ignored local variability (Punjab Agri-Tech Report, 2023).

Affordability poses the third challenge. Most digital farming tools are priced out of reach for smallholders. A basic IoT soil sensor cost Rs15,000, equivalent to 40% of a smallholder's annual income (AgriTech Pakistan, 2024). Drones, priced over Rs200,000, are even less accessible (World Bank, 2024). However, KP's e-Kisan Voucher Program (2023) showed that subsidizing 50% of the cost increased adoption by 35%, demonstrating that affordability can be a catalyst for uptake (KP Agriculture Dept., 2024).

Finally, gender disparities exacerbate the divide. While women manage up to 70% of livestock, 85% of rural women do not own a mobile phone (GSMA, 2023). Cultural norms often restrict women from participating in training sessions, especially in conservative areas like KP (UN Women, 2024). The Punjab Women Development Department's Nawabari app (2023) tackled this by offering female-exclusive content in regional languages. As a result, it empowered

30,000 women and boosted kitchen garden yields by 25%.

The impact of this divide is measurable. According to the Pakistan Agri-Tech Coalition (2024), tech-enabled farms have a 47% higher wheat yield, 60% higher income, and significantly lower post-harvest losses compared to non-tech farms. Bridging the digital divide is not just about access, it is about equity, empowerment, and national resilience.

Breaking Barriers: Successful Models

Successful models of digital inclusion in Pakistan's agriculture sector demonstrate that bridging the digital divide is possible through localized, inclusive, and collaborative approaches. In Sindh, the Dharti App has made significant strides by offering an interface in Sindhi, which led to a 55% adoption rate among cotton farmers who were previously disconnected from digital advisories (Sindh AgriTech, 2024). Similarly, Khyber Pakhtunkhwa's radio-based alerts system has reached 80% of non-literate farmers, delivering daily weather and crop updates without requiring smartphones or internet access (KP Agriculture, 2023). These examples show that when digital tools are customized to local linguistic and literacy contexts, adoption rates improve dramatically.

Public-private partnerships (PPPs) have also been instrumental in reducing affordability barriers and expanding outreach. Telenor's Kisan Dost initiative provided subsidized smartphones for as little as Rs1,500 per month, bundled with farming advisory apps. Meanwhile, JazzCash's agri-loan program has enabled over 150,000 farmers to obtain collateral-free loans specifically for purchasing agri-tech tools (Jazz, 2024). These PPPs illustrate how telecom and fintech sectors can jointly accelerate digital inclusion.

Women-focused programs are proving especially transformative. UN Women's Digital Saheli initiative trained 12,000 women to use moisture sensors for better crop management, while the Nawabari App in Punjab reached 30,000 female users with localized tutorials and extension services (Punjab WDD, 2024). These initiatives demonstrate that when technology is gender-sensitive, women can become key drivers of agricultural innovation.

To scale these successes, several policy recommendations are essential. Universal rural connectivity must be prioritized, with at least 5% of CPEC infrastructure funds allocated to 4G/5G expansion and satellite internet partnerships like Starlink to serve remote regions. Digital literacy drives, such as mobile e-Khidmat vans and school-level agri-tech courses, will build long-term capacity. Tech affordability can be improved by replicating India's DIGITAL GREEN model, distributing free tablets to farmer groups, and through tax exemptions for locally produced agri-tech devices. Gender inclusion must be institutionalized by reserving 40% of agri-tech program slots for women and setting up female-only training centers in conservative areas. Together, these actions can build a digitally empowered rural economy.

Conclusion

Bridging the digital divide in Pakistani agriculture is not just a technological necessity, it is a socio-economic imperative. As the country grapples with mounting challenges of climate change, food insecurity, and rural poverty, digital inclusion has emerged as a transformative pathway to resilience and growth. Smallholder farmers, who form the backbone of Pakistan's agricultural output, remain largely excluded from the digital revolution due to systemic barriers including poor connectivity, digital illiteracy, high technology costs, and gender disparities. Yet, successful localized initiatives, from radio-based advisories in KP to Sindhi-language mobile apps in Sindh, demonstrate that when solutions are tailored to real-world contexts, adoption and impact increase significantly.

Moving forward, a holistic policy framework is essential. This must prioritize universal internet coverage, public-private investment in affordable tools, context-sensitive training, and gender-inclusive platforms. The experiences of the e-Kisan Voucher Program and Nawabari App show that digital equity is attainable when affordability, access, and awareness align. Technology, if made inclusive, can empower farmers with timely information, reduce post-harvest losses, enhance yields, and connect producers directly to markets.

Ultimately, digital agriculture is not about replacing tradition, it's about equipping traditional farmers with modern tools to thrive. Ensuring that no farmer is left behind in this digital transformation is key to Pakistan's sustainable and inclusive agricultural future.

References: FAO; GSMA; KP Agriculture Department; Punjab Women Development; World Bank; AgriTech Pakistan; PTA; NEPRA; Punjab Energy Department; Gallup Pakistan; PARC; UN Women; Sindh AgriTech; Punjab WDD

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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Modernizing Sindh's Irrigation Infrastructure

Modernizing Sindh's irrigation infrastructure is essential for agricultural sustainability and water security. Addressing outdated systems is crucial for meeting the demands of a growing population, worsening climate conditions, and increasing food insecurity.

Aisha Ghouri

5/6/2025

Sindh, Pakistan's agricultural heartland, plays a vital role in ensuring national food security, producing over 60% of the country's rice and 35% of its wheat (Sindh Agriculture Department, 2022). Yet, this potential is severely hampered by an outdated irrigation system that dates to colonial times. The reliance on flood irrigation method with just 35% efficiency has led to significant water losses, with approximately 5.2 million acre-feet lost annually to seepage and evaporation (World Bank, 2023). This inefficiency is exacerbated by the extremely low adoption of modern irrigation methods such as drip and sprinkler systems, which account for less than 2% of total irrigation practices in the province.

The implications of this outdated system are profound. Climate change is intensifying water scarcity through erratic rainfall patterns and declining river flows, while population growth continues to drive up demand for food and water. Without immediate reforms, Sindh faces worsening water stress, declining crop yields, and heightened food insecurity.

Modernizing Sindh's irrigation infrastructure is not just a technical challenge but a socio-economic necessity. Potential solutions include lining canals to prevent seepage, subsidizing drip and sprinkler technologies, investing in solar-powered pumps, and introducing precision irrigation supported by satellite data. These measures can dramatically improve water-use efficiency, reduce production costs, and enhance climate resilience. Moreover, integrating farmer training programs and community-based water management can ensure sustainable adoption and long-term impact. As one of the most water-stressed regions in Pakistan, Sindh must transition from inefficiency to innovation to protect its agricultural future. The urgency of reform cannot be overstated modern irrigation is essential for sustaining productivity, conserving precious water resources, and securing livelihoods in one of Pakistan's most important agricultural zones.

Current State of Irrigation in Sindh

Sindh's irrigation system, a relic of British colonial engineering from the 19th century, spans approximately 9,000 miles of canals and distributaries (PCRWR, 2020). Despite its vast reach, the network is increasingly inefficient due to decades of neglect, poor maintenance, and outdated practices. One of the most pressing issues is the prevalence of unlined canals, over 80% of the system lacks proper lining, resulting in massive seepage losses estimated at 40–50% (World Bank, 2023). In addition, evaporation further exacerbates water loss, especially in Sindh's arid districts such as Tharparkar and Badin, where high temperatures lead to 15–20% evaporation of surface water (FAO, 2021).

The dominance of flood irrigation, used by more than 90% of farmers, compounds the problem. This method is notoriously inefficient, wasting 50–60% of the water applied and contributing to severe land degradation (PCRWR, 2020). As a result, waterlogging and soil salinity have become chronic issues, leaving nearly 27% of Sindh's arable land unproductive and threatening long-term agricultural sustainability (Sindh Agriculture Department, 2022).

Moreover, water distribution remains highly inequitable. The existing legal framework, shaped during colonial times, disproportionately favors large landholders and upstream users. Small farmers in tail-end areas like Badin and Tharparkar often face acute water shortages, undermining their livelihoods and triggering local disputes (UNDP, 2023). Political interference in water allocation further disrupts fair distribution, with decisions often influenced by patronage rather than need or equity (World Bank, 2023). Collectively, these structural inefficiencies present formidable challenges to Sindh's agricultural productivity and water security. Addressing them requires a comprehensive modernization strategy that rethinks infrastructure, governance, and water-use practices to ensure sustainable and equitable access for all stakeholders.

Challenges to Modernization

Modernizing Sindh's irrigation infrastructure is a critical, yet complex endeavor hindered by intertwined financial, technical, and institutional barriers. Foremost among these are severe financial constraints. Upgrading the province's outdated irrigation system is estimated to cost between $2 to $3 billion, an immense challenge given that 37% of Sindh's rural households live below the poverty line (Sindh Agriculture Department, 2022). Government support for this transformation remains inadequate, with subsidies for modern technologies like drip and sprinkler systems reaching only 5% of farmers (FAO, 2021). The lack of accessible credit and targeted investment leaves most smallholders unable to adopt more efficient irrigation solutions.

Technical barriers further slow progress. Most farmers are unfamiliar with the

installation, maintenance, and operation of precision irrigation systems, which require a shift from traditional flood irrigation. Energy costs add another layer of difficulty; electric and diesel-powered pumps are costly to operate, making pressurized systems unaffordable for many small-scale cultivators (UNDP, 2023). These challenges are compounded by the absence of structured training programs or farmer extension services to facilitate the adoption of modern practices.

Institutional inertia represents yet another major roadblock. Bureaucratic delays, political interference, and fragmented governance have paralyzed key initiatives like the Sindh Irrigated Agriculture Productivity Enhancement Program (SIAPEP). Corruption within water governance structures also remains endemic. Illegal water diversions by influential actors deprive tail-end farmers of their fair share, undermining both efficiency and equity in water distribution (World Bank, 2023). Without robust regulatory oversight and transparent mechanisms, even well-funded modernization projects risk failure.

Despite these challenges, a coordinated and forward-looking strategy could unlock Sindh's potential. Shifting to precision irrigation through drip and sprinkler systems can drastically improve efficiency, as seen in Punjab's cotton fields where drip systems increased yields by 22% (PCRWR, 2020). Replacing diesel pumps with solar-powered alternatives could lower operationally costs by up to 70%, making high-efficiency systems more accessible (UNDP, 2023). Lining even a portion of the province's canals, 1,000 miles, for instance, could save up to 2.8 million acre-feet of water annually, while deploying smart meters and IoT sensors could monitor real-time flows and curb theft.

Innovative approaches such as solar desalination and wastewater recycling offer additional pathways. Coastal areas like Thatta and Karachi could benefit from solar-powered desalination plants, turning brackish groundwater into usable supply. Reclaiming and treating Sindh's municipal wastewater, of which 80% remains untreated, could irrigate up to 500,000 acres, reducing dependence on freshwater sources (PCRWR, 2020).

Policy reform is equally critical. Establishing a Provincial Water Authority to oversee water allocation, crack down on illegal extractions, and digitize water governance could dramatically improve outcomes. Public-private partnerships (PPPs), like those proposed in the Green Pakistan Initiative, can mobilize funding and technical expertise for projects such as canal lining and solar pump installation. International collaboration with the World Bank, ADB, and FAO could provide both financial backing and technical guidance. Subsidizing up to 50% of the cost of modern systems and offering interest-free loans for solar technology would provide the financial stimulus needed to jumpstart this transformation.

Conclusion

Modernizing Sindh's irrigation infrastructure is no longer a matter of choice, it is a necessity for the province's agricultural sustainability, water security, and socio-economic development. The current system, built for a different era, can no longer meet the demands of a growing population, worsening climate conditions, and increasing food insecurity. While the challenges are significant, ranging from financial and technical constraints to entrenched institutional inefficiencies, they are not insurmountable. Through a combination of smart investments, policy reform, and community engagement, Sindh can transition from water inefficiency to innovation.

Prioritizing canal lining, promoting precision irrigation, expanding solar-powered systems, and recycling wastewater are all viable solutions with proven benefits. However, technology alone will not suffice without transparent governance, equitable water distribution, and strong institutional support. Farmers must be empowered through training and incentives, and the public sector must collaborate with private and international partners to mobilize resources. Sindh stands at a critical juncture; failure to act now will only deepen the water crisis and erode agricultural resilience. With bold action, inclusive planning, and sustained commitment, Sindh can transform its irrigation landscape and secure a more sustainable and prosperous future for its farmers and the nation at large.

References: World Bank; FAO; PCRWR; UNDP; Sindh Agriculture Department; Green Pakistan Initiative

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Jujube: A Solution for Climate-Resilient Agriculture

Discover how jujube (ziziphus mauritiana) can transform Pakistani agriculture in the face of climate change. Learn about its adaptability, minimal resource needs, and economic benefits that enhance farmer income while promoting ecological balance.

Mahgul Ashique Ali

5/7/2025

Climate change is increasingly threatening global agriculture, especially in vulnerable regions like South Asia, where shifting weather patterns, heatwaves, and water scarcity are undermining food production and farmer livelihoods. Pakistan, which contributes significantly to regional agricultural output, is among the top ten countries most affected by climate-related disasters, according to the Global Climate Risk Index 2021 (Eckstein et al., 2021). With agriculture accounting for 18.9% of the national GDP and employing a large portion of the rural workforce, building resilience in this sector is critical for economic stability and food security. Conventional crops such as rice, wheat, and sugarcane are becoming less viable due to their high water demands and sensitivity to climate extremes. In this context, the adoption of climate-resilient crops is not only an adaptation strategy but an economic necessity.

Jujube (Ziziphus mauritiana), locally known as “ber,” presents a compelling case for climate-smart agriculture in Pakistan. This underutilized fruit tree thrives in arid and semi-arid climates, requires minimal water, and performs well in degraded or saline soils. Its adaptability to harsh conditions makes it an ideal alternative for areas facing desertification or groundwater depletion. Jujube also matures relatively quickly and bears fruit within three to four years, providing farmers with an early return on investment. Nutritionally rich and used in traditional medicine, jujube holds market potential both domestically and for export, especially as demand for functional foods rises globally.

Despite its potential, jujube remains largely marginalized due to limited awareness, poor supply chain infrastructure, and lack of targeted policy support. This article explores the economic and agronomic benefits of jujube cultivation, analyzes current production bottlenecks, and offers policy recommendations to integrate this hardy fruit into Pakistan’s broader climate adaptation and rural development strategy.

Understanding Jujube and Its Unique Strengths

Jujube (Ziziphus mauritiana), a member of the Rhamnaceae family, is a hardy, drought-tolerant fruit tree native to South Asia and parts of Africa. It is well adapted to arid and semi-arid climates, making it an ideal candidate for sustainable agriculture in water-stressed regions. This small deciduous tree can reach heights of 10 to 12 meters and is characterized by a deep root system that enables it to access moisture from subsoil layers. This trait allows jujube to thrive in environments with limited surface water, offering a viable alternative to traditional, water-intensive fruit crops such as mangoes and citrus. Its capacity to endure prolonged dry periods, over two months without irrigation, demonstrates its exceptional drought resistance, which is supported by physiological adaptations like efficient water-use mechanisms and reduced transpiration through its foliage.

Jujube also performs well in poor soil conditions, including saline and degraded lands, which are increasingly common in Pakistan due to unsustainable agricultural practices and climate change. In a country where per capita water availability has plummeted from 5,260 m^3 in 1951 to just 908 m^3 in 2022 (PCRWR, 2022), jujube cultivation offers a sustainable path forward, particularly in arid regions such as Thar, Cholistan, and parts of Balochistan. Furthermore, the tree tolerates extreme temperatures, thriving in conditions up to 50°C—well-suited for areas facing intensifying heatwaves due to global warming (IPCC, 2021). Its moderate salinity tolerance further enhances its appeal in areas where soil degradation has made conventional crops untenable. Given these unique agronomic strengths, jujube emerges as a climate-resilient, low-input crop that can contribute to both ecological sustainability and rural economic stability.

Furthermore, Jujube plays a vital role in promoting climate-resilient agriculture, particularly in water-stressed regions of Pakistan. With the country’s groundwater depleting at an alarming rate of 3.5 meters per year (World Bank, 2021), jujube’s minimal water requirement, typically just 2 to 3 irrigations per season, makes it a sustainable alternative to traditional water-intensive crops like rice and sugarcane. As a deep-rooted perennial tree, jujube contributes to soil restoration by stabilizing degraded land, improving fertility through organic leaf litter, and preventing desertification in arid zones. Moreover, its role in carbon sequestration is significant; mature jujube plantations can capture 5 to 10 tons of CO_2 per hectare annually, helping mitigate greenhouse gas emissions (ICRAF, 2020). When incorporated into agroforestry systems, jujube enhances on-farm biodiversity, provides natural windbreaks and shade for companion crops, and supports pollinator habitats. These attributes not only increase ecological sustainability but also reduce farmers’ exposure to climate-induced shocks, ensuring long-term resilience and productivity.

Expanding its cultivation across Pakistan's vulnerable agro-ecological zones could play a pivotal role in addressing water scarcity, enhancing food security, and adapting to climate-induced stress.

Economic Advantages for Farmers

Jujube cultivation offers significant economic advantages for smallholder farmers, particularly in resource-constrained regions of Pakistan. Its appeal lies in high productivity combined with low production costs. Unlike conventional crops such as rice, cotton, or sugarcane that require intensive inputs, jujube is a low-input crop. It grows well in marginal soils with minimal fertilization, has natural resistance to pests, reducing pesticide costs, and demands less labor for pruning and harvesting. According to Pareek (2013), a mature jujube tree yields between 80 to 160 kg per season, with per-acre input costs approximately 30–40% lower than mango or guava cultivation.

A recent cost-benefit analysis conducted by the Punjab Agriculture Department (2023) estimated the total production cost of jujube at around PKR 120,000 per acre. With average yields of 6,000 to 8,000 kg per acre and farm-gate prices ranging from PKR 80–150 per kg, gross revenues can reach PKR 480,000 to 1,200,000 per acre. This results in net profits between PKR 360,000 and 1,080,000 per acre, depending on market price and yield quality. The estimated Benefit-Cost Ratio (BCR) ranges from 1:3 to 1:9, indicating high economic viability compared to traditional crops, which typically yield a BCR of 1:1.5 to 1:2 under similar conditions (Punjab Agriculture Department, 2023).

Jujube's profitability is further supported by strong domestic and international demand. It is marketed fresh, dried, and in processed forms, and used in traditional medicine for its nutritional and therapeutic value. Farmers in regions like Tharparkar and Hyderabad are increasingly adopting jujube after suffering repeated losses in water-intensive crops due to erratic rainfall. With growing export interest from China, the UAE, and Saudi Arabia (FAO, 2022), and the potential for value-added processing, jujube represents a climate-resilient and economically rewarding crop for sustainable agriculture in Pakistan.

Challenges and Gaps to Address

Despite its resilience and promise, jujube cultivation in Pakistan faces several systemic barriers that hinder its widespread adoption. One of the most significant challenges is limited awareness among farmers. Many continue to cultivate traditional, water-intensive crops despite declining productivity and profitability, primarily due to a lack of exposure to climate-resilient alternatives like jujube. Furthermore, the absence of improved, high-yielding cultivars in the local seed market exacerbates the problem. Most growers rely on inferior, indigenous varieties, whereas high-performing cultivars such as 'Gola' and 'Umran', successfully developed and adopted in India, remain underutilized in Pakistan.

Market limitations further impede the crop's potential. Jujube lacks organized supply chains, formal processing facilities, and branding initiatives that are commonplace for mainstream fruits like mango and citrus. This weak market infrastructure reduces profitability and discourages farmer participation. Moreover, the absence of institutional support reflects policy neglect. Jujube remains largely excluded from national agriculture and climate adaptation policies, resulting in minimal public investment in research, development, or extension services.

To unlock the jujube's full potential, a multifaceted approach is needed. Policy integration is crucial, jujube should be incorporated into frameworks such as Pakistan's National Adaptation Plan for Agriculture, with targeted subsidies for saplings and efficient irrigation systems. Research institutions must prioritize the development of high-yielding, disease-resistant varieties and conduct trials to refine agronomic practices. Farmer awareness can be enhanced through demonstration plots, capacity-building workshops, and peer learning networks. Finally, establishing local processing units for dried fruit, herbal products, and value-added derivatives will help formalize supply chains and improve market access. Creating export linkages, particularly to high-demand markets like the Middle East and China, can significantly boost profitability. These interventions can transform jujube from a neglected crop into a cornerstone of climate-smart agriculture in Pakistan.

Conclusion

Jujube (Ziziphus mauritiana) stands out as a powerful, underutilized solution to many of the challenges facing Pakistani agriculture in the era of climate change. Its remarkable adaptability to arid and semi-arid conditions, minimal water and input requirements, and ability to thrive on degraded or saline soils make it an ideal candidate for climate-resilient farming. Economically, jujube offers impressive returns on investment with a high benefit-cost ratio and strong market demand both locally and internationally. It holds promise not only for enhancing farmer income but also for restoring ecological balance by supporting soil health, biodiversity, and carbon sequestration.

However, realizing these potential demands concerted efforts to address the existing gaps in awareness, policy support, research, and market development. Integrating jujube into national agricultural strategies, investing in improved varieties, building supply chains, and training farmers are essential steps. With coordinated action from government, research institutions, and the private sector, jujube cultivation can be scaled up to serve as a cornerstone of sustainable agriculture. In doing so, it can help secure livelihoods, conserve precious water resources, and build a more resilient food system, ensuring that Pakistan's rural economy not only survives but thrives in a changing climate.

References: Eckstein, et al.; FAO; Gao, et al.; PCRWR; World Bank; Pareek, O. P.; Punjab Agriculture Department; IPCC; ICRAF; Pareek

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Enhancing Resource Use Efficiency in Smallholder Farms

Improving resource use efficiency (RUE) in smallholder farms is crucial for sustainable development. By overcoming challenges like land fragmentation and limited access to credit, smallholders can evolve into resilient, market-driven enterprises.

Abdul Khalique Jarwar

5/8/2025

Smallholder farms are the backbone of global food systems, particularly in developing countries where they represent over 80% of all farms and produce more than 70% of the food consumed in regions like Asia and sub-Saharan Africa (FAO, 2021). These farms are critical to food security, rural employment, and poverty alleviation. Despite their importance, smallholder farmers continue to struggle with systemic barriers that suppress productivity and economic viability. Among these, inefficient resource use is one of the most persistent and impactful constraints. Many smallholders operate on marginal lands with limited access to irrigation, inputs, and capital, resulting in suboptimal crop yields and continued economic vulnerability.

Resource use efficiency (RUE) refers to the effective utilization of key agricultural inputs, land, water, labor, fertilizers, and financial resources, to produce maximum output with minimal waste or environmental degradation. Enhancing RUE is not only essential for boosting farm-level productivity and profitability but also for promoting climate-smart and environmentally sustainable agriculture. However, RUE among smallholders is frequently limited by low levels of education, lack of access to extension services, inadequate infrastructure, and fragmented markets.

Addressing these issues requires a multifaceted approach. Technological interventions such as precision farming, drip irrigation, and mobile-based advisory services can help optimize input use. Policy reforms, including targeted subsidies, access to credit, and land tenure security, can remove structural barriers to investment. Additionally, strengthening farmer cooperatives, encouraging participatory research, and promoting gender-inclusive training can enhance social capital and enable more equitable resource distribution. By improving RUE, smallholder farms can transition from survival-based operations to resilient, market-oriented enterprises that contribute meaningfully to global food systems and sustainable development. This article delves into the dimensions, limitations, and opportunities of resource use efficiency, with a focus on empowering smallholders to overcome constraints and achieve long-term agricultural sustainability.

Dimensions of Resource Use Efficiency

Resource Use Efficiency (RUE) in agriculture encompasses three interrelated dimensions: technical, allocative, and economic efficiency. These dimensions provide a comprehensive framework for evaluating how effectively smallholder farmers utilize limited resources to achieve optimal productivity and profitability.

Technical efficiency refers to a farmer's ability to convert inputs, such as land, labor, seeds, and fertilizers—into maximum possible output, like crop yields or livestock products. A technically efficient farm operates on the "production frontier," achieving the best output levels given the input set. However, evidence from developing countries suggests that smallholder farms typically operate at 50–80% technical efficiency, indicating considerable room for productivity enhancement (Ogundari, 2018).

Allocative efficiency assesses whether inputs are used in optimal proportions relative to their costs. A farmer may apply fertilizers correctly in terms of quantity, but if they rely on expensive synthetic variants when more affordable organic alternatives are available, they remain allocatively inefficient. Factors such as market imperfections, credit limitations, and poor access to price information often result in suboptimal input choices (Abdulai & Huffman, 2014).

Economic efficiency integrates both technical and allocative aspects, focusing on whether a farmer maximizes profit given prevailing input and output prices. Smallholder farmers often fall short in this area due to high input costs, volatile market prices, and limited access to profitable markets (Bravo-Ureta et al., 2020).

To measure RUE, agricultural economists commonly employ Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis (SFA). DEA, a non-parametric approach, benchmarks multiple farms against the most efficient ones to identify best practices, although it cannot account for random shocks like weather variability (Coelli et al., 2005). SFA, on the other hand, is a parametric method that separates inefficiency from stochastic events, making it particularly suitable for assessing performance in the volatile environments where smallholders operate (Kumbhakar & Lovell, 2000). Together, these analytical tools help identify gaps and inform targeted interventions to improve smallholder efficiency.

Key Constraints to Resource Use Efficiency in Smallholder Farms

Resource use efficiency (RUE) in smallholder farming systems is often compromised by a combination of structural, economic, and institutional challenges. One of the most critical constraints is land scarcity and

fragmentation. Most smallholders cultivate less than two hectares of land, limiting their ability to benefit from economies of scale (Lowder et al., 2021). Compounding this issue, land degradation now affects approximately 33% of global farmland, eroding productivity and soil health (UNCCD, 2022). Additionally, insecure land tenure discourages long-term investments in conservation practices, irrigation systems, and agroforestry.

Labor shortages also hamper RUE. Smallholders typically rely on family labor, which often lacks the technical skills required for mechanized or precision farming. Seasonal labor unavailability delays critical operations like planting and harvesting, directly affecting yields. Similarly, access to capital and agricultural inputs remains limited. In sub-Saharan Africa, only 30% of smallholders have formal access to credit (World Bank, 2023), making it difficult to afford improved seeds, fertilizers, and pesticides.

Technology adoption is another bottleneck. Fewer than 5% of African smallholders utilize mechanized tools, and digital extension platforms are underutilized due to literacy and infrastructure gaps (AGRA, 2022). Socio-economic and institutional barriers further exacerbate inefficiencies. Female farmers, for instance, have 24% less access to productive resources than men (FAO, 2023), and only 20% of smallholders receive consistent agronomic support from public extension services (IFPRI, 2021). Poor market connectivity results in post-harvest losses of 30–40% due to inadequate storage and weak buyer networks (World Food Program, 2022).

To overcome these constraints and enhance RUE, several targeted strategies are necessary. On the farm level, practices such as Integrated Soil Fertility Management (ISFM) can boost yields by 50–200% (Vanlauwe et al., 2019), while water-saving methods like drip irrigation and rainwater harvesting can reduce water use by up to 60% (IWMI, 2021). Crop diversification and intercropping improve land utilization and resilience. Small-scale mechanization, like two-wheel tractors, can reduce labor costs by 40% (FAO, 2022). At the policy level, ensuring land tenure security, expanding subsidized input programs, promoting digital extension services, and empowering cooperatives can significantly strengthen smallholders' capacity to use resources more efficiently and sustainably.

Conclusion

Enhancing resource use efficiency (RUE) in smallholder farms is not just a technical imperative, it is a socioeconomic and environmental necessity. As the cornerstone of food systems in developing countries, smallholders face a complex web of challenges, from land fragmentation and limited credit access to labor shortages, low technology adoption, and weak market linkages. These constraints collectively suppress productivity and limit the sector's contribution to sustainable development. However, the potential for transformation is equally immense. By addressing the structural and institutional barriers that limit efficiency, smallholder farms can evolve into resilient, market-driven enterprises capable of producing more with fewer inputs while minimizing environmental harm.

A combination of farm-level innovations, such as integrated soil fertility management, small-scale mechanization, and efficient irrigation, alongside supportive policy measures, including land tenure reform, digital advisory systems, and inclusive cooperatives, can drive this change. Moreover, targeted investments in research, gender-sensitive extension services, and rural infrastructure are essential to ensure equitable and widespread improvements. As global demand for food continues to rise and climate pressures intensify, improving RUE among smallholders is one of the most impactful strategies to secure food systems, empower rural communities, and foster long-term agricultural sustainability. The pathway is clear, what remains is the political and institutional will to act.

References: FAO; World Bank; AGRA; IFPRI; Vanlauwe, et al.; Ogundari; Abdulai & Huffman; Bravo-Ureta et al.; Coelli et al.; Kumbhakar & Lovell; Lowder et al.; World Food Program; Vanlauwe et al.; IWMI

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Digital Transformation in South Asia's Agriculture

As South Asia's agricultural sector embraces digital transformation, AI-driven crop analytics and IoT-enabled systems promise to boost productivity and improve rural livelihoods. However, these innovations are vulnerable to cyber threats that could derail entire farming seasons, disrupt food supply.

Masooma Zahra

5/13/2025

Agriculture in South Asia is undergoing a profound digital transformation, reshaping the traditional farming landscape through the integration of cutting-edge technologies. In India and Pakistan, farmers, agribusinesses, and government agencies are increasingly leveraging satellite imagery for crop monitoring, IoT-based soil and moisture sensors for precision irrigation, AI-driven analytics for yield forecasting, and blockchain systems for transparent supply chain management (World Bank, 2023). These advancements are not only helping to boost farm productivity but are also proving essential in tackling persistent structural challenges, such as water scarcity, unpredictable climate conditions, pest outbreaks, and market inefficiencies, that have long plagued the region's agricultural systems (FAO, 2022).

However, this digital shift comes with a new and under-recognized set of risks. As agriculture becomes increasingly data-dependent, it also becomes more susceptible to cyber threats. Vulnerabilities in satellite data streams, farm-level IoT devices, and cloud-based farm management platforms expose the sector to potential hacking, misinformation campaigns, and technological sabotage. These risks are particularly acute in South Asia, where geopolitical tensions between nuclear-armed neighbors like India and Pakistan remain high. In such a contested environment, the weaponization of agri-tech systems, whether through disrupting irrigation data, corrupting yield forecasts, or falsifying market prices, could inflict large-scale economic damage and food insecurity.

Indeed, digital agriculture is now a double-edged sword: a tool for resilience, but also a potential vector for disruption. As both countries deepen their reliance on smart farming solutions, it becomes imperative to develop robust digital security frameworks, region-wide data integrity protocols, and emergency response systems for cyber incidents. Without this, the very technologies meant to future-proof South Asia's food systems may instead become liabilities in the face of escalating cyber warfare, making agricultural cyber-defense as critical as crop protection or climate resilience.

The Growing Threat of Cyber Attacks on Agri-Tech Systems

As South Asia's agricultural sector embraces digitalization, it simultaneously faces a growing and underappreciated threat: cyber-attacks targeting agri-tech systems. These attacks exploit the region's weak rural cybersecurity infrastructure and are emerging as a serious risk to food security, economic stability, and farmer livelihoods. Modern farms now depend on digital tools for everything from weather forecasting and pest alerts to irrigation control and supply chain management. Yet a 2023 Symantec report found that 42% of agricultural IoT devices in developing countries lack even basic encryption, exposing critical systems to manipulation and sabotage.

For example, tampered weather data can mislead farmers into planting at the wrong time, causing yield losses of 15–20% (ICAR, 2022). Similarly, false pest alerts could lead to unnecessary pesticide application, raising production costs and causing ecological damage. Beyond the farm, cyber threats are disrupting agri-supply chains. INTERPOL reported a 65% rise in ransomware attacks targeting food logistics between 2021 and 2023, including critical infrastructure like grain silos and dairy plants. The 2021 ransomware attack on U.S.-based NEW Cooperative, which demanded $5.9 million in ransom, highlighted the vulnerability of such systems. A similar event in South Asia could cripple regional food distribution and drive inflation.

Meanwhile, smart farming technologies, such as automated irrigation systems, drones, and autonomous tractors, are becoming widespread across Punjab and Maharashtra. However, a 2024 Kaspersky study revealed that 78% of these devices still operate with default passwords, making them extremely easy for hackers to hijack. Cyber attackers could exploit this to over-irrigate fields, flood supply chains, or spray incorrect chemicals via drones, resulting in devastating harvest failures and long-term soil degradation. As smart agriculture scales so too must the region's investment in digital security. Without proactive defense mechanisms, agri-cyber vulnerabilities could undermine the very technologies designed to future-proof South Asia's food systems.

Geopolitical Risks: Cyber Warfare in India-Pakistan Agriculture

As India and Pakistan advance rapidly in agricultural digitization, the sector is emerging as a potential frontier for geopolitical conflict in cyberspace. Historically, both nations have engaged in state-sponsored cyber activities targeting critical infrastructure such as energy, finance, and defense (MITRE, 2023). With the increasing integration of smart technologies into farming, ranging from India's Kisan Drones to Pakistan's Precision Agriculture Initiatives,

agriculture itself is becoming a strategic vulnerability. These technologies, which rely on GPS, real-time data, and automated systems, could be easily disrupted during critical sowing or harvest seasons, resulting in crop failure, food inflation, and economic instability.

The threat isn't limited to system sabotage. Disinformation campaigns, such as fake fertilizer shortage alerts or false pesticide bans disseminated via WhatsApp, can spread panic among farmers. Such tactics were observed during India's 2020 farm protests, where viral misinformation fueled nationwide unrest (BBC, 2020). In an already tense bilateral environment, cyber disruption in agriculture could deepen political instability and rural disenfranchisement.

To address this evolving threat, a three-pronged mitigation strategy is essential. First, government-led policy frameworks must mandate cybersecurity audits for all agri-tech platforms, drawing inspiration from the EU's NIS2 Directive. A National Agri-Cybersecurity Task Force should be established, like the USDA's Cyber Threat Hub, to monitor threats in real time.

Second, the private sector must enhance product security by subsidizing secure IoT devices, like encrypted soil moisture sensors and tamper-proof drone software. Parallel to this, digital literacy campaigns should teach farmers basic cyber hygiene, including password protection and phishing detection.

Lastly, regional cooperation, though politically sensitive, remains vital. CERT-In (India) and PkCERT (Pakistan) could explore joint early warning systems and shared threat intelligence for agricultural cyber incidents. Simulated cyber drills focused on agri-tech infrastructure could foster preparedness while depoliticizing digital food security. In an age where war is increasingly waged through code, securing agricultural cyberspace is no longer optional, it is existential.

Conclusion

As South Asia's agricultural sector embraces digital transformation, the region finds itself navigating an increasingly complex and high-stakes terrain. Technologies like AI-driven crop analytics, IoT-enabled irrigation systems, and blockchain-based supply chains offer immense promise for boosting productivity, mitigating climate risks, and improving rural livelihoods. Yet these same innovations are vulnerable to cyber threats that could derail entire farming seasons, disrupt food supply chains, and ignite rural unrest. With India and Pakistan, two geopolitical rivals, both heavily invested in smart farming technologies, agriculture is becoming an unguarded flank in the broader cyber warfare arena.

From false pest alerts to ransomware attacks on logistics infrastructure, cyber vulnerabilities in agri-tech systems can translate into real-world consequences: failed harvests, food inflation, mass farmer distress, and even political destabilization. The 2020 farm protest misinformation wave and the precedent of cyber-attacks on food systems in other countries only underscore how fragile digitally integrated agriculture can be in the absence of robust cybersecurity.

To secure the future of food in South Asia, digital defense must become as essential as pest control or irrigation. Governments must establish cybersecurity mandates, companies must design safer tech, and farmers must be trained in digital awareness. If left unaddressed, cyber insecurity in agriculture risk turning resilience into vulnerability, and innovation into a weapon.

References: FAO; INTERPOL; Kaspersky; MITRE; World Bank; ICAR; BBC

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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Sorghum: Transforming Sindh's Agriculture

Discover how sorghum, a drought-resilient and low-input crop, can transform agriculture in Sindh. Learn about its benefits for food security, fodder supply, and biofuel industries in semi-arid districts like Khairpur, Sukkur, and Sanghar.

Aslam Memon[1] & Muhammad Ismail Kumbhar[2]

5/14/2025

Sorghum, locally known as Jowar, is a vital grain crop in Pakistan with significant agronomic, nutritional, and economic importance. As a climate-resilient crop, sorghum thrives in dryland and semi-arid conditions, making it particularly well-suited to the southern and southwestern regions of Pakistan where other cereal crops struggle due to heat stress and water scarcity. Its drought tolerance, low input requirement, and short growing cycle make it a critical asset for ensuring food and fodder security under increasing climatic variability.

Sorghum has diverse uses: its grain is consumed by rural households, its stalks and leaves serve as valuable fodder for livestock, and sweet sorghum varieties are cultivated for bioethanol production, contributing to renewable energy potential (Hussain et al., 2023). Despite these strengths, the crop has experienced a concerning decline in cultivation and productivity in recent years. According to the International Production Assessment Division (IPAD), the area under sorghum cultivation fell from 77,000 hectares in 2021/2022 to just 47,000 hectares in 2023/2024. Concurrently, total production dropped from 64,000 tonnes to 39,000 tonnes, reflecting a significant reduction in national output.

This decline is attributed to a combination of policy neglect, market disincentives, and shifts toward higher-return crops like maize and cotton. Punjab and Sindh remain the leading sorghum-producing provinces, contributing 47% and 26%, respectively, but face mounting challenges due to shrinking farm sizes and limited extension support. Revitalizing sorghum cultivation in Pakistan requires targeted interventions, including crop insurance schemes, processing infrastructure, and market incentives for biofuel applications. Given its potential to improve rural resilience and reduce Pakistan's dependence on water-intensive cereals, sorghum deserves renewed focus in national agricultural policy and climate adaptation strategies.

Sorghum Cultivation in Sindh and its Potential

Sorghum, a resilient and multipurpose grain crop, holds immense untapped potential for sustainable cultivation in Sindh, Pakistan's second-most populous and agriculturally significant province. The semi-arid climate of Sindh, characterized by high temperatures, erratic rainfall, and saline soils, provides ideal agro-ecological conditions for sorghum cultivation. Unlike water-intensive crops such as sugarcane or rice, sorghum thrives with minimal water input, making it particularly valuable in water-scarce regions. Presently, sorghum is primarily grown in Khairpur, Sukkur, Sanghar, Mirpurkhas, and Jamshoro districts. Statistical data indicates that Khairpur and Sukkur alone account for 43% and 22% respectively of the total sorghum output in the province, underscoring the strategic importance of these districts in scaling up production.

Sorghum plays a crucial role in enhancing food security in Sindh, particularly in regions affected by climate stress and declining irrigation potential. Its innate ability to withstand prolonged dry spells, extreme heat, and poor soil quality positions it as a reliable alternative to traditional cereal crops. In a province where agricultural productivity is increasingly threatened by climate-induced water shortages, sorghum offers a practical and resilient solution. The crop's high adaptability challenges the longstanding perception that successful farming in Sindh is contingent upon canal irrigation or large-scale infrastructure. Instead, it demonstrates that rain-fed and dryland farming systems can yield stable and marketable harvests when matched with appropriate crop choices.

Furthermore, the potential of sorghum to transform marginal lands is substantial. Arid and semi-arid zones, historically underutilized due to poor soil fertility and inadequate water supply, can be rehabilitated through sorghum cultivation. This not only boosts regional food availability but also opens new pathways for inclusive economic growth by bringing previously uncultivable lands into productive use. Smallholder farmers, in particular, benefit from the crop's low input costs and modest labor demands. These characteristics make sorghum an excellent candidate for diversification, especially among farmers vulnerable to climate variability and economic shocks.

Economically, sorghum offers a sustainable revenue stream for farmers in Sindh. In areas where crops such as cotton or rice have become unviable due to water scarcity or pest pressure, sorghum serves as a profitable alternative. Its robustness under adverse conditions ensures consistent yields, thus stabilizing farmer income. Integrating sorghum into existing crop rotations can reduce dependency on a few major crops, mitigating risks from price fluctuations and seasonal yield variability. Additionally, sorghum's multipurpose utility, spanning food, fodder, and biofuel, allows farmers to tap into multiple value chains, further strengthening rural economies.

Sorghum's market potential extends well beyond domestic use. With targeted investment in extension services, improved seed access, and better market linkages, farmers in Sindh could unlock significant value from this underutilized crop. Processing sorghum for flour, livestock feed, or bioethanol production could further enhance its economic return. Local value addition not only raises income levels for producers but also stimulates employment and entrepreneurship in rural communities. To harness these benefits, however, a coordinated approach involving government support, private investment, and farmer training is essential.

One of the most promising opportunities lies in exporting sorghum to international markets, particularly to China. Over the last decade, China has emerged as a major global importer of sorghum, driven largely by rising demand in its livestock and ethanol industries. Trade research by Wang and Malaga (2016) shows that Chinese imports have surged due to domestic corn pricing policies that make imported sorghum a cost-effective substitute. While the United States, Argentina, and Australia have historically dominated Chinese sorghum supply, recent trade tensions between China and the U.S. have created space for alternative exporters like Pakistan.

Pakistan's geographic proximity to China offers significant logistical advantages in terms of reduced freight costs and shorter delivery times. By leveraging the infrastructure and trade facilitation mechanisms of the China-Pakistan Economic Corridor (CPEC), Pakistan could establish a reliable supply chain for sorghum exports. To realize this potential, Pakistan must pursue phytosanitary agreements, ensure compliance with Chinese import regulations, and standardize quality controls across the production and processing stages. Engaging with Chinese trade authorities and investors will be crucial to secure long-term market access.

Moreover, creating institutional mechanisms to support export readiness, such as national sorghum quality standards, certified seed programs, and export-oriented farmer clusters, would position Pakistan as a credible player in the global sorghum market. Doing so would not only boost foreign exchange earnings but also stimulate rural development and agricultural diversification. The success of such an initiative would depend on Pakistan's ability to coordinate across agricultural, trade, and diplomatic sectors to establish a strong presence in one of the world's most dynamic commodity markets.

In conclusion, expanding sorghum cultivation in Sindh is not just an agronomic necessity, it is an economic opportunity. As climate change intensifies and conventional crops become increasingly vulnerable, sorghum stands out as a strategic solution that supports food security, enhances farmer resilience, and opens doors to global trade. Realizing its full potential will require targeted investments, forward-looking policies, and cross-sector collaboration—but the long-term rewards for Sindh's agricultural future are undeniable.

Opportunities and Challenges

Pakistan, particularly Sindh, holds considerable potential to benefit from the rising global demand for sorghum—especially in China, where the crop is used increasingly for animal feed and ethanol production. To seize this opportunity, a comprehensive and strategic approach is essential. Key interventions include improving farming practices by introducing high-yielding, drought-tolerant sorghum varieties, and expanding cultivation into climate-resilient zones. Enhanced agronomic methods, including better crop rotation, weed control, and irrigation efficiency, can significantly boost yields and farm profitability.

Equally important is the improvement of post-harvest handling. Many smallholder farmers currently lack the training and infrastructure to meet international quality and hygiene standards. Investments in cold storage, hermetic grain storage bags, moisture control, and climate-controlled transport systems will be critical for minimizing post-harvest losses and maintaining export-grade quality. Establishing centralized collection and processing centers can further streamline supply chains.

Policy support is also essential. The government must develop farmer-friendly policies, including export facilitation schemes, subsidized inputs, extension services, and access to affordable credit. However, various challenges need to be addressed. Sindh's agriculture depends heavily on the Indus Basin, which is under increasing stress due to water shortages. Changing climate patterns, such as higher temperatures and erratic rainfall, pose additional risks to crop productivity. Moreover, many farmers remain unaware of modern cultivation techniques, export protocols, and the potential of sorghum in international markets.

To overcome these barriers, targeted knowledge-building initiatives, such as farmer field schools, digital advisory platforms, and community-based extension programs, must be implemented. Additionally, contract farming models and public-private partnerships can support value chain development and market integration. Certified seed systems need to be established to ensure quality input supply and higher productivity. Incentivizing the cultivation of grain-type sorghum, which has greater export potential, and facilitating direct business-to-business linkages between Chinese importers and Sindh-based producer groups will further enhance competitiveness. By addressing these opportunities and constraints holistically, Pakistan can position itself as a key player in the global sorghum trade while strengthening domestic agricultural resilience.

Conclusion

Sorghum holds transformative potential for Sindh's agriculture amid escalating climate and market challenges. As a drought-resilient, low-input crop, it offers a sustainable alternative to water-intensive cereals, particularly in semi-arid districts like Khairpur, Sukkur, and Sanghar. Beyond its agronomic advantages, sorghum contributes to household food security, provides essential fodder, and supports biofuel industries, making it a multifunctional asset in Pakistan's evolving agroeconomy.

With global demand, especially from China, on the rise, Pakistan is well-positioned to explore sorghum as a strategic export commodity. The country's proximity to China, logistical advantages through CPEC, and the shifting dynamics of global sorghum trade offer a rare opportunity to diversify exports and earn valuable foreign exchange. However, realizing this potential will require coordinated action: improving seed systems, farmer training, post-harvest handling, and policy support.

The path forward must integrate climate-smart practices, institutional reforms, and market linkages tailored to the realities of smallholder farming. By investing in sorghum's production and export ecosystem, Pakistan can unlock inclusive rural development, reduce vulnerability to climate and commodity shocks, and establish itself as a reliable global supplier. In an era of rising food insecurity and water stress, scaling sorghum is not just an agricultural option, it is a strategic imperative for Sindh and the nation.

References: Hussain et al.; Wang and Malaga

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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Rethinking Sustainable Agriculture for Climate Resilience

The future of agriculture requires a shift in priorities, emphasizing not just yield but also environmental restoration, social equity, and economic resilience. Learn how smallholders, women, and youth can lead this change in the face of climate change for the sake of sustainable agriculture.

Qadir Bux Aghani

5/20/2025

Agriculture today faces a complex reality. It's no longer just about producing more food; it's about doing so in a way that sustains our environment and uplifts the communities behind it. With climate change accelerating, water scarcity intensifying, and rural inequalities deepening, the future of farming hinges on balancing productivity with human well-being and ecological health.

For decades, agricultural progress was measured primarily by yielding how much a piece of land could produce. While this approach helped meet growing food demands, it often came at a cost: 30% of global farmland is now degraded (FAO, 2023), biodiversity has declined by 23% since 1970 (WWF, 2022), and smallholder farmers, who produce 80% of food in developing countries (IFAD, 2023), remain economically vulnerable. Yield remains important, but it cannot be the sole metric of success.

True agricultural sustainability must now account for environmental regeneration, economic inclusion, and social equity. This means investing in climate-smart practices, improving soil health, conserving water, and supporting diverse cropping systems that promote biodiversity. It also means empowering farmers, especially women, youth, and marginalized groups, with better access to land, credit, markets, and training. Such an approach recognizes that farming is not just an economic activity; it's a vital livelihood, a way of life, and a cornerstone of rural identity and resilience.

Agriculture must evolve to become part of the solution to our most urgent challenges. By rethinking what we value and reward in food systems, we can shift from extractive models to regenerative ones, where productivity goes hand in hand with fairness, where land is healed rather than exploited, and where rural communities thrive alongside the ecosystems they depend on. The choices we make today will shape not only the future of farming but the health of our planet and the dignity of those who feed it.

Putting Farmers and Communities First While Protecting Nature

Farming sustains the livelihoods of over 2.5 billion people worldwide, the majority of whom are small-scale farmers, women, and youth (World Bank, 2023). These individuals are not only essential to food production but also play a crucial role in maintaining rural economies and cultural traditions. In Pakistan, innovative approaches such as smart farming and precision agriculture are equipping young farmers with tools to reduce water use by up to 40% while simultaneously increasing crop yields (Pakistan Agricultural Research Council, 2024). Such progress demonstrates the potential of technology to transform farming into a viable and attractive livelihood. However, systemic barriers remain, many farmers still face limited access to credit, insecure land rights, volatile market prices, and heightened exposure to climate risks. When policies prioritize equitable access to resources, training, digital tools, and fair markets, agriculture can move beyond subsistence and become a genuine pathway to prosperity and dignity for rural populations.

At the same time, agriculture must work in harmony with the natural environment. Farming is deeply dependent on healthy soils, clean water, pollinators, and a stable climate, yet, paradoxically, it is also a major driver of environmental degradation. Globally, agriculture consumes about 70% of freshwater resources (UN Water, 2023) and contributes 24% of greenhouse gas emissions (IPCC, 2023). In Türkiye, for instance, unsustainable practices have led to soil erosion and deforestation, prompting a nationwide shift toward agroecology and regenerative techniques (Ministry of Agriculture and Forestry, Türkiye, 2023). Practices like cover cropping, agroforestry, reduced chemical inputs, and organic farming not only restore degraded ecosystems but also enhance long-term food security. Building food systems that put farmers and nature at the center is no longer optional, it is the foundation for a resilient, equitable, and sustainable future.

The Power of Policy and Innovation for a Balanced Future

Governments, institutions, and the private sector play a pivotal role in steering agriculture toward sustainability. Policy frameworks have the power to set priorities, direct investments, and create enabling environments for innovation. The European Union's Farm to Fork Strategy is a prime example, aiming to reduce pesticide use by 50% and expand organic farming to cover 25% of agricultural land by 2030 (European Commission, 2024). Such targets signal a clear shift toward practices that prioritize environmental health and food system resilience. At the same time, technological innovation is rapidly transforming the agricultural landscape. From AI-driven crop monitoring systems that help optimize inputs, to solar-powered irrigation technologies that reduce water dependence, and

drought-resistant seeds that withstand extreme weather, these advances are making farming not only more efficient but also more adaptive to climate challenges (World Economic Forum, 2023).

However, innovation alone is not enough. Without inclusive policies, these advancements risk widening existing inequalities, particularly for smallholder farmers who may lack access to technology, infrastructure, or training. Policies must therefore be intentionally designed to be inclusive, supporting capacity-building, research, and equitable access to digital and financial tools. A sustainable agricultural future must rest on both technological progress and social justice.

Ultimately, the choices we make today, at every level from local governance to global strategy, will determine whether agriculture becomes a force for regeneration or a driver of further environmental and social harm. We must move beyond the outdated mindset that equates success solely with higher yields. Instead, we must embrace food systems that are productive, equitable, and ecologically sound. Farming must be about more than output; it must be about restoring dignity to rural communities, enhancing resilience in the face of climate change, and safeguarding the future of our planet.

Conclusion

The path forward for agriculture demands a fundamental rethinking of priorities. Yield alone can no longer define success. As climate change intensifies and natural resources grow scarcer, the true measure of agricultural progress must include environmental restoration, social equity, and economic resilience. Farmers, especially smallholders, women, and youth, must be at the heart of this transformation, supported by policies that ensure fair access to resources, markets, and technologies. At the same time, protecting the ecosystems that sustain farming, soil, water, biodiversity, and climate, must be non-negotiable. Regenerative practices, inclusive innovation, and forward-thinking governance can turn agriculture into a powerful force for good.

The examples from Pakistan, Türkiye, and the European Union show that change is both possible and already underway. But scaling these efforts requires coordinated action across all levels, from local communities to global institutions. We have the tools and knowledge to build a food system that nourishes people, revitalizes nature, and secures livelihoods. The challenge now is to act with urgency and integrity. By aligning agriculture with the goals of sustainability and justice, we can ensure that farming not only feeds the world but also preserves the planet for generations to come. Farming beyond yield is not just a vision, it's a necessity.

References: FAO; IPCC; IFAD; Pakistan Agricultural Research Council; European Commission; World Economic Forum; WWF; UN Water; Ministry of Agriculture and Forestry, Türkiye

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Türkiye's Agricultural Sector: Opportunities & Challenges

Explore how Türkiye's agricultural sector is navigating the complexities of globalization while leveraging its agro-ecological diversity. Discover strategies for empowering farmers and positioning Türkiye as a leader in the global agri-food market.

Mithat Direk

5/23/2025

Agriculture in Türkiye, like in many other parts of the world, is experiencing a significant transformation shaped by the forces of globalization. Historically characterized by smallholder, subsistence-based farming practices, the Turkish agricultural sector is increasingly shifting toward market-oriented and commercially integrated production systems. This transition is driven by both domestic reforms and international trade dynamics, as producers respond to the evolving demands of global supply chains, consumer preferences, and regulatory standards (FAO, 2023). Türkiye's geographic and climatic diversity, ranging from coastal Mediterranean zones to mountainous continental interiors, enables the cultivation of over 100 of the world's 150 most significant crops, making the country a vital player in international agri-food markets (TÜİK, 2023).

Despite this strategic advantage, the transformation from traditional to modern agriculture has been uneven. While large-scale producers and export-oriented agribusinesses have adapted to global standards and achieved productivity gains, many small and medium-sized farms remain marginalized. These farmers face constraints such as limited access to capital, fragmented land holdings, outdated technologies, and inadequate infrastructure. As a result, gaps persist in productivity, environmental sustainability, and value chain integration, particularly in less-developed rural regions.

Furthermore, climate change, fluctuating global commodity prices, and trade policy uncertainties add pressure on Turkish farmers to increase efficiency while preserving ecological resilience. To ensure inclusive and sustainable growth, agricultural policies must prioritize investment in research and development, promote cooperative models, and strengthen rural extension services. Supporting farmers in adopting digital technologies, sustainable practices, and climate-smart innovations will be essential for enhancing Türkiye's competitiveness and food security in a globalized economy. The future of Turkish agriculture lies not just in expanding trade, but in equipping all producers, regardless of size, with the tools and knowledge to thrive in a fast-changing agri-food landscape.

The Impact of Globalization on Turkish Farming

Globalization has reshaped agriculture from a subsistence livelihood into a market-oriented, profit-driven enterprise that requires farmers to possess a diverse skill set encompassing market analysis, technological literacy, and logistical coordination. In this new landscape, relying solely on traditional farming methods exposes producers to intense economic volatility. Price fluctuations driven by international market dynamics can result in significant gains one year and severe financial losses the next. According to the World Bank (2022), such instability disproportionately affects smallholders lacking access to price forecasting tools and risk mitigation strategies.

Türkiye's agricultural exports reached $30.6 billion in 2023, up from $22.3 billion in 2022 (CBS, 2023; TIM, 2024), underscoring the sector's increasing integration into global agri-food supply chains. However, this growth belies the fact that only a small percentage of farmers are equipped to compete in global markets. Many lack the infrastructure, knowledge, or capital to meet export standards, leaving them vulnerable to being sidelined in an increasingly competitive environment.

The proliferation of geographical indications (GIs) such as Antep pistachios, Aydın figs, and Malatya apricots illustrates a dual trend: while GIs protect and promote regional heritage and cultural identity, they also reflect the pressures of commodification. Industrial-scale agriculture, enabled by biotechnology like drought-resistant seeds and mechanized harvesting, has made it possible to scale production rapidly, often at the expense of small, artisanal producers (Nizam, 2009).

This duality presents a policy dilemma. On one hand, modernization and economies of scale improve efficiency and global competitiveness. On the other, without strategic support for smaller farms and traditional producers, globalization risks deepening inequalities within the agricultural sector. For Turkish agriculture to thrive equitably, modernization must be paired with inclusive policies that preserve rural livelihoods while embracing innovation.

Türkiye's Agricultural Policy: From Peasantry to Professionalization

Türkiye's transition from a peasant-based agricultural system to a professionalized, market-oriented model began with the enactment of the 2006 Agricultural Law, which formally recognized farming as a professional occupation. While this legal framework was a critical milestone, the practical implementation of policies supporting this shift remains inconsistent. Despite state intentions to modernize the sector, education and technology adoption lag significantly behind. Only 18% of Turkish farmers currently receive formal agricultural training, limiting their

ability to adopt innovations and respond to market demands (Ministry of Agriculture, 2023). The digital divide further exacerbates this gap: just 34% of rural farms utilize precision agriculture technologies such as Internet of Things (IoT) devices or remote sensors, which are crucial for increasing yields and resource efficiency (TÜBİTAK, 2023).

A comparison with the Netherlands highlights Türkiye's untapped potential. Despite having only a fraction of Türkiye's arable land, the Dutch agricultural sector ranks among the world's top exporters due to its strategic use of greenhouse technologies, cooperative farming structures, and robust research and development systems (WUR, 2023). Türkiye can emulate this model by investing in agricultural cooperatives like the Trakya Grain Union, which can enhance farmers' bargaining power and lower input costs through collective procurement and marketing.

Moreover, Türkiye is underutilizing digital sales channels; only 12% of agri-businesses engage in e-commerce, missing valuable opportunities in international markets (TOBB, 2023). To accelerate professionalization, the government must mandate the use of certified agri-consultants with practical experience, expand R&D spending from 0.8% to 2% of GDP, and scale climate-resilient practices like drip irrigation, currently adopted by just 22% of farms (DSİ, 2023). Bridging these gaps will be essential if Türkiye is to transform its agricultural sector into a globally competitive, sustainable, and professionally managed industry.

Conclusion

Türkiye's agricultural sector stands at a pivotal juncture, where the promises and perils of globalization intersect with longstanding structural challenges. The country's rich agro-ecological diversity and growing agri-export capacity present significant opportunities to position itself as a global agri-food leader. Yet, realizing this potential requires far more than increased trade volume. It demands a strategic, inclusive transformation that empowers all farmers, large and small, to adapt, compete, and thrive in a rapidly evolving global market.

Globalization has undeniably spurred growth and innovation but has also exposed the vulnerabilities of smallholders and traditional producers who often lack access to capital, education, and digital infrastructure. The rise of high-tech farming, e-commerce platforms, and biotechnology signals a shift toward a more sophisticated and capital-intensive model of agriculture. Without targeted policies, however, this evolution risks deepening rural inequality and accelerating the decline of traditional agricultural communities.

To navigate these tensions, Türkiye must commit to a dual strategy: promoting modernization while ensuring inclusivity. Expanding access to training, digital tools, climate-smart techniques, and cooperative marketing systems is essential for equitable growth. As Türkiye continues its agricultural transformation, success will ultimately be measured not just by export figures, but by how well it supports rural livelihoods, strengthens resilience, and fosters a sustainable and competitive agricultural future for all.

References: CBS; FAO; TÜİK; World Bank; CBS; TIM; Nizam; Ministry of Agriculture; TÜBİTAK; WUR

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Essential Animal Health Indicators for Goat Farming

In Pakistan's goat farming economy, especially during Eid-ul-Adha, understanding animal health indicators like the sunken flank and body condition score (BCS) is crucial. These tools help farmers identify malnutrition and dehydration, ensuring better animal welfare and economic returns.

Syed Ibtihaj Ahmed

5/23/2025

Goat and sheep farming play a vital role in Pakistan's rural and urban economy, contributing approximately 35% to the country's livestock GDP (Pakistan Economic Survey, 2023). Among small ruminants, goats and sheep are particularly important due to their adaptability to harsh environments, low input requirements, and high cultural and religious significance. The annual demand surges during Eid-ul-Adha, when over 10 million animals are sacrificed nationwide (Ministry of Livestock, 2023). To ensure both animal welfare and economic return, farmers and sellers must closely monitor the health and body condition of their livestock. One of the simplest yet most telling indicators of health status is the Sunken Flank, commonly known as the "Hunger Pit", the triangular hollow located between the animal's last rib and hip bone.

A prominently hollow Sunken Flank can signal serious nutritional deficiencies. This may result from poor-quality food, inadequate concentration feeding, parasitic infections, or chronic dehydration, particularly in arid regions such as Tharparkar or Balochistan. Studies show that around 40% of small ruminants in Pakistan suffer from malnutrition, leading to a 20–30% decline in market value (University of Veterinary and Animal Sciences, 2023).

On the opposite end, an almost invisible Sunken Flank may indicate overfeeding, a trend increasingly observed in urban markets before Eid. Urban buyers often over-fatten animals with rich foods like grains, chickpeas, and even unhealthy snacks like bread or sugary beverages. While this may boost short-term weight, it raises health risks such as bloat, acidosis, fatty liver, and even complications during lambing or kidding. The Sunken Flank also varies with daily feeding. For accurate assessment, the best time to observe it is early morning before feeding and watering. Regular monitoring of this simple anatomical feature can help farmers strike the right balance between health, nutrition, and market readiness.

Mastering Body Condition Scoring (BCS) for Goats and Sheep

Body Condition Scoring (BCS) is an essential management tool for Pakistani farmers aiming to improve the health and market value of goats and sheep, especially in the lead-up to Eid-ul-Adha. When combined with Sunken Flank observation, BCS offers a more accurate, holistic understanding of an animal's nutritional status and overall well-being. BCS uses a scale from 1 to 5, where 1 indicates an emaciated animal and 5 denotes obesity. Ideally, goats and sheep for Eid should fall between 2.5 and 3.5, showing they are healthy, well-fed, but not over-conditioned (Livestock Department Punjab, 2023).

For instance, an animal with a BCS of 1 will have visible ribs and a deeply hollow flank, indicating malnutrition. A BCS of 3 reflects an ideal balance, smooth body lines and only a slightly visible flank. By contrast, animals scoring 5 may appear large and attractive to buyers, but excessive fat compromises mobility and raises health risks like dystocia or digestive disorders.

To achieve optimal BCS, farmers must follow good animal husbandry practices. Balanced feeding is the cornerstone: 60–70% of the diet should be roughage such as wheat straw or maize stover, complemented by 20–30% green fodder like berseem or oat grass, and 10–20% concentrates including cottonseed cake or maize. Supplementing minerals and salt prevents common deficiencies, particularly calcium and phosphorus. Proper nutrition alone can increase weight gain by 15–25% over six weeks (SAARC Agriculture Centre, 2023).

Clean water is equally crucial. Goats require 4–8 liters daily, with higher needs during summer. Dehydration can lead to digestive issues, weight loss, and urinary stones. Regular deworming (every 2–3 months) and vaccinations against diseases such as PPR, Enterotoxemia, and FMD are also vital, with free government vaccines available in many districts.

Housing, hygiene, and grooming further support animal health. Well-ventilated, dry shelters prevent infections, while daily cleaning reduces parasites. Hoof trimming and brushing help detect health issues early. Finally, behavioral changes—like lethargy or diarrhea—should prompt immediate veterinary attention. Informed care not only protects animal welfare but ensures better returns during the festive season.

Preparing Your Goat for Eid-ul-Adha

Eid-ul-Adha is not just a religious occasion, it's a time when livestock health, presentation, and welfare come under scrutiny. For Pakistani farmers, especially those selling goats for sacrifice, proper care begins weeks in advance. Starting 4 to 6 weeks before Eid is crucial. Gradual weight gain through a consistent and balanced diet leads to healthier animals, while sudden fattening efforts using grains or junk food like bananas, bread, or soda can cause serious digestive problems such as bloat or acidosis. Instead, focus on feeding nutrient-rich options like chickpeas (chana), cottonseed cake (khal), and fresh green fodder.

Daily walking routines are essential to build muscle tone and reduce stress, helping goats appear more active and robust. Gentle handling and regular grooming not only calm the animal but also make them more presentable to buyers. In urban areas, especially on rooftops, hygiene becomes even more important. Clean shelters daily to prevent infections and avoid stress-inducing practices such as tying goats with short ropes or hanging heavy bells around their necks.

As Eid approaches, perform a last-minute health check. Monitor for coughing, diarrhea, or fever, any of which may signal underlying illness. A sick animal is not only less marketable but also less fit for the spiritual significance of Qurbani. Consult a veterinarian promptly if any issues arise.

Understanding key indicators like the Sunken Flank and maintaining an ideal Body Condition Score (BCS) can significantly boost the goat's market value, healthy animals fetch 15–30% more. They also offer better meat quality and reflect ethical, sustainable farming practices. Investing time and effort into scientific animal care is not just about profit; it honors the spirit of sacrifice and ensures respect for the animal's life.

Conclusion

In the context of Pakistan's vibrant goat and sheep farming economy, especially during the high-stakes Eid-ul-Adha season, understanding animal health indicators like the Sunken Flank and Body Condition Score (BCS) is no longer optional, it is essential. These simple, low-cost tools enable farmers to make informed decisions that impact both animal welfare and economic returns. By accurately assessing the Sunken Flank, farmers can identify malnutrition, dehydration, or overfeeding before these issues lead to serious health problems or loss in market value. Pairing this visual cue with BCS, ideally between 2.5 and 3.5 for Eid animals, provides a more holistic picture of an animal's condition, guiding feeding and management strategies more effectively.

With over 10 million goats and sheep sacrificed annually during Eid, demand pressures often lead to poor practices like overfeeding or neglecting early health checks. However, with proper planning, starting at least a month in advance, farmers can ensure gradual weight gain, robust health, and better presentation. Clean water, balanced nutrition, vaccination, deworming, shelter hygiene, and behavioral monitoring must all work in tandem.

Ultimately, healthy livestock not only fetch higher prices but also fulfils the spiritual, ethical, and economic expectations of Qurbani. Embracing these science-backed practices honors both the animals and the values they represent.

References: Ministry of Livestock, Pakistan; University of Veterinary & Animal Sciences, Lahore; SAARC Agriculture Centre; Pakistan Economic Survey; Livestock Department Punjab

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Transforming Pakistan's Agriculture with Biotechnology

Explore how plant biotechnology is revolutionizing agriculture in Pakistan. From genetically modified crops to tissue culture techniques, discover innovative solutions for pest & drought resistance to tissue culture and genomic tools that accelerate breeding and improve nutritional outcomes.

Bilal Hussain Shah

5/23/2025

Plant biotechnology represents a transformative force in modern agriculture, leveraging genetic and molecular advancements to address pressing challenges such as food security, climate change, and environmental sustainability. As global food demand is projected to increase by 59-98% by 2050 (FAO, 2023), countries like Pakistan, where agriculture contributes 22.7% of GDP and employs a large rural population, must adopt innovative solutions to ensure agricultural resilience and productivity (Pakistan Economic Survey, 2023).

Biotechnological tools such as genetic modification (GM), marker-assisted selection (MAS), and CRISPR-based genome editing are enabling the development of crops that are drought-tolerant, pest-resistant, and nutritionally enhanced. For instance, BT cotton, one of Pakistan's earliest GM crops, has significantly reduced the need for chemical pesticides and increased yields in certain regions. Similarly, research into biotech wheat and rice varieties could address salinity and water stress, which are growing threats due to climate variability.

Plant biotechnology also offers avenues for reducing post-harvest losses, improving shelf life, and enhancing nutritional content, critical for tackling hidden hunger and rural malnutrition. However, ethical and biosafety considerations remain central. Concerns about gene flow, biodiversity loss, and corporate seed monopolies require robust regulatory oversight, transparent communication with farmers, and public engagement.

For Pakistan to harness the full potential of plant biotechnology, investments in research infrastructure, scientific education, and public-private partnerships are essential. Equally important is the development of locally adapted biotechnological solutions that reflect the socio-economic realities of smallholder farmers. Integrating biotechnology into national agricultural policy will be key to building a climate-resilient, food-secure future for Pakistan. This article examines both the promise and the challenges of plant biotechnology, offering a balanced perspective on its role in sustainable crop improvement.

Building Resilience in Agriculture

Plant biotechnology harnesses scientific techniques to modify plants at the genetic and cellular level, addressing key challenges such as low productivity, pest infestations, nutritional deficiencies, and climate stress. This sector is rapidly evolving in Pakistan, driven by the need to modernize agriculture and ensure long-term food security.

One of the cornerstone techniques is genetic engineering, which involves direct manipulation of plant DNA to enhance desired traits. Pakistan's first genetically modified crop, *Bt cotton*, significantly reduced bollworm infestations and improved yields by 30-40% (PARC, 2023). Globally, herbicide-tolerant soybeans have cut chemical usage by 25% (ISAAA, 2022), showcasing the environmental benefits of such innovations.

Tissue culture is another essential biotechnology tool, enabling the mass propagation of disease-free plants. Sindh's Date Palm Project utilized tissue-cultured saplings, resulting in a 50% increase in productivity (SAU Tandojam, 2022). This method is particularly valuable for banana, potato, and other vegetatively propagated crops.

Molecular markers and genomic selection have accelerated breeding programs by allowing scientists to identify desired traits such as drought or disease resistance early in the breeding cycle. Pakistan's "Dharti" wheat variety, developed through marker-assisted selection, exhibits strong drought tolerance. This precision reduces breeding cycles from over a decade to just 3-4 years (USDA, 2023).

In terms of agricultural applications, biotechnology enhances productivity through drought-tolerant maize, flood-resistant rice (*Swarna-Sub1*), and nutrient-enriched varieties like *Golden Rice* and *Zinc Wheat*. These innovations can combat widespread deficiencies, such as vitamin A and zinc, affecting millions in Pakistan.

Pest- and disease-resistant crops like *BT brinjal* in Bangladesh, which reduced pesticide use by 80% (Cornell University, 2023), and *CRISPR-edited wheat* in Punjab offer safer, more sustainable production systems. Environmental sustainability is further supported by nitrogen-efficient crops and genomics-based cover crops that enhance soil health and reduce emissions.

However, challenges persist. GMO-related concerns include risks of gene flow to wild relatives, seen in *BT cotton* hybridization in Sindh, and corporate control, where just four companies hold 85% of GM seed patents (ETC Group, 2023). Regulatory hurdles also remain; Pakistan's biosafety rules lag global standards, and GM food labeling is inconsistent.

Looking ahead, CRISPR-Cas9 holds immense promise, with trials on salinity-tolerant *kinnow* and virus-resistant *chickpea* underway. Integration with digital agriculture, AI-driven gene editing and blockchain-based seed traceability, is also gaining traction. These technologies could revolutionize how Pakistan addresses food security, resilience, and environmental stewardship in the coming decades.

Policy Recommendations for Advancing Plant Biotechnology in Pakistan

To fully harness the potential of plant biotechnology in Pakistan, a comprehensive and inclusive policy framework is essential. This must address the barriers to adoption, knowledge gaps, and institutional constraints currently limiting the widespread use of biotech tools.

Public-private partnerships (PPPs) are a critical mechanism for scaling up the adoption of biofortified and genetically improved crops. The government should collaborate with seed companies, research institutions, and civil society organizations to provide subsidies or financial incentives for smallholder farmers to access high-quality biotech seeds. For example, subsidizing zinc-enriched wheat or drought-resistant maize could help farmers adopt these crops without financial burden, while also addressing key nutritional and climate challenges. PPPs can also support infrastructure development for seed testing, certification, and distribution, ensuring quality assurance and traceability.

Equally important is farmer education and capacity building. A 2023 survey by Sindh Agriculture University revealed that only 18% of Pakistani farmers have a basic understanding of genetically modified technologies. This lack of awareness leads to hesitation and misinformation, limiting adoption. Therefore, extension services must be strengthened to deliver hands-on training and awareness campaigns at the grassroots level. Farmer field schools, demonstration plots, and multilingual mobile-based advisory services can help demystify biotechnology and promote its benefits in a locally relevant manner.

In parallel, Pakistan needs to modernize its regulatory framework for biotechnology. Clear, science-based biosafety rules aligned with international standards would facilitate faster approval and commercialization of new biotech crops. Transparent labeling policies are also necessary to build public trust and allow informed consumer choices. Lastly, fostering youth engagement and innovation—through biotech incubators and university research grants—can drive long-term capacity and ensure a skilled workforce to support this high-potential sector. By aligning policy, education, and investment, Pakistan can build a resilient, tech-enabled agricultural future.

Conclusion

Plant biotechnology holds immense promise for transforming Pakistan's agriculture into a more productive, resilient, and sustainable sector. From genetically modified crops that resist pests and tolerate drought, to tissue culture and genomic tools that accelerate breeding and improve nutritional outcomes, biotechnological innovations are offering real solutions to some of the country's most urgent agricultural challenges. As climate change intensifies and food insecurity looms, these scientific tools provide not just yield improvements but also a pathway to environmental conservation and public health gains.

Yet, realizing this potential will depend on more than just scientific progress. It requires enabling policies, targeted investments, and a strong emphasis on farmer education. With only a fraction of the farming community currently aware of or trained in biotechnological practices, the benefits remain unevenly distributed. Equally important are ethical safeguards, ensuring biodiversity protection, transparent labeling, and fair access to patented technologies.

By strengthening public-private partnerships, modernizing biosafety regulations, and fostering grassroots awareness, Pakistan can position itself at the forefront of agricultural innovation. Plant biotechnology, when responsibly deployed, can help the country overcome structural limitations in its food system and empower its farmers to thrive in a changing climate. The future of sustainable agriculture in Pakistan will be written in its genes.

References: FAO; PARC; ISAAA; IRRI; ETC Group; Pakistan Economic Survey; SAU Tandojam; USDA; Cornell University

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 Bioenergy from Agricultural Waste in Türkiye

Türkiye is at a pivotal point in transforming its vast agricultural waste into a thriving bioenergy sector. With over 50 million tons produced annually and only a fraction repurposed, a coordinated effort can convert it into sustainable bioenergy hub.

Mithat Direk

5/30/2025

Türkiye currently lacks a comprehensive inventory of agricultural waste, encompassing both plant residues such as straws, stalks, and husks, and animal byproducts including manure and processing offal. Although these materials are implicitly covered under the "Regulation on General Principles of Waste Management" (Official Gazette No. 26927, 05.07.2008), which is harmonized with European Union directives, no centralized database or systematic survey exists to quantify their volumes or geographic distribution. Without precise data on seasonal crop residues, such as wheat stubble from the Central Anatolia plain or olive pomace from Aegean groves, and on animal waste streams from intensive livestock operations in Thrace or dairy farms in Marmara, policymakers and investors cannot accurately gauge the true potential for converting agricultural waste into bioenergy or biofertilizers.

Establishing a robust, collaborative study led jointly by the Ministry of Agriculture and Forestry and the Ministry of Environment, Urbanization, and Climate Change is therefore critical. This initiative would involve field surveys, remote sensing to estimate crop biomass, and farm-level reporting systems to capture manure generation rates. By integrating data on yields, harvest schedules, and livestock densities, authorities could model the annual tonnage of recoverable biomass. Such an evidence-based inventory would facilitate strategic planning for waste-to-energy facilities, whether on-farm anaerobic digesters for biogas, centralized pelletization plants for biomass briquettes, or small-scale composting hubs. Furthermore, aligning this effort with TÜİK's ongoing agricultural statistics programs would ensure consistency and enable periodic updates. Ultimately, a detailed agricultural waste inventory would unlock significant economic and environmental benefits by reducing open-field burning, lowering greenhouse gas emissions, and providing a reliable feedstock for renewable energy generation and soil amendment practices.

Harnessing Agricultural Waste for Renewable Energy

Türkiye generates over 50 million tons of agricultural waste annually, yet only 10–15% is currently repurposed for energy or composting (TÜİK, 2023). In greenhouse-intensive regions such as Antalya, Mersin, and İzmir, significant quantities of plant residues, including tomato and pepper vines, plastic mulch, and pruning waste, accumulate each season. For example, greenhouse farming alone produces approximately 2.5 million tons of organic waste per year, but recycling infrastructure remains limited (Ministry of Agriculture, 2022). The Kumluca Municipality's greenhouse waste recycling facility exemplifies how these residues can be converted into valuable resources: once operational, it will transform plant waste into compost and biogas for electricity generation, alleviating local disposal challenges and supplying renewable power to the grid (Kumluca Municipality, 2022).

Beyond composting, plant-based waste can be pelletized or briquetted to serve as a biomass fuel for boilers and generators. Residues such as cereal straw, vineyard prunings, and olive branches can yield biochar and briquettes, reducing open burning and mitigating air pollution. Additionally, feedstock variety allows co-firing with fossil fuels in existing power plants, thereby reducing carbon intensity.

Animal husbandry also contributes substantially to Türkiye's waste stream. Manure from cattle, sheep, and poultry averages several million tons annually in livestock-rich provinces such as Konya, Balıkesir, and Afyon. Through anaerobic digestion, these manures can generate methane-rich biogas. As of 2023, over 80 biogas plants operate nationwide, producing roughly 150 MW of installed capacity (ENERJİSA, 2023). By co-digesting crop residues with manure, facilities can increase biogas yield and stabilize feedstock supply. Projections indicate the potential to expand biogas capacity to 500 MW by 2030 (TEİAŞ, 2023), provided regulatory support, investment in digesters, and farmer cooperatives.

Strategic development of both plant-based and animal-based waste utilization, backed by public incentives, streamlined permitting, and technical training, could transform Türkiye's agricultural sector into a cornerstone of its renewable energy transition, reducing greenhouse gas emissions and fostering rural economic growth.

Global Trends and EU Policies on Bioenergy

The European Union has emerged as a frontrunner in transforming agricultural residues and organic waste into sustainable energy. Central to this effort is the European Industrial Bioenergy Initiative (EIBI), which identifies seven principal bioenergy pathways: gasification of waste, biomethane production, biocrude (bio-oil) extraction, ethanol and bio-alcohol blending, sugar-to-hydrocarbon conversion, algae-based biofuels, and

anaerobic digestion for biogas (European Commission, 2022). By promoting these pathways, the EU seeks to reduce greenhouse gas emissions, diversify energy sources, and support the circular economy. Under the Renewable Energy Directive (RED II), member states are mandated to achieve at least 32% of final energy consumption from renewable sources by 2030, with specific targets for advanced biofuels and waste-based feedstocks to ensure sustainability and minimize land-use conflicts.

Denmark exemplifies successful implementation of these policies. The country has set an ambitious goal to eliminate fossil fuel use by 2050, with biogas projected to supply approximately 30% of its national energy mix. Through substantial investments in anaerobic digestion facilities, Denmark now processes manure, food waste, and agricultural byproducts at industrial scale, injecting biomethane into the natural gas grid and using digestate as a high-quality fertilizer. This model not only meets energy targets but also addresses rural waste management challenges and supports farm incomes.

Across the EU, other nations are following suit. Germany has rapidly expanded its network of biogas plants, converting livestock manure and crop residues into green electricity and heat for local communities. Sweden integrates forest residues and agricultural waste into combined-heat-and-power (CHP) plants, contributing to its goal of net-zero emissions by 2045. Spain and Italy leverage their abundant olive and grape wastes for bioethanol and biomethane production, demonstrating regional specialties. Meanwhile, research into next-generation algae-based biofuels and microbial fermentation processes continues to advance, aiming to scale up production and reduce costs.

Global trends mirror the EU's leadership: Brazil's sugarcane ethanol sector remains one of the largest biofuel programs globally, while the United States expands cellulosic ethanol from crop residues. In Asia, countries like South Korea and Japan invest heavily in waste-to-energy biorefineries. These collective efforts underline a growing recognition that bioenergy, particularly when sourced from agricultural and organic waste, offers a viable path to energy security, rural development, and climate mitigation.

Challenges and Opportunities in Türkiye's Bioenergy Sector

Türkiye's potential to harness agricultural and organic wastes for bioenergy is constrained by several critical barriers. Small-scale biogas projects struggle without targeted financial incentives. High initial capital costs, covering digesters, storage tanks, and distribution infrastructure, discourage farmers and local entrepreneurs, who lack access to low-interest loans or grants. Additionally, waste collection and processing infrastructure remain inadequate: many rural areas lack organized systems for gathering manure, crop residues, and food scraps, resulting in feedstock scarcity for potential bioenergy facilities. Regulatory hurdles further complicated development. Securing permits for bioenergy plants often involves navigating opaque approval processes, overlapping jurisdictions, and evolving environmental standards, leading to protracted delays and elevated project costs (SHURA, 2023).

Despite these obstacles, promising opportunities exist for scaling up Türkiye's bioenergy capacity. Introducing government-backed incentives, such as feed-in tariffs or direct subsidies for biogas produced from agricultural waste, could significantly improve project bankability. By ensuring a stable, predictable revenue stream per kilowatt hour of biogas-derived electricity injected into the grid, these mechanisms encourage investment and lower financing costs. Public-private partnerships (PPPs) represent another avenue to mobilize capital and technical expertise. Collaborative ventures between municipalities, agro-industrial cooperatives, and private energy firms can facilitate the construction of centralized anaerobic digestion hubs that co-digest livestock manure with crop residues, achieving economies of scale that benefit smaller farmers.

Technological advancements also hold promise. Improvements in anaerobic digestion, such as pre-treatment of lignocellulosic residues, co-generation systems that capture both heat and power, and optimized microbial consortia, can raise methane yields and reduce processing times. Similarly, modern gasification technologies enable high-temperature conversion of crop wastes into syngas, which can be used for electricity or upgraded into biomethane. Collaboration with international research centers and leveraging World Bank technical assistance can accelerate the transfer of these innovations to local contexts (World Bank, 2023). Moreover, Türkiye's alignment with EU Green Deal targets may unlock additional funding streams and technical support, further catalyzing growth.

By addressing financial, regulatory, and infrastructural gaps, and embracing both policy incentives and cutting-edge technologies, Türkiye can transform its underutilized agricultural waste into a robust bioenergy sector that enhances energy security, mitigates greenhouse gas emissions, and fosters rural economic development.

Conclusion

Türkiye stands at a crossroads in converting underutilized agricultural waste into a sustainable bioenergy sector. Currently, the absence of a detailed waste inventory prevents accurate assessment of available plant residues, ranging from greenhouse vines to vineyard pruning, and animal byproducts such as manure from Konya's livestock farms. Instituting a coordinated study by the Ministry of Agriculture and Forestry and the Ministry of Environment, Urbanization, and Climate Change is essential to quantify biomass volumes via field

surveys, remote sensing, and farm-level reporting. With over 50 million tons of agricultural waste produced annually yet only 10-15% repurposed, substantial technical and economic benefits remain untapped. Greenhouse regions like Antalya, Mersin, and İzmir could support composting and biogas facilities, as exemplified by Kumluca Municipality's pilot plant.

Leveraging EU bioenergy frameworks, such as anaerobic digestion for biogas and biomass pelletization, offers proven pathways. Denmark's ambition to source 30% of its energy from biogas by 2050 and Germany's extensive biogas network demonstrate replicable models. Expanding Türkiye's 150 MW installed biogas capacity toward a projected 500 MW by 2030 requires regulatory streamlining, financial incentives (e.g., feed-in tariffs), and public-private partnerships. Technological advances in gasification and microbial digestion will improve yields. By addressing infrastructural gaps, simplifying permitting, and aligning with EU Green Deal financing, Türkiye can transform its agricultural residues into renewable power, reduce greenhouse gas emissions, and catalyze rural economic growth.

References: TÜİK; Ministry of Agriculture and Forestry; European Commission; ENERJİSA; IEA; SHURA Energy Transition Center; Kumluca Municipality; ENERJİSA; TEİAŞ

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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Skilled Labor Shortage in Sindh's Agriculture Sector

The skilled labor shortage in Sindh's agriculture sector poses a significant threat to Pakistan's food security and rural development. As labor sources diminish due to migration, lack of training, low wages, and delayed mechanization.

Rizwan Ali Kamboh

5/1/2025

Agriculture continues to serve as the backbone of Pakistan's economy, contributing approximately 24% to the national GDP and employing nearly 37.4% of the country's labor force (PBS, 2023). Sindh, a province rich in alluvial soil and traversed by the Indus River, remains one of the most agriculturally significant regions in the country. It plays a pivotal role in national food security and exports by cultivating major crops such as wheat, cotton, rice, and sugarcane. Despite its historical strength and potential, Sindh's agricultural sector is currently facing a critical shortage of skilled labor, a challenge that threatens to undermine productivity, exacerbate rural poverty, and compromise food supply chains.

The labor shortage is the result of a combination of interlinked issues. Rural-to-urban migration continues to drain young and productive workers from villages to cities in search of better economic opportunities, while those who remain often lack access to formal agricultural training. Low wages and poor working conditions further discourage laborers from continuing in the sector, and the slow pace of mechanization means that productivity gains remain limited. This imbalance has serious implications, not only for agricultural yields and income levels but also for national food security and overall economic stability.

If not addressed through strategic interventions, the skilled labor deficit in agriculture could result in increased input costs, declining crop output, and inflation in food prices. It could also widen socio-economic disparities between rural and urban populations. Moving forward, comprehensive reforms are needed, including the development of vocational training programs, investment in agricultural extension services, incentives for farm mechanization, and improvements in rural infrastructure. By empowering agricultural laborers and enhancing their skills, Sindh can reinvigorate its farming sector and safeguard its contribution to Pakistan's food and economic security.

Causes of Skilled Labor Shortage in Sindh's Agriculture

The skilled labor shortage in Sindh's agricultural sector stems from a complex interplay of socio-economic, educational, and technological factors that continue to weaken productivity and undermine the sustainability of farming livelihoods. One of the most significant contributors is the steady and large-scale rural-to-urban migration. Young workers are increasingly moving from agricultural communities in Sindh to urban centers like Karachi and Hyderabad or even seeking employment abroad. According to the International Labor Organization (ILO, 2022), nearly 30% of Sindh's rural youth have migrated to urban areas in search of better-paying and more stable employment opportunities in the manufacturing, service, and informal sectors. Agriculture is widely perceived by the younger generation as labor-intensive, low-income, and lacking in social mobility. As a result, 65% of Pakistan's rural youth prefer non-farming occupations, leaving many farms understaffed and dependent on aging or seasonal laborers, which undermines long-term agricultural efficiency and innovation (World Bank, 2023).

Another critical issue is the lack of technical training and agricultural education. While countries like the Netherlands, the U.S., and Australia have invested heavily in developing their agricultural human capital, most farmers in Sindh still practice traditional farming methods. The Sindh Technical Education & Vocational Training Authority (STEVTA, 2023) notes that fewer than 5% of farmers in the province have received formal training in key areas such as pest and disease management, efficient irrigation practices, mechanization, or post-harvest handling. The shortage of vocational training institutes and agricultural extension services has left a gap in the workforce, where even willing laborers often lack the technical skills required to operate modern equipment, apply fertilizers judiciously, or adopt climate-resilient techniques.

Low wages and harsh working conditions further dis-incentivize skilled labor from staying in agriculture. Farm laborers in Sindh typically earn between PKR 15,000 to 20,000 per month (PBS, 2023), often without any form of job security, healthcare, or pension benefits. Exposure to extreme weather events such as floods and heatwaves adds to the physical toll of farm work. A 2023 report by the Sindh Agriculture Department found that nearly 40% of agricultural workers transitioned to jobs in construction or manufacturing within five years, primarily due to poor working conditions and economic insecurity.

Finally, the slow adoption of mechanization in Sindh exacerbates the labor shortage. While Punjab has advanced significantly in deploying tractors, harvesters, and drip irrigation systems, Sindh lags. According to the Food and Agriculture Organization (FAO, 2022), only 25% of farms in Sindh use mechanized tools, compared to 45% in Punjab. The high cost of machinery, where a single tractor can cost between PKR 1.5 to 2 million, combined with limited access to agricultural credit, subsidies, and operator training, deters small and medium farmers from adopting labor-saving technology. Consequently,

many farmers remain dependent on manual labor, which becomes increasingly scarce during critical periods such as sowing and harvest seasons.

Consequences of the Skilled Labor Shortage

The consequences of the skilled labor shortage in Sindh's agricultural sector are becoming increasingly evident and far-reaching. One of the most immediate effects is a noticeable decline in crop yields. With a shrinking pool of trained workers, farms are unable to maintain optimal productivity. The Sindh Chamber of Agriculture (2023) reports a consistent 15–20% decline in wheat and cotton yields over the past five years, largely attributed to labor deficits and outdated farming practices. These lower yields directly affect food availability and contribute to broader economic instability.

As the labor pool contracts, farmers are compelled to raise wages by 20–30% during critical sowing and harvesting seasons to attract available workers. While this may temporarily resolve labor scarcities, it significantly increases production costs, especially for smallholders who already operate on narrow margins. In many cases, unaffordable labor results in unharvested crops, financial loss, and increased debt, further marginalizing vulnerable farmers.

This labor shortfall also contributes to rising food prices. Disruptions in supply chains due to reduced output create price volatility for essential commodities such as wheat, rice, and vegetables. According to the World Food Program (2023), nearly 38% of Sindh's population now faces moderate to severe food insecurity, with rural areas most acutely affected.

The broader economic impact is substantial. Sindh's agriculture underpins critical industries like textiles, which rely on cotton, and rice exports. A weakened farming sector could reduce national GDP growth by 1–2% annually, according to World Bank estimates (2023), worsening unemployment and trade imbalances.

Addressing these challenges requires a multifaceted strategy. Expanding vocational training through government and private partnerships will equip farmers with modern skills. Subsidizing machinery and improving access to credit can ease the transition to mechanized farming. Ensuring fair wages, social security, and safer working conditions will help retain skilled labor. Finally, engaging youth through digital platforms and incubator programs can rejuvenate interest in agriculture, creating a new generation of tech-savvy farmers. These steps are critical not only for Sindh's agricultural sustainability but for national food and economic security.

Conclusion

The shortage of skilled labor in Sindh's agriculture sector represents a critical challenge with far-reaching implications for Pakistan's food security, rural development, and overall economic stability. As traditional labor sources dwindle due to rural-to-urban migration, lack of training, low wages, and delayed mechanization, farms are increasingly unable to meet production targets. This has led to declining crop yields, higher input costs, and growing food insecurity, particularly for smallholder farmers who form the backbone of Sindh's agricultural economy.

The continued neglect of this issue risks widening rural-urban disparities and undermining the agricultural sector's contribution to GDP and exports. However, this crisis also presents an opportunity for transformation. With strategic policy interventions, the province can reinvigorate its agricultural workforce. This includes expanding vocational training, promoting public-private partnerships to support mechanization, and providing incentives for youth engagement in agri-entrepreneurship. Simultaneously, improving labor conditions, enforcing fair wages, and offering social security and health benefits will be vital to attract and retain skilled workers.

The future of Sindh's agriculture depends not only on its fertile lands and water resources, but on the people who cultivate them. Empowering this labor force with the tools, knowledge, and dignity they deserve is not just an imperative policy, it is a national necessity.

References: PBS; World Bank; Sindh Agriculture Department; ILO; FAO; WFP; STEVTA; Sindh Chamber of Agriculture

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Empowering Women for Agriculture's Future in Sindh

Discover how empowering women in agriculture is crucial for the future of agriculture in Sindh, Pakistan. Address socio-economic barriers to unlock their potential and enhance agricultural productivity.

Mahgul Ashique Ali

5/1/2025

Agriculture is the backbone of Pakistan's economy, contributing approximately 23% to the national GDP and employing around 37% of the country's labor force (PBS, 2023). In rural Sindh, where nearly 70% of the population relies on agriculture for their livelihoods, women are at the heart of farming communities. They contribute between 60% and 80% of the labor involved in core agricultural tasks such as sowing, transplanting, weeding, harvesting, post-harvest processing, and livestock management (FAO, 2022). Despite their indispensable role, women's contributions remain largely unrecognized and undervalued within both household and institutional frameworks.

Most rural women in Sindh work as unpaid family laborers or are engaged informally, lacking access to land ownership, credit, extension services, agricultural training, and fair wages. Cultural constraints, legal exclusion, limited mobility, and low literacy rates further entrench their marginalization. According to UN Women (2022), less than 5% of rural women in Sindh own agricultural land, and fewer than 10% have access to formal banking or agricultural support services. As a result, they remain trapped in cycles of poverty, despite being key contributors to household food security and rural economies.

This research explores the pivotal role women play in sustaining Sindh's agricultural sector, while critically examining the socio-economic, legal, and institutional barriers that hinder their full participation and productivity. It argues that empowering women in agriculture is not only a matter of gender equity, but a strategic necessity for improving food security, enhancing agricultural efficiency, and accelerating economic development. Key strategies for empowerment include implementing gender-responsive agricultural policies, expanding access to microfinance and land rights, strengthening rural education, and promoting women's participation in cooperatives and decision-making bodies. Recognizing and investing in female farmers is vital for building a more inclusive, resilient, and productive rural economy in Pakistan.

The Role of Women in Sindh's Agriculture

In rural Sindh, women form the backbone of agricultural labor, participating extensively in crop production, livestock rearing, and post-harvest processing. Despite their vital contributions, their roles often go unrecognized in official data and remain undervalued in economic terms. Women are actively involved in nearly every stage of crop production. They assist in land preparation, including clearing and plowing, particularly on smallholder farms where mechanization is limited or absent. During the sowing and transplanting seasons, especially for rice and vegetables, women work long hours, often knee-deep in muddy fields. They also handle manual weeding and irrigation tasks, contributing significantly to crop maintenance. At harvest time, women lead in threshing, drying, cleaning, and storing the produce. According to a 2023 study by the Sindh Agriculture Department, women contribute over 60% of the labor in major crops such as wheat, cotton, and rice, yet their input is largely excluded from labor force surveys and wage assessments.

Beyond crops, women in Sindh play a crucial role in livestock rearing, which is often a primary or supplementary income source for rural households. Their responsibilities include feeding and milking animals, managing fodder, cleaning animal shelters, administering basic healthcare, and producing dairy products like yogurt, butter, and ghee. However, due to patriarchal land and inheritance systems, less than 5% of women own livestock or have access to veterinary support and market linkages (ILO, 2022). Their work is often unpaid and carried out within the family structure, leaving them economically invisible.

Women also contribute to small-scale rural enterprises such as embroidery, basket weaving, food preservation, and the informal sale of eggs, milk, and vegetables. These ventures help supplement household income but are constrained by limited market access, financial exclusion, and reliance on exploitative middlemen. Despite their productivity, women continue to face barriers that limit their economic empowerment in agriculture.

Challenges Faced by Women in Agriculture

Women in agriculture in Sindh face numerous intersecting challenges that hinder their full participation and recognition in the sector. One of the most persistent issues is limited landownership. Despite Islamic laws granting women inheritance rights, customary practices overwhelmingly favor male heirs, leaving less than 2% of women in Sindh with formal land titles (World Bank, 2023). Without ownership documentation, women are excluded from accessing agricultural loans, government subsidy schemes, or support programs that require proof of landholding. This structural marginalization perpetuates dependency

and limits women's ability to invest in their farms or secure financial independence.

The lack of access to credit and agricultural inputs further deepens this inequality. State Bank of Pakistan (2023) data shows that 98% of agricultural loans in Sindh are granted to men. Women are often left without access to essential resources like quality seeds, fertilizers, or mechanized tools, which are typically distributed through male-dominated cooperatives. In addition, most agricultural machinery is ergonomically designed for male users, while innovations in climate-resilient farming rarely reach women.

Women are also systematically excluded from agricultural extension services. Only 10% of extension workers in Sindh are women, and training sessions are frequently inaccessible due to cultural norms that restrict women's mobility, low literacy rates (30% in rural areas), and male-centric training venues (FAO, 2023). As a result, women miss out on technical knowledge, limiting their ability to innovate or improve yields.

Wage discrimination and labor exploitation are rampant. Female agricultural workers earn 30–40% less than men for equivalent labor (PBS, 2023), and many work unpaid as family helpers. They lack access to social security, health coverage, or labor protections, making their employment precarious and undervalued.

Climate change has also intensified their workload. In drought-prone regions like Tharparkar, women spend up to eight hours a day gathering water and fodder, increasing their exposure to heat stress without adequate protective gear. Nevertheless, community-led initiatives are creating change. In Umerkot, women supported by SRSO have formed dairy and poultry cooperatives, boosting household incomes. In Badin, AKRSP's micro-loans have enabled women to start vegetable farming businesses, with some now supplying produce to Karachi's markets. These examples show that with the right support, rural women can become powerful agents of agricultural resilience and economic transformation.

Empowering Women in Agriculture: Policy Recommendations

Empowering women in agriculture is vital for achieving food security, rural development, and gender equality in Pakistan. In Sindh, where women contribute over 60% of agricultural labor, their contributions remain largely informal, underpaid, and invisible in policy frameworks. To change this, a range of gender-sensitive reforms must be implemented at legal, institutional, and grassroots levels. Legal reforms are essential to ensure that women can own and inherit land. Enforcing Islamic inheritance laws and introducing joint land titles for married couples under government support programs would grant women greater control over agricultural resources and improve access to financial services.

Improving access to credit and inputs is another critical step. Financial institutions should introduce targeted microcredit schemes, such as the Khushhali Bank's Gender Finance Initiative, to provide women with the capital needed to invest in farming. Additionally, subsidies for essential resources like quality seeds, fertilizers, and solar-powered irrigation systems must be made accessible to female farmers, particularly those in remote areas.

Education and extension services need a gender-inclusive approach. Mobile training units and a dedicated cadre of female extension officers can provide women with agricultural knowledge, from crop management to market access. These efforts should be supported by adult literacy programs and media campaigns that highlight the success of women in agriculture, helping change societal attitudes.

Ensuring fair wages and direct market access is also key. The establishment of women-led cooperatives can empower female farmers to bypass exploitative middlemen, while digital platforms such as TajirNow can connect them with urban consumers and e-commerce markets. Collectively, these strategies not only address structural barriers but also unlock the full potential of women as agents of agricultural innovation and sustainability. With inclusive policies, women can help transform Sindh's rural economy and contribute meaningfully to Pakistan's broader development goals.

Conclusion

The future of agriculture in Sindh, and by extension, Pakistan, cannot be fully realized without recognizing, valuing, and investing in the women who sustain it. Despite forming the backbone of the rural agricultural workforce, women in Sindh continue to face entrenched socio-economic barriers that limit their potential and contributions. From landlessness and financial exclusion to lack of technical training and wage discrimination, these challenges perpetuate gender inequality and hinder overall agricultural productivity.

However, evidence shows that when women are provided with access to land, credit, inputs, education, and fair markets, they become powerful drivers of food security, climate resilience, and economic development. Successful grassroots initiatives, such as cooperatives and microfinance programs, demonstrate that targeted support can uplift entire communities. Therefore, empowering women in agriculture must move beyond rhetoric and become a cornerstone of Pakistan's rural development strategy. By mainstreaming gender into agricultural policies, reforming land rights, expanding inclusive extension services, and promoting women's leadership in cooperatives and decision-making platforms, Pakistan can unlock a transformative opportunity. It is not just a matter of equity, it is a strategic imperative for building a resilient, inclusive, and sustainable agricultural future. The time has come to shift from invisibility to empowerment and ensure that the women of Sindh are not just laborers, but leaders in agriculture.

References: FAO; World Bank; PBS; ILO; Sindh Rural Support Organization; UN Women; State Bank of Pakistan

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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Livestock Sector in Rural Sindh: A Pivotal Resource

Explore the vital role of the livestock sector in rural Sindh, which supports millions through income and nutrition. Discover how this traditional industry addresses modern challenges and empowers women's livelihoods while adapting to climate change.

Abdul Hannan Cheepa

5/7/2025

In the arid landscapes of rural Sindh, where erratic rainfall and groundwater scarcity severely limit crop cultivation, livestock serves as a vital economic pillar. Accounting for a diverse mix of buffaloes (32%), cattle (28%), goats (27%), and sheep (13%) of the province's livestock population (Pakistan Economic Survey 2022–23), this sector is deeply woven into the socioeconomic fabric of rural life. Valued at an estimated $4.2 billion, the livestock economy supports more than 70% of rural households in Sindh, many of whom rely on it for food security, income, and daily survival (Sindh Livestock Department, 2023).

The economic benefits of date palm farming in Khairpur are significant. A mature date orchard can yield 80–100 kilograms of fruit per tree annually, with gross returns ranging from PKR 250,000 to 400,000 per acre depending on variety, quality, and market access. With relatively low input costs, mainly water, labor, and basic fertilization, farmers can achieve favorable profit margins, especially during export seasons when prices peak. However, profitability is often constrained by outdated post-harvest practices, poor cold storage infrastructure, and limited access to global certification standards such as HACCP and GlobalGAP.

This article provides a detailed profitability and cost-benefit analysis of date palm cultivation in Khairpur Mirs, focusing on production costs, market dynamics, export competitiveness, and value chain bottlenecks. It also explores emerging opportunities in processing, value addition, and climate-smart farming practices that could enhance the sector’s long-term sustainability. By addressing logistical, technical, and financial barriers, Khairpur’s date industry holds the potential to become a high-value agribusiness hub, creating jobs, boosting exports, and supporting inclusive rural development in one of Pakistan’s most agriculturally strategic districts.

Historical Background and Agro-Climatic Suitability

Khairpur Mirs, located approximately 450 kilometers from Karachi, has long been recognized as a center for date palm cultivation, with its agricultural prominence tracing back to the 1930s. This transformation was catalyzed by the construction of the Sukkur Barrage, which revolutionized irrigation systems in upper Sindh and turned Khairpur into one of Pakistan’s most fertile regions for date farming (Sindh Agriculture Department, 2022). The region’s unique agro-climatic conditions make it especially suited for high-quality date production. Its hot desert climate, with summer temperatures frequently reaching an average of 40°C, combined with well-drained sandy loam soil, offers an optimal environment for the growth and ripening of date palms.

These conditions are particularly favorable for the cultivation of the Aseel variety, which is not only renowned for its rich taste and long shelf life but also constitutes around 60% of Khairpur’s total date exports (Horticulture Research Institute, 2023). The long, hot summers and the relatively dry monsoon period from July to September provide a critical window for harvesting and sun-drying, which enhances the quality and commercial value of the fruit.

As of 2023, Khairpur’s total cultivated area under date palms spans approximately 75,000 acres. With an average planting density of 60 trees per acre and yields averaging around 100 kilograms per tree, the district produces nearly 450,000 tonnes of dates annually. This substantial output supports a vibrant local economy based on harvesting, processing, packaging, and trade. The concentration of both traditional know-how and favorable natural conditions has helped Khairpur become the epicenter of Pakistan’s date industry. The region’s historical development and natural advantages continue to anchor its competitive edge in national and international markets, positioning it as a strategic player in the global date supply chain.

Economic Contribution of Date Palm Cultivation in Khairpur

Date palm cultivation serves as the economic backbone of Khairpur Mirs, offering extensive livelihood opportunities and driving the rural economy. During the peak harvest season, the industry supports over 500,000 workers across various nodes of the value chain (Labor Department of Sindh, 2023). A robust formal processing sector comprises more than 20 industrial units, each employing an average of 200 workers who earn daily wages Rs. 300 and Rs. 500. These export-focused facilities primarily handle high-demand varieties such as Aseel, Dhakki, and Begum Jangi, targeting Middle Eastern markets where demand for Pakistani dates remains strong.

Beyond the formal sector, a vibrant informal and cottage industry also plays a critical role. Between 12,000 and 15,000 home-based workers, predominantly women, engage in labor-intensive activities such as grading, pitting, and packaging. Additionally,

over 200 roadside vendors earn daily incomes of Rs. 1,000 to Rs. 2,000 by selling fresh and processed dates. Ancillary services like transport, wholesale, and retail further contribute to income generation, with each step adding a 40–60% markup before the product reaches end consumers (Sindh Chamber of Agriculture, 2023).

From a financial standpoint, the economics of date palm cultivation in Khairpur are compelling. The per-acre cost of production is around Rs. 250,000, distributed across land preparation, irrigation, fertilizers, labor, marketing, and miscellaneous expenses. With an average yield of 6,000 kilograms per acre and wholesale prices ranging from Rs. 80 to Rs. 120 per kilogram for the Aseel variety, farmers can generate gross revenues between Rs. 480,000 and Rs. 720,000 per acre. This results in net profits between Rs. 230,000 and Rs. 470,000 per acre, translating to a benefit-cost ratio of 1:1.9 to 1:2.8, significantly higher than regions like Kech in Balochistan, which reports a lower BCR due to higher post-harvest losses (PARC, 2023).

Constraints and Strategic Opportunities in Khairpur's Date Palm Economy

Despite its strong economic potential, date palm cultivation in Khairpur Mirs faces several persistent challenges that limit profitability for farmers and agribusinesses. Post-harvest losses remain one of the most significant issues, with 20–30% of the annual yield lost due to substandard drying and storage practices. Traditional sun-drying techniques, widely used across the region, expose dates to fungal contamination and insect infestation. Moreover, the absence of cold storage infrastructure contributes to spoilage rates of 10–15% before the product even reaches markets. These inefficiencies directly impact on farmer income and national export competitiveness.

Market access barriers further constrain profitability. Nearly 80% of growers are dependent on middlemen who purchase dates at prices 40–50% lower than retail market rates. Inadequate road infrastructure inflates transportation costs by 15–20%, disproportionately affecting smallholders in remote villages. Meanwhile, climate risks are intensifying. Monsoon rains during the July–September harvest season threaten up to 90% of the crop in flood-prone zones, while rising temperatures, often exceeding 45°C, have reduced fruit-setting rates by 12–18%, according to the Pakistan Meteorological Department (2023).

Technological adoption remains minimal, with less than 5% of farms using drip irrigation, despite its potential to reduce water use by 30%. Additionally, the lack of tissue culture laboratories limits access to disease-free saplings, stalling orchard renewal and productivity gains.

To address these constraints, targeted policy interventions and investments are needed. Establishing ten modern processing units and solar-powered cold storage facilities could dramatically reduce post-harvest losses. Market reforms, such as integrating e-commerce platforms and setting up export zones in Karachi, would enhance price realization. Financial support, including subsidies for drip systems and interest-free loans via Sindh Bank, could boost productivity by 20%. Climate adaptation strategies, including early maturing varieties and weather-indexed crop insurance, would further safeguard farmer livelihoods.

Conclusion

Date palm cultivation in Khairpur Mirs stands as a cornerstone of Pakistan's agricultural economy, offering immense potential for rural development, export growth, and poverty alleviation. The sector's profitability, evidenced by net returns of Rs. 230,000-470,000 per acre and a 1:1.9–2.8 benefit-cost ratio, demonstrates its viability, yet systemic challenges hinder its full potential. Post-harvest losses (20–30%), middleman exploitation, and climate vulnerabilities significantly reduce farmer incomes, while outdated infrastructure and limited technology adoption constrain competitiveness.

Strategic interventions, such as modern processing units, cold storage facilities, and drip irrigation subsidies, could transform Khairpur into a high-value agribusiness hub. Expanding direct market access and export certifications would enhance price realization, while climate-resilient varieties and insurance schemes could mitigate monsoon risks. With 70% of Sindh's date output and 30% of Pakistan's exports, Khairpur's success hinges on policy support, private investment, and research-driven innovation. By addressing these gaps, Pakistan can elevate its global standing in the $13 billion date market (FAO, 2023), ensuring sustainable prosperity for Khairpur's farming communities.

References: FAO; Pakistan Bureau of Statistics; PARC; Sindh Agriculture Department; World Bank; Horticulture Research Institute; Labor Department of Sindh; Sindh Chamber of Agriculture; Pakistan Meteorological Department

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Climate Change Impact on Sindh Agriculture

Sindh faces a critical climate change crisis affecting its agricultural foundation and rural economy. Extreme weather, rising temperatures, and soil degradation threaten food production, leading to collapsing yields and rising unemployment. Discover how these challenges impact livelihoods.

Attia Khaskheli

5/9/2025

Sindh, Pakistan's second-most populous province, plays a pivotal role in the nation's food and economic security, contributing 23% to agricultural GDP and employing over 60% of the rural labor force (World Bank, 2023). However, this lifeline is under growing threat from the escalating impacts of climate change. Rising average temperatures, intensifying heatwaves, unpredictable monsoon patterns, and recurrent floods have begun to drastically undermine the productivity and reliability of Sindh's agricultural systems. Crops such as wheat, rice, and cotton, long considered staples of the region, are now increasingly vulnerable to heat stress, erratic rainfall, and water shortages, leading to lower yields and seasonal disruptions in planting and harvesting.

The 2022 super floods were a grim manifestation of these climate risks. Over 4.4 million acres of productive farmland were submerged, triggering $30 billion in national economic losses and plunging 8.4 million people into acute food insecurity (UNOCHA, 2023). These shocks did not merely affect crops, they triggered a cascade of socioeconomic disruptions. Rural employment fell sharply as demand for seasonal labor collapsed, with the Pakistan Bureau of Statistics (2023) reporting a 22% rise in rural joblessness in affected districts.

Moreover, saltwater intrusion in coastal areas of Thatta and Badin, driven by sea-level rise and reduced freshwater flows, is further degrading arable land and forcing communities to abandon farming altogether. The knock-on effects include rising rural-to-urban migration, overburdened urban job markets, and increasing strain on food distribution systems.

This article delves into the intersection of climate and labor vulnerability in Sindh's rural economy. It argues that without urgent interventions, such as investing in climate-resilient crops, adaptive irrigation systems, and rural employment guarantees, Sindh may face a deepening crisis of rural dispossession and chronic food insecurity. Proactive climate adaptation and labor protection policies are vital to preserving agricultural livelihoods and stabilizing Pakistan's agrarian future.

Climate Change Impacts on Sindh's Agriculture

Climate change is reshaping the agricultural landscape of Sindh, exacerbating environmental stresses and threatening the province's role as a key food-producing region. The province has experienced a 1.2°C increase in average temperature since 1960, contributing to a fivefold rise in the frequency of heatwaves (PMD, 2023). These extreme temperatures have had a direct impact on crop productivity. For instance, wheat yields in Larkana have declined by 15% due to heat stress during the flowering stage, which is critical for grain formation (CIMMYT, 2023). Meanwhile, erratic rainfall patterns have disrupted traditional sowing calendars. In 2023, delayed monsoon rains in Dadu resulted in a 30% loss in rice yields, undermining both farmer incomes and food availability (FAO, 2024).

The province also faces a recurring cycle of floods and droughts, both of which have intensified in frequency and severity. Major floods in 2010 and 2022 alone destroyed over 4.6 million acres of standing crops across Sindh (NDMA, 2023). Conversely, prolonged drought conditions in Tharparkar between 2018 and 2023 led to a catastrophic 48% loss in livestock populations, which are essential to pastoralist communities (Sindh Livestock Department, 2024). These hydrological extremes are not isolated events, they destabilize the entire agricultural economy by triggering migration, food shortages, and debt cycles.

Compounding these challenges is the growing problem of sea intrusion and salinization in coastal districts. Since 2000, 1.4 million acres of productive farmland in Thatta and Badin have been rendered unfit for cultivation due to seawater encroachment (WWF-Pakistan, 2024). Badin's rice yields have dropped by 60%, largely due to soil salinity that hampers germination and plant growth (IWMI, 2023). Together, these climate-induced threats are eroding the foundations of Sindh's agricultural resilience, highlighting an urgent need for climate-smart strategies and adaptive land and water management practices.

Agricultural Risks and Economic Fallout

Sindh's agricultural economy is teetering under the combined weight of climate-induced shocks, pest outbreaks, and escalating input costs, causing significant disruptions across crop production, livestock rearing, and rural livelihoods. The province's two major crops, cotton and wheat, have witnessed staggering declines. Cotton production halved from 4.2 million bales in 2014 to 2.1 million in 2023, while wheat yields dropped 24% over the same period (PBS Agriculture Census, 2024). A key contributor is whitefly infestations, exacerbated by humidity fluctuations linked to climate change. In Sanghar

district alone, pest-related cotton losses reached Rs. 12 billion in 2023 (Sindh Agriculture Department, 2024). These collapses not only affect domestic food and fiber supply but also impair export revenue and rural income security.

The livestock sector faces parallel crises. The 2022 floods wiped out 1.2 million cattle, inflicting losses of Rs. 80 billion (FAO, 2023), while prolonged droughts have slashed milk yields by 40% in districts like Umerkot (SAU, 2024). Rising diesel prices (Rs. 300/liter) and fertilizer costs (Rs. 6,500 per bag of urea) have pushed input costs beyond affordability for smallholders, forcing many to abandon cultivation altogether (FPCCI, 2024).

These agricultural setbacks have cascaded into rural labor markets. Seasonal unemployment has surged, Khairpur's date harvesters remain idle for eight months a year, while average wages stagnate at Rs. 800/day, below the national poverty threshold (ILO, 2023; World Bank, 2024). Rural distress migration is accelerating; Hyderabad's informal settlements have grown by 18%, largely due to displaced farming families (UN-Habitat, 2024). Left behind, women shoulder increased workloads in agriculture, domestic chores, and livestock care, often without institutional support (ODI, 2023). Child labor is rising too, 16% of Sindh's children aged 10-14 are now engaged in exploitative labor, especially in brick kilns and fisheries (PBS, 2023).

Although promising initiatives exist, such as the Sindh Agriculture Growth Project's salt-tolerant rice and solar irrigation pilots, their reach remains limited, covering only 12% of farmers (ADB, 2024). Social safety nets are also insufficient; 63% of flood-affected households are excluded from BISP coverage (UNDP, 2023), and disaster preparedness systems like Dadu's early-warning infrastructure lack the resources for broader deployment (NDMA, 2024).

To foster resilience, policymakers must scale up climate-smart agriculture through drought-tolerant seeds and microinsurance. Rural job creation via agro-processing hubs and vocational training can absorb labor market shocks. Gender-responsive policies, including land rights and mobile advisories, are vital for inclusive adaptation. Lastly, establishing the proposed Sindh Climate Authority and community-led flood management structures can embed long-term resilience and governance into the region's development framework.

Conclusion

Sindh stands at a critical juncture, where climate change is no longer a looming threat but a present crisis undermining its agrarian foundation and rural economy. The province's historical role as a food basket for Pakistan is rapidly eroding under the weight of extreme weather events, rising temperatures, soil degradation, pest outbreaks, and economic pressures. From collapsing cotton and wheat yields to livestock losses and surging rural unemployment, climate-induced shocks are disrupting not just food production but the very livelihoods of millions who depend on agriculture.

The socioeconomic fallout is profound, distress migration, deepening poverty, gendered burdens, and child labor are becoming systemic features of Sindh's rural landscape. Despite pilot programs in climate-smart agriculture and disaster preparedness, the scale and pace of intervention remain insufficient to meet the magnitude of the crisis.

Sindh risks cascading into chronic rural dispossession, food insecurity, and economic marginalization. Solutions exist scaling up resilient seed varieties, expanding microinsurance, investing in rural job diversification, enforcing inclusive land rights, and institutionalizing climate governance through entities like the proposed Sindh Climate Authority. The urgency is clear. Building a climate-resilient future for Sindh is not only essential for protecting livelihoods, but also indispensable for safeguarding national food security and sustainable development.

References: World Bank; FAO; PMD; UNDP; ILO; UNOCHA; CIMMYT; NDMA; Sindh Livestock Department; IWMI; PBS Agriculture Census; FPCCI; FAU; UN-Habitat; ODI; PBS; FPCCI

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Youth-Led Solutions for Pakistan's Challenges

Pakistan faces three critical challenges: youth unemployment, food shortages, and environmental damage. This article shows how youth-led solutions can tackle these issues through smart farming and climate-smart agriculture. Learn how their tech-driven solutions create jobs, and boost food security.

Alina Arain

5/15/2025

Pakistan is facing a complex convergence of three critical national crises: surging youth unemployment, persistent food insecurity, and accelerating environmental degradation. With 64% of its population under the age of 30 (UNDP, 2024), the country's future hinges on whether this demographic dividend can be harnessed productively. At the same time, agriculture, contributing 24% to GDP and employing 38% of the national workforce (World Bank, 2024), remains central to Pakistan's economic and social fabric, yet it is deeply inefficient, environmentally taxing, and increasingly unappealing to the younger generation.

This article explores a transformative solution: the mass training and mobilization of youth in smart farming technologies. By aligning human capital development with sustainable agricultural innovation, this strategy presents a triple-win opportunity. First, it addresses Pakistan's environmental challenges, particularly methane emissions, 43% of which originate from agriculture (PCRWR, 2024), by promoting climate-smart practices such as precision irrigation, organic inputs, and regenerative soil techniques. Second, it offers an urgent response to youth unemployment, which stands at 38% nationally (UNDP, 2024), by equipping young people with market-relevant skills in agri-tech, drone mapping, AI-based crop monitoring, and agribusiness management. Third, it confronts rising food insecurity, currently affecting 36% of the population (FAO, 2024), by enhancing productivity, reducing waste, and building resilient food systems.

Based on fieldwork conducted across Punjab, Sindh, and Khyber Pakhtunkhwa (KP), this study highlights existing youth-led smart farming initiatives and their replicable impacts. These include digital extension services, solar-powered irrigation startups, and climate-resilient seed enterprises. The findings suggest that targeted investment in training, mentorship, and infrastructure can catalyze widespread transformation. The article proposes a national framework, centered on public-private partnerships, digital innovation hubs, and youth cooperatives, to scale these efforts and unlock the full potential of Pakistan's young population as drivers of food security, environmental stewardship, and inclusive economic growth.

The Triple Crisis: By the Numbers

Pakistan is grappling with a triple crisis that threatens its economic stability, social cohesion, and environmental sustainability: an employment emergency, escalating food insecurity, and worsening environmental degradation. Together, these intersecting challenges demand immediate, systemic, and coordinated responses.

On the employment front, the country adds approximately 1.5 million new job seekers every year (ILO, 2024), yet economic absorption is weak, particularly among the youth. Youth unemployment stands at a staggering 38%, nearly double the national average (UNDP, 2024). While agriculture remains the largest employer, it is plagued by inefficiencies and informal labor structures, with underemployment affecting over 52% of its workforce (Labor Force Survey, 2023). This mismatch between labor demand and supply highlights the urgent need to modernize the sector and create dignified, technology-driven employment pathways.

Simultaneously, food insecurity continues to rise, affecting 36% of the population with moderate to severe intensity (FAO, 2024). Wheat yields remain stagnant at 2.9 tons per hectare—far below the attainable benchmark of 4.5 tons (PARC, 2024). Furthermore, poor post-harvest infrastructure leads to over $1 billion in annual food losses (Ministry of Food Security, 2023), undermining both farmer incomes and national food supply chains.

Environmentally, agriculture has become a major source of pollution and climate risk. It accounts for 43% of Pakistan's methane emissions, with rice cultivation alone emitting 15 tons of CO_2-equivalent per hectare per year (PCRWR, 2024). Additionally, the burning of crop residues contributes to 20% of winter air pollution in Punjab (EPA Punjab, 2023), exacerbating respiratory illnesses and environmental degradation.

This triple crisis underscores the urgency for integrated policy reforms and investment in climate-smart, youth-led agricultural innovation. Addressing these challenges holistically is critical not only for economic recovery but also for sustainable development and social equity.

Youth-Led Agri-Tech Innovations

Three innovative, youth-led agricultural technology initiatives from across Pakistan demonstrate how smart farming can address the triple crisis of unemployment, food insecurity, and environmental degradation while empowering the next generation. These initiatives, AgriBot in Punjab, Green Warriors in Sindh, and CropGenius in Khyber Pakhtunkhwa, are pioneering examples of how digital tools and climate-smart practices can transform agriculture at the grassroots level.

In Punjab's rice belt, AgriBot was launched by a team of university

graduates to counter traditional inefficiencies in irrigation and fertilizer usage. Using solar-powered IoT sensors and AI algorithms, the system provides farmers with real-time data on soil moisture and nutrient needs. Between 2020 and 2024, AgriBot reduced water use by 45% and fertilizer application by 52% across 5,000 acres, while boosting crop yields by 30% on 3,200 farms. This translated into substantial emission reductions, over 8,200 tons of CO_2e annually, and generated 1,200 new jobs for rural youth. For many farmers like Muhammad Asif in Lahore, the technology has revolutionized daily decision-making: "Before AgriBot, we were farming blindly. Now we get alerts when crops need water or nutrients."

In Sindh, Green Warriors turned an environmental hazard into a sustainable income source. Previously, 10 million tons of crop residue were burned annually, causing $150 million in health costs and depleting soil carbon. Green Warriors, founded in Hyderabad, trained over 1,500 youth to produce biochar, carbon-rich fertilizer, from crop waste using mobile pyrolysis units. The result: residue burning was reduced by 70% across eight districts, soil organic carbon increased by 40% on 4,500 acres, and 300 farmers generated $200,000 in carbon credit revenue. "We turned a pollution problem into profit," said founder Aisha Malik. "Each ton of biochar adds $50 to farmer incomes."

In KP's Swat Valley, where tomato farmers were losing 40% of crops annually to pests, young coders developed CropGenius, an AI-driven pest forecasting system based on satellite imagery and SMS alerts. Farmers also received natural pesticide recipes to reduce chemical dependency. In just one year, 68% of Swat's tomato growers adopted the system, yielding a 37% boost in harvests and 45% reduction in pesticide costs. "CropGenius warned us 10 days before the pest attack. We saved our entire crop," noted Farman Ullah, a local farmer.

The Policy Blueprint: National Youth Agri-Tech Corps

To address Pakistan's converging crises of youth unemployment, food insecurity, and environmental degradation, a National Youth Agri-Tech Corps is proposed as a transformative policy framework. This initiative aims to train 50,000 youth annually, 40% of them women, in emerging agricultural technologies such as Internet of Things (IoT), drones, artificial intelligence (AI), and biochar production. Training will be delivered through 50 dedicated hubs nationwide, with 20 operational in the first year.

The funding mechanism combines redirected social protection funds, climate finance, and private sector partnerships. Specifically, Rs. 15 billion from BISP would support youth stipends, Rs. 20 billion from international climate finance would underwrite technology grants, and Rs. 10 billion would be secured through private sector matching funds to foster innovation and scalability.

Implementation would unfold in three phases: a pilot in five districts by 2025, a national rollout during 2026–27, and a self-sustaining model by 2028. A centralized digital dashboard would track key outcomes, employment generation, emission reductions, and crop productivity. Independent audits by partners such as the World Bank would ensure transparency and credibility.

By 2030, this initiative aims to increase youth employment in agriculture from 2.1 million to 5 million, reduce agriculture's methane emissions share from 43% to 30%, cut food insecurity from 36% to 25%, and raise average crop yields from 2.9 to 3.8 tons per hectare.

Field insights inform critical design features. To overcome digital literacy gaps, mobile-first modules modeled on platforms like Jazz's Agri-Ustad app will be deployed. Financing gaps will be bridged through blockchain-enabled microloans, as piloted by HBL. To ensure gender inclusion, women-led biochar cooperatives in Sindh demonstrate that participation can increase 300% when childcare and social support systems are integrated. With the right policy push, this blueprint can future-proof Pakistan's agriculture and its youth.

Conclusion

Pakistan stands at a defining crossroads, where its most pressing national challenges, youth unemployment, food insecurity, and environmental degradation, can either deepen into chronic crises or be transformed into historic opportunities. The evidence presented in this study confirms that the path forward lies in unleashing the potential of Pakistan's youth through a national strategy of smart, climate-resilient agriculture. Youth-led initiatives such as AgriBot, Green Warriors, and CropGenius already illustrate that innovation, when combined with local knowledge and inclusive design, can drive remarkable improvements in productivity, environmental sustainability, and rural livelihoods.

By scaling such models through the proposed National Youth Agri-Tech Corps, Pakistan can simultaneously train a new generation of agri-innovators, modernize its farming systems, and reduce the ecological footprint of its largest economic sector. This will not only ease youth unemployment and elevate food production but also position agriculture as a dynamic, tech-driven engine of national renewal.

The stakes are high, but so is the potential. With bold policymaking, targeted investments, and public-private collaboration, Pakistan can turn its demographic bulge into a climate-smart, food-secure, and economically empowered future. In doing so, it will not only feed its people and protect its land but also inspire a new generation to see farming not as a burden of the past, but as a frontier of innovation.

References: FAO; UNDP; PCRWR; World Bank; KP Agriculture Department; Sindh EPA; ILO; Labor Force Survey; PARC; Ministry of Food Security; EPA Punjab

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Water Crisis & Gender Equity in Rural Pakistan

Explore the dual challenge of the water crisis in rural Pakistan, focusing on gender equity. Women, as primary water stewards, face significant burdens. Learn how empowering women leads to improved water access and sustainability across Sindh, Punjab, Balochistan, and Khyber Pakhtunkhwa.

Komal Qasim

5/21/2025

Water is a vital resource for human survival, food production, and national stability, yet in rural Pakistan, access to clean drinking water remains a major challenge. According to the World Bank (2023), nearly 70% of rural residents do not have access to safe water sources. In these communities, women are the primary stewards of water, they are responsible for collecting, storing, and conserving it for household use. Despite the central role they play, their voices are largely absent from formal water governance and decision-making processes. This exclusion not only perpetuates gender inequality but also weakens efforts to address Pakistan's worsening water crisis, which is now ranked as the third most severe globally (IMF, 2023).

Women in rural Pakistan walk an average of 5 to 10 kilometers daily to fetch water (Pakistan Council of Research in Water Resources, 2023). This daily burden takes a heavy toll. It reduces school attendance for girls by up to 40% (UNICEF, 2023), as many are pulled out of school to help with water collection. For adult women, the time spent gathering water, often 3 to 5 hours each day, significantly limits opportunities to engage in income-generating activities (ILO, 2023). The physical demands of this task also result in long-term health consequences, such as chronic back pain, joint problems, and fatigue (WHO, 2023).

Climate change is compounding the crisis. Increasing drought frequency and erratic rainfall patterns are drying up traditional water sources, forcing women to travel even greater distances. This not only heightens the physical and emotional toll but also increases their exposure to extreme heat, poor road conditions, and threats to personal safety (NDMA, 2023). Without urgent investment in rural water infrastructure and inclusive governance that empowers women, Pakistan's water insecurity will continue to undermine both development and gender equity.

Women's Role and Struggles in Water Governance

In rural Pakistan, women function as the de facto water managers in their households and communities, overseeing up to 90% of water-related tasks. Their responsibilities span the full spectrum of domestic and productive needs, including drinking, cooking, sanitation, small-scale irrigation for kitchen gardens, and providing water for livestock. This work, though largely informal and unpaid, is critical to rural survival and food security. Women also possess deep traditional knowledge of water conservation practices, such as rainwater harvesting and groundwater recharge. These indigenous methods play a vital role in sustaining local water cycles, particularly in arid and drought-prone regions. However, their expertise is rarely acknowledged in formal water policies or programs. Only 12% of water management committees in Pakistan include women (UNDP, 2023), reflecting a glaring gender gap in decision-making that renders many policies ineffective and disconnected from on-the-ground realities.

This exclusion from governance is compounded by structural barriers. Fewer than 5% of women hold leadership roles in water user associations (World Bank, 2023), and limited land ownership further restricts their access to water rights. With only 3% of agricultural land owned by women (PBS, 2023), they are often sidelined in negotiations over water allocation. The consequences are far-reaching: contaminated water sources contribute to over 60% of rural diseases, disproportionately affecting women and children (WHO, 2023). In addition, women face safety risks while collecting water, including harassment and encounters with dangerous wildlife (HRCP, 2023).

Climate change is intensifying these challenges. Pakistan has lost 35% of its freshwater resources over the past two decades (PCRWR, 2023), and increasingly erratic monsoons and prolonged droughts have forced many rural families to rely on expensive water tankers. Women, already stretched thin, are bearing the brunt, both physically and economically, as household debts rise to cover these basic needs.

Women-Led Innovations in Water Management

Amid the challenges of water scarcity and gender inequality, women across rural Pakistan are pioneering local solutions that are transforming water access and governance. These grassroots initiatives are not only addressing critical needs but also reshaping traditional power dynamics within communities.

In Sindh and Punjab, the establishment of women-led village water committees has significantly improved the fairness and transparency of water distribution. These committees ensure that all households, regardless of social status, receive adequate water for drinking, cooking, and sanitation. Their leadership has led to more inclusive decision-making, timely conflict resolution, and

greater community trust in water governance systems (WaterAid, 2023).

In the arid regions of Balochistan, women have taken the lead in managing solar-powered wells, drastically reducing the burden of water collection. By cutting collection time by 70%, these wells have freed up several hours daily for women and girls, allowing them to pursue education, income-generating work, and rest (UNDP, 2023). The solar technology also provides an environmentally sustainable alternative to diesel pumps, making these systems both cost-effective and climate resilient.

In Khyber Pakhtunkhwa, technical training programs for women in hand pump maintenance have had far-reaching impacts. Over 5,000 households now enjoy improved access to safe water thanks to the efforts of women trained to install, repair, and maintain these essential systems (UNICEF, 2023). These women are not only improving public health and hygiene but also gaining technical skills, confidence, and community respect.

These success stories demonstrate the transformative potential of involving women in water management. When women are given the tools, training, and authority to lead, they deliver practical, sustainable solutions that benefit entire communities. Scaling such initiatives can help address Pakistan's water crisis while promoting gender equity and rural resilience.

Advancing Gender-Inclusive Water Governance in Rural Pakistan

To address the water crisis in rural Pakistan effectively and equitably, a gender-inclusive approach to water management is essential. Women are central to water collection, use, and conservation, yet their exclusion from formal governance structures limits the effectiveness and sustainability of water solutions. A comprehensive policy framework must therefore integrate gender equity into legal, infrastructural, and educational dimensions.

Legal and institutional reforms are foundational. Mandating a minimum of 30% female representation in water governance bodies, such as water user associations and village water committees, can ensure that women's voices and needs are reflected in policy decisions (UN Women, 2023). Strengthening inheritance laws is also crucial; without secure land tenure, women lack legal access to water resources, especially for agricultural purposes. Reforming land and water rights together can empower rural women and enhance their decision-making power (HRCP, 2023).

On the infrastructure front, investments must be gender sensitive. Building water sources closer to homes and deploying motorized pumps can significantly reduce the physical burden on women and girls. Moreover, integrating digital technologies, such as GIS mapping and IoT sensors, can help monitor water usage efficiently, reducing reliance on manual labor and increasing resource transparency (World Bank, 2023).

Education and awareness campaigns also play a vital role in transforming water governance. Training women in water conservation methods like drip irrigation and rainwater harvesting equips them with skills to manage resources sustainably. Incorporating water management into girls' education curricula can cultivate a new generation of leaders equipped to tackle future challenges (UNESCO, 2023).

Together, these reforms can transform women from invisible laborers into recognized agents of change. A gender-responsive water governance model is not only a matter of equity, it is a prerequisite for sustainable development and climate resilience in rural Pakistan.

Conclusion

The water crisis in rural Pakistan is both a development and gender equity challenge. Women, as the primary stewards of household water, bear the heaviest burdens, spending hours daily collecting water, risking their health and safety, and sacrificing education and economic opportunities. Despite their central role, they are largely excluded from formal decision-making processes in water governance. This exclusion limits the effectiveness of water policies and exacerbates gender inequalities. However, the success stories emerging from Sindh, Punjab, Balochistan, and Khyber Pakhtunkhwa show that when women are empowered to lead, water access, equity, and sustainability all improve.

Women-led initiatives have demonstrated innovative, climate-resilient solutions that benefit entire communities. These efforts highlight the urgent need for systemic change. Gender-inclusive reforms, such as ensuring women's representation in water governance, securing land and water rights, investing in gender-sensitive infrastructure, and providing education and technical training, can unlock women's potential as agents of change. Without integrating women's voices, knowledge, and leadership into water management, Pakistan risks undermining its development goals and climate resilience. Conversely, by investing in women, the country can build a more equitable, sustainable future where safe water is accessible to all. Empowering women in water governance is not just a policy recommendation; it is a national imperative.

References: FAO; IMF; NDMA; UN Women; World Bank; ILO; UNISEF; WHO; UNDP; PBS; HRCP; PCRWR; WaterAid; UNESCO

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Improved Sanitation for Rural Public Health

Access to improved sanitation is vital for rural public health and economic resilience. It helps prevent diarrheal diseases and other health issues, yet 43% of people still lack safe sanitation. Explore the impacts and costs of inadequate sanitation on communities and economies.

Palwasha Asif

5/29/2025

Sanitation refers to the provision of facilities and services for the safe disposal of human urine and feces. An improved sanitation facility hygienically separates human excreta from human contact, typically involving physically enclosed latrines or toilets connected to a sewer system, septic tank, or pit latrine, alongside reduced waiting times and safer waste disposal methods (WHO, 2021). Improved facilities may also include engineered components such as ventilated improved pit latrines, composting toilets, and flush/pour-flush systems linked to onsite or offsite treatment.

Poor sanitation contributes significantly to the global disease burden. Diseases linked to inadequate sanitation and unsafe water account for nearly 10% of the global disease burden, encompassing diarrheal diseases, acute respiratory infections, undernutrition, and neglected tropical diseases such as helminthiasis and schistosomiasis (WHO, 2023). Diarrheal illnesses alone cause severe dehydration and nutrient loss, particularly among children under five, undermining growth and cognitive development. Furthermore, inadequate sanitation exacerbates environmental contamination, affecting water bodies used for drinking, bathing, and irrigation, which in turn perpetuates disease transmission within communities.

Despite progress, a staggering 3.5 billion people (43% of the global population) still lack access to safely managed sanitation services, meaning facilities that are not only improved but also ensure excreta are safely handled, transported, and treated (WHO, 2023). Approximately 1.7 billion people continue to practice open defecation or rely on unsafe sanitation facilities, with the vast majority residing in low- and middle-income countries (LMICs) (World Bank, 2022). This lack of access is most acute in sub-Saharan Africa and South Asia, where rural populations often contend with limited infrastructure, cultural barriers, and financial constraints. Diarrheal diseases caused by poor sanitation, hygiene, and unsafe drinking water result in 297,000 child deaths annually, equating to over 800 children under five dying each day (UNICEF, 2023). Beyond mortality, poor sanitation imposes economic burdens through healthcare expenditures, lost productivity, and diminished educational outcomes, as children frequently miss school due to illness. Achieving universal access to improved sanitation by 2030, an objective embedded within Sustainable Development Goal 6, remains critical for reducing disease, fostering economic growth, and protecting human dignity worldwide.

Sanitation as a Human Right and Public Good

Sanitation is enshrined as a fundamental human right under United Nations Sustainable Development Goal 6, which mandates that everyone, everywhere, must have access to safe, private, and affordable sanitation services (UN, 2010). Ensuring equitable sanitation access is not merely a matter of infrastructure; it affirms dignity, privacy, and basic health standards for all individuals. As a public good, improved sanitation delivers collective benefits, reducing disease transmission, bolstering economic productivity, and fostering social development (Hutton & Varughese, 2016). When communities are equipped with safely managed toilets and waste treatment, outbreaks of diarrheal diseases and parasitic infections decline, freeing households from avoidable medical expenses and children from preventable school absences.

The economic costs of poor sanitation are staggering, particularly in regions such as Sub-Saharan Africa and South Asia, where infrastructure gaps are most acute. Direct healthcare expenditures amount as households pay for consultations, medications, and hospital stays to treat sanitation-related illnesses. Indirect costs manifest through lost productivity: adults miss workdays due to illness, and premature deaths erode the workforce, undermining household incomes and national economic output. Environmental degradation compounds these burdens, as untreated human waste contaminates water sources; communities must then rely on alternative, often costlier, water supplies or invest in energy-intensive purification systems (World Bank, 2021).

At the macroeconomic level, inadequate sanitation drags on GDP. A 2021 WHO study estimated that poor sanitation costs low- and middle-income countries

between 0.5% and 6.3% of GDP. In Ghana and Pakistan, malnutrition stemming from waterborne diseases adds 40% to the financial burden of child mortality, inflicting long-term consequences on educational attainment and labor productivity (Hutton, 2018). In India, sanitation-related health impacts account for a loss of approximately 6.4% of GDP annually (World Bank, 2020). These figures underscore that investments in sanitation infrastructure, behavior-change campaigns, and regulatory frameworks not only save lives but also yield substantial economic returns by reducing healthcare costs, improving workforce participation, and preserving environmental resources. Ensuring universal access to improved sanitation is therefore both a moral imperative and a sound economic strategy for sustainable development.

Ecological Sanitation and Rural Improvements

Ecological sanitation integrates sanitation infrastructure with nutrient recycling to create sustainable, low-cost solutions tailored to underserved rural areas. By treating human waste through composting toilets or urine-diverting dry toilets, nutrients become safe, valuable fertilizers that enhance soil fertility and food security (Strande et al., 2014). In resource-limited settings, such closed-loop systems reduce reliance on chemical fertilizers, lower costs for smallholder farmers, and promote healthier crops. Moreover, ecological sanitation facilities often require fewer water resources, making them particularly suited to regions facing water scarcity.

However, rural sanitation faces significant challenges. In many villages, 72.4% of households rely on community dumping spots because waste collection systems are inadequate or nonexistent (National Statistical Office, 2022). These open dumps lead to environmental contamination, heightening the risk of waterborne diseases. Additionally, maintenance issues frequently undermine sanitation projects: without regular upkeep, toilets break down, and composting pits overflow, prompting communities to revert to open defecation (UNICEF, 2022). Sustainable rural sanitation, therefore, demands robust community engagement from the outset, training local caretakers, establishing management committees, and providing simple maintenance tools to ensure long-term functionality.

Investments in improved sanitation yield substantial economic benefits. According to WHO (2021), every $1 invested in sanitation generates $5.50 in economic returns by preventing illness and increasing productivity. Families save an average of 1,000 hours per year by avoiding long walks to distant water sources or open defecation sites, freeing time for education and income-generating activities (World Bank, 2020). In schools, the presence of gender-segregated, functioning toilets correlates with higher attendance rates, especially among adolescent girls, and improves overall educational outcomes (UNESCO, 2022). Protecting water supplies from contamination also lowers costs for water treatment systems and reduces public spending on healthcare and emergency interventions (UN-Water, 2023).

In Pakistan, the Water Supply and Sanitation (WSS) sector has made strides, but rural coverage remains limited. Public Health Engineering Departments (PHEDs) prioritize large-scale piped water schemes, which often bypass small villages and remote communities (World Bank, 2022). As a result, only 48% of rural Pakistanis have access to improved sanitation facilities (Pakistan Bureau of Statistics, 2023). Introducing ecological sanitation can help bridge this gap by offering low-cost, decentralized alternatives that communities can manage and maintain. Scaling up such initiatives, coupled with hygiene education campaigns and small grants for local maintenance, can transform rural sanitation, improve public health, and stimulate lasting social and economic development.

Conclusion

Access to improved sanitation is a cornerstone of rural public health and economic resilience. By hygienically separating human excreta from communities, improved sanitation prevents diarrheal diseases, undernutrition, and neglected tropical illnesses that together comprise nearly 10% of the global disease burden. Despite global progress, 43% of people still lack safely managed sanitation, with 1.7 billion practicing open defecation, most in low- and middle-income countries. These gaps impose staggering costs: healthcare expenditures, lost productivity, environmental cleanup, and macroeconomic losses amounting to up to 6.3% of GDP in some nations.

Sanitation is not only a fundamental human right under SDG 6 but also a critical public good; investments in infrastructure and behavior-change yield high economic returns, every dollar spent can generate $5.50 in societal benefits. Ecological sanitation offers a sustainable, low-cost model for rural contexts by recycling nutrients, conserving water, and promoting food security. Yet maintenance challenges and limited coverage, only 48% of rural Pakistan has improved sanitation, underscore the need for community engagement, capacity building, and supportive policies.

Moving forward, scaling up decentralized ecological solutions, strengthening waste management systems, and integrating hygiene education will drive down disease, enhance workforce participation, and foster long-term rural development. Ensuring universal sanitation access is thus both a moral imperative and an economically sound strategy for protecting health, boosting productivity, and advancing sustainable growth in rural communities.

References: Hutton, G.; WHO; UNICEF; World Bank; UN-Water; Hutton & Varughese; Hutton; Strande et al.; National Statistical Office; UNESCO; Pakistan Bureau of Statistics

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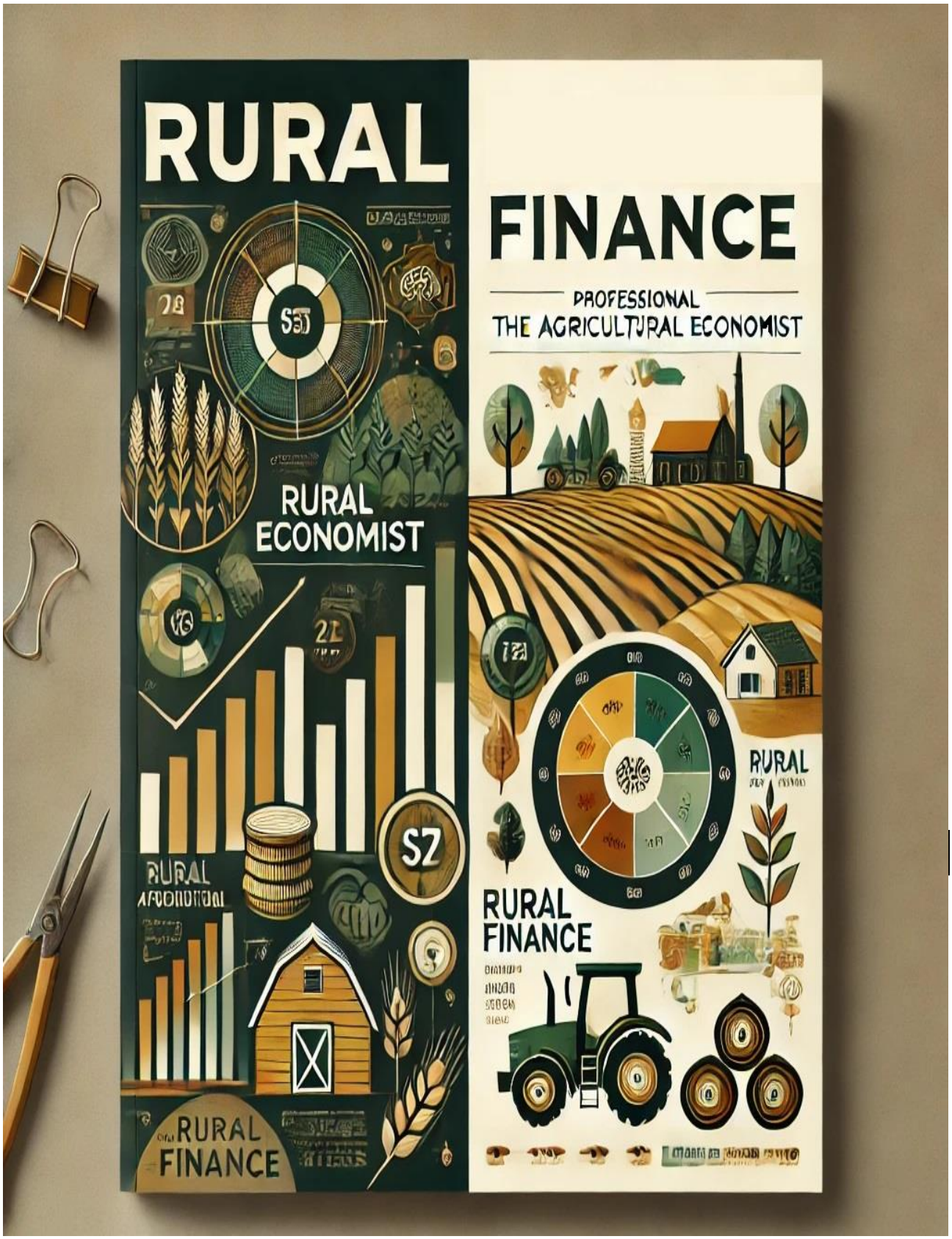
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Date Palm Cultivation in Khairpur Mirs

Explore the significance of date palm cultivation in Khairpur Mirs, Pakistan. This vital sector contributes to the agricultural economy, offering high profitability and potential for rural development, while facing challenges like post-harvest losses and climate vulnerabilities.

Attia Khaskheli

5/6/2025

Date palm cultivation in Khairpur Mirs, Sindh, represents one of Pakistan's most valuable and export-oriented agricultural sectors, playing a critical role in the country's rural economy and food systems. As the 5th largest date producer globally, Pakistan owes much of its production strength to Khairpur, which cultivates over 200 date varieties, including popular ones like Aseel, Karblain, and Kupro, across more than 75,000 acres of land (FAO, 2023). This district alone contributes 70% of Sindh's total date output and nearly 30% of Pakistan's overall date exports, underlining its importance in both domestic markets and international trade (Pakistan Bureau of Statistics, 2023).

The economic benefits of date palm farming in Khairpur are significant. A mature date orchard can yield 80–100 kilograms of fruit per tree annually, with gross returns ranging from PKR 250,000 to 400,000 per acre depending on variety, quality, and market access. With relatively low input costs, mainly water, labor, and basic fertilization, farmers can achieve favorable profit margins, especially during export seasons when prices peak. However, profitability is often constrained by outdated post-harvest practices, poor cold storage infrastructure, and limited access to global certification standards such as HACCP and GlobalGAP.

This article provides a detailed profitability and cost-benefit analysis of date palm cultivation in Khairpur Mirs, focusing on production costs, market dynamics, export competitiveness, and value chain bottlenecks. It also explores emerging opportunities in processing, value addition, and climate-smart farming practices that could enhance the sector's long-term sustainability. By addressing logistical, technical, and financial barriers, Khairpur's date industry holds the potential to become a high-value agribusiness hub, creating jobs, boosting exports, and supporting inclusive rural development in one of Pakistan's most agriculturally strategic districts.

Historical Background and Agro-Climatic Suitability

Khairpur Mirs, located approximately 450 kilometers from Karachi, has long been recognized as a center for date palm cultivation, with its agricultural prominence tracing back to the 1930s. This transformation was catalyzed by the construction of the Sukkur Barrage, which revolutionized irrigation systems in upper Sindh and turned Khairpur into one of Pakistan's most fertile regions for date farming (Sindh Agriculture Department, 2022). The region's unique agro-climatic conditions make it especially suited for high-quality date production. Its hot desert climate, with summer temperatures frequently reaching an average of 40°C, combined with well-drained sandy loam soil, offers an optimal environment for the growth and ripening of date palms.

These conditions are particularly favorable for the cultivation of the Aseel variety, which is not only renowned for its rich taste and long shelf life but also constitutes around 60% of Khairpur's total date exports (Horticulture Research Institute, 2023). The long, hot summers and the relatively dry monsoon period from July to September provide a critical window for harvesting and sun-drying, which enhances the quality and commercial value of the fruit.

As of 2023, Khairpur's total cultivated area under date palms spans approximately 75,000 acres. With an average planting density of 60 trees per acre and yields averaging around 100 kilograms per tree, the district produces nearly 450,000 tonnes of dates annually. This substantial output supports a vibrant local economy based on harvesting, processing, packaging, and trade. The concentration of both traditional know-how and favorable natural conditions has helped Khairpur become the epicenter of Pakistan's date industry. The region's historical development and natural advantages continue to anchor its competitive edge in national and international markets, positioning it as a strategic player in the global date supply chain.

Economic Contribution of Date Palm Cultivation in Khairpur

Date palm cultivation serves as the economic backbone of Khairpur Mirs, offering extensive livelihood opportunities and driving the rural economy. During the peak harvest season, the industry supports over 500,000 workers across various nodes of the value chain (Labor Department of Sindh, 2023). A robust formal processing sector comprises more than 20 industrial units, each employing an average of 200 workers who earn daily wages Rs. 300 and Rs. 500. These export-focused facilities primarily handle high-demand varieties such as Aseel, Dhakki, and Begum Jangi, targeting Middle Eastern markets where demand for Pakistani dates remains strong.

Beyond the formal sector, a vibrant informal and cottage industry also plays a critical role. Between 12,000 and 15,000 home-based workers, predominantly women, engage in labor-intensive activities such as grading,

pitting, and packaging. Additionally, over 200 roadside vendors earn daily incomes of Rs. 1,000 to Rs. 2,000 by selling fresh and processed dates. Ancillary services like transport, wholesale, and retail further contribute to income generation, with each step adding a 40–60% markup before the product reaches end consumers (Sindh Chamber of Agriculture, 2023).

From a financial standpoint, the economics of date palm cultivation in Khairpur are compelling. The per-acre cost of production is around Rs. 250,000, distributed across land preparation, irrigation, fertilizers, labor, marketing, and miscellaneous expenses. With an average yield of 6,000 kilograms per acre and wholesale prices ranging from Rs. 80 to Rs. 120 per kilogram for the Aseel variety, farmers can generate gross revenues between Rs. 480,000 and Rs. 720,000 per acre. This results in net profits between Rs. 230,000 and Rs. 470,000 per acre, translating to a benefit-cost ratio of 1:1.9 to 1:2.8, significantly higher than regions like Kech in Balochistan, which reports a lower BCR due to higher post-harvest losses (PARC, 2023).

Constraints and Strategic Opportunities in Khairpur's Date Palm Economy

Despite its strong economic potential, date palm cultivation in Khairpur Mirs faces several persistent challenges that limit profitability for farmers and agribusinesses. Post-harvest losses remain one of the most significant issues, with 20–30% of the annual yield lost due to substandard drying and storage practices. Traditional sun-drying techniques, widely used across the region, expose dates to fungal contamination and insect infestation. Moreover, the absence of cold storage infrastructure contributes to spoilage rates of 10–15% before the product even reaches markets. These inefficiencies directly impact on farmer income and national export competitiveness.

Market access barriers further constrain profitability. Nearly 80% of growers are dependent on middlemen who purchase dates at prices 40–50% lower than retail market rates. Inadequate road infrastructure inflates transportation costs by 15–20%, disproportionately affecting smallholders in remote villages. Meanwhile, climate risks are intensifying. Monsoon rains during the July–September harvest season threaten up to 90% of the crop in flood-prone zones, while rising temperatures, often exceeding 45°C, have reduced fruit-setting rates by 12–18%, according to the Pakistan Meteorological Department (2023).

Technological adoption remains minimal, with less than 5% of farms using drip irrigation, despite its potential to reduce water use by 30%. Additionally, the lack of tissue culture laboratories limits access to disease-free saplings, stalling orchard renewal and productivity gains.

To address these constraints, targeted policy interventions and investments are needed. Establishing ten modern processing units and solar-powered cold storage facilities could dramatically reduce post-harvest losses. Market reforms, such as integrating e-commerce platforms and setting up export zones in Karachi, would enhance price realization. Financial support, including subsidies for drip systems and interest-free loans via Sindh Bank, could boost productivity by 20%. Climate adaptation strategies, including early maturing varieties and weather-indexed crop insurance, would further safeguard farmer livelihoods.

Conclusion

Date palm cultivation in Khairpur Mirs stands as a cornerstone of Pakistan's agricultural economy, offering immense potential for rural development, export growth, and poverty alleviation. The sector's profitability, evidenced by net returns of Rs. 230,000-470,000 per acre and a 1:1.9–2.8 benefit-cost ratio, demonstrates its viability, yet systemic challenges hinder its full potential. Post-harvest losses (20–30%), middleman exploitation, and climate vulnerabilities significantly reduce farmer incomes, while outdated infrastructure and limited technology adoption constrain competitiveness.

Strategic interventions, such as modern processing units, cold storage facilities, and drip irrigation subsidies, could transform Khairpur into a high-value agribusiness hub. Expanding direct market access and export certifications would enhance price realization, while climate-resilient varieties and insurance schemes could mitigate monsoon risks. With 70% of Sindh's date output and 30% of Pakistan's exports, Khairpur's success hinges on policy support, private investment, and research-driven innovation. By addressing these gaps, Pakistan can elevate its global standing in the $13 billion date market (FAO, 2023), ensuring sustainable prosperity for Khairpur's farming communities.

References: FAO; Pakistan Bureau of Statistics; PARC; Sindh Agriculture Department; World Bank; Horticulture Research Institute; Labor Department of Sindh; Sindh Chamber of Agriculture; Pakistan Meteorological Department

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Sustainable Farming in Turkish Agriculture

Farming is a long-term investment that requires patience, knowledge, and risk management. To build a sustainable future for Turkish agriculture, it is essential to focus on education, infrastructure improvements, and effective crop insurance to protect against climate risks.

Mithat Direk

5/16/2025

Agriculture remains a cornerstone of Türkiye's economy, contributing approximately 6.5% of GDP and employing nearly 15% of the workforce (TÜİK, 2023). Yet, despite this structural importance, many farmers face persistent difficulties in turning a sustainable profit. A significant reason lies in the common underestimation of true production costs. While many producers' base profitability on direct expenses, such as seeds, fertilizer, and fuel, they often ignore hidden costs like labor (including unpaid family labor), depreciation of machinery, land rental value, irrigation system maintenance, and foregone income from alternative crops or land uses.

This narrow view distorts the real picture of profitability. For instance, a farmer may perceive a crop as successful because it generated a net cash income, but once opportunity costs and long-term capital depreciation are factored in, the enterprise may, in fact, be operating at a loss. Additionally, volatility in input prices and markets, exacerbated by inflation and global supply shocks, makes forward planning difficult without robust cost-accounting tools.

Another concern is the lure of niche or trendy crops, such as medicinal herbs or exotic vegetables. While these may promise high returns, they also carry higher risks. Without stable markets or buyer guarantees, many farmers find themselves unable to recover even basic costs when prices collapse.

Recent field examples from Central Anatolia and the Aegean region illustrate the severity of the issue: producers who shifted from wheat to quinoa, hoping for export demand, ended up facing severe price drops and unsold harvests due to oversupply and lack of marketing channels. In the absence of a comprehensive risk assessment and diversified market strategy, such missteps can lead to financial strain or even bankruptcy.

Therefore, it is critical that farmers adopt a comprehensive cost analysis approach, factoring in both visible and invisible costs, to make informed decisions. Enhanced training in farm economics, supported by agricultural extension services, could improve long-term financial resilience and help sustain rural livelihoods.

The Misunderstood Economics of Farming

Farmers often assess their operations based on visible costs, such as expenditures on seeds, fertilizers, pesticides, irrigation, and fuel. While these direct costs are essential to track, they provide only a partial picture of actual profitability. Agricultural economists stress the importance of accounting for hidden costs to make informed financial decisions and avoid common misconceptions that lead to economic vulnerability.

One key hidden cost is family labor. Many smallholder farmers rely heavily on unpaid family members to manage fields, livestock, and post-harvest work. If this labor were monetized at local wage rates, it would significantly reduce net profits. Similarly, depreciation of farm machinery, tractors, harvesters, and irrigation systems, is rarely accounted for in routine calculations. Over time, this oversight distorts profitability and delays essential reinvestment.

Opportunity costs also matter. Choosing one crop over another means forgoing alternative income. A farmer who grows wheat but could earn more from lentils or sunflowers may face unseen financial loss despite earning positive cash flow. Additionally, the living expenses of farming families, housing, education, healthcare, must be included to assess whether agriculture supports a viable livelihood.

A 2022 survey by Türkiye's Ministry of Agriculture and Forestry revealed that 40% of small-scale farmers underestimate production costs, often resulting in liquidity issues when prices drop or yields fall. Furthermore, high yields can be misleading. For example, producing 40,000 TL worth of wheat after spending 10,000 TL seems like a large profit, but if alternative crops like corn could earn 50,000 TL, the real net gain is diminished when factoring in opportunity cost.

The Union of Agricultural Chambers (TZOB, 2023) reports average net profit margins of just 12–15% in crop farming, far below those in manufacturing and services. These tight margins make comprehensive cost accounting not just advisable but essential. Without it, many farmers unknowingly operate at or near a financial loss.

The Dangers of Niche Markets in Turkish Agriculture

In the pursuit of higher profits, many Turkish farmers are increasingly drawn to niche markets, small, specialized segments offering high returns to a limited number of producers. These markets often revolve around crops such as medicinal herbs (thyme, sage), exotic fruits (like avocados in Antalya), or specialty items like birdseed. While profitable for early adopters, niche markets are extremely sensitive to oversupply, making them risky for mass adoption.

A telling example is the 2021–2023 birdseed boom and bust in Konya. Initially, a handful of farmers reaped high returns by cultivating bird seed for the domestic pet market. Their success quickly drew attention, prompting neighboring farmers to switch production. Within two seasons, supply surged by 300% (TZOB, 2023), but consumer demand remained unchanged. Prices plummeted by 60%, rendering the crop unprofitable and leading to widespread losses. This reflects what experts call the "neighbor's goose effect", when farmers imitate perceived success without evaluating long-term viability, ultimately saturating the market and damaging everyone involved.

Another powerful cautionary tale is the "Mehmet Çavuş Onion Crisis." In this case, a wealthy landowner abandoned a low-priced onion harvest and offered it freely to a local farmer, Mehmet. Seizing the opportunity, Mehmet bore costs for labor, packaging, and transport to sell the onions in Konya's vegetable market. Unfortunately, a glut in the market left the onions unsold, exposed to rain, and ultimately rotting. Market authorities disposed of the produce, and Mehmet incurred losses due to fines, wasted investment, and unpaid debts. This example underlines that even "free" crops can be economically ruinous without proper market analysis, storage, and sales strategies.

Compounding these issues, Türkiye faces significant post-harvest losses. The FAO (2023) reports that 15–25% of fresh produce is wasted due to poor storage, inadequate transportation, and weak cold chain systems. TÜİK (2023) estimates that nearly one-third of fruits and vegetables never reach consumers, costing the agricultural sector over $2 billion annually.

While crop diversification is a sound strategy in theory, shifting to unproven or fashionable crops carries steep risks. New varieties may not suit the local climate or require unfamiliar inputs, increasing costs and uncertainty. According to the Turkish Agricultural Risk Assessment Report (2023), 70% of farmers who ventured into new crops experienced losses within their first two seasons. For most producers, sticking to well-researched, locally adapted, and consistently demanded crops offers a safer, more sustainable path to profitability.

The Stability of Traditional Farming

Traditional farming practices in Türkiye may not promise extraordinary profits, but they offer something far more valuable, stability. For generations, families have relied on crops like wheat, barley, corn, and lentils to provide steady income, food for the household, and a sense of security during uncertain economic times. The resilience of traditional agriculture lies in its predictability. These crops have known growing cycles, established markets, and decades of experience behind them. Even when prices fluctuate, farmers are often able to recover due to lower input costs and their ability to use part of the harvest for personal consumption.

There's a popular saying among Turkish farmers: "No one has ever become rich from farming, but no one has ever starved from it either." This sentiment reflects the role of farming as a buffer against poverty, rather than a pathway to wealth. Unlike speculative ventures or niche markets that can lead to quick losses, traditional crops offer a more grounded approach to agricultural livelihood.

Conclusion

Farming is not a shortcut to riches, it's a long-term investment requiring patience, knowledge, and risk management. To build a sustainable future for Turkish agriculture, several steps are essential. Farmers need better education on calculating real production costs, including hidden and opportunity costs. Improving storage, logistics, and cold chain infrastructure can reduce post-harvest losses and stabilize income. Niche markets, while potentially profitable, must be monitored and regulated to avoid oversupply and market crashes. Finally, crop insurance and subsidies must be strengthened to protect against climate-induced losses and price volatility.

Türkiye's farmers are the foundation of its food security. While the sector faces numerous challenges, smarter planning, better policies, and practical support can help farmers navigate risks and build a more resilient agricultural future. As the proverb says, "Stick to what you know, and let the neighbor's goose be just that, a goose."

References: Turkish Statistical Institute (TÜİK); Ministry of Agriculture and Forestry; TZOB; FAO

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Empowering Rural Women in Pakistan through Microfinance

Microfinance has the potential to transform the lives of rural women in Pakistan by providing credit access. This empowerment leads to improved food security, health outcomes, and climate resilience.

Qadir Bux Aghani

5/16/2025

In Pakistan's rural communities, women play a central yet often invisible role in sustaining agriculture and family livelihoods. They perform critical tasks such as sowing seeds, weeding, harvesting, tending to livestock, processing food, and managing household nutrition. According to the Pakistan Bureau of Statistics (2023), women make up 66% of the agricultural workforce, yet only 5% of them own land, leaving the vast majority without collateral or legal recognition as farmers. This lack of land ownership limits their access to formal credit, extension services, and agricultural subsidies. In this context, microfinance has emerged as a transformative force, providing rural women with the capital they need to invest in income-generating activities, agricultural inputs, and climate-adaptive practices.

Access to small loans, group savings, and micro-insurance allows women to diversify their livelihoods, ranging from poultry farming and kitchen gardening to handicrafts and small-scale retail. Evidence from microfinance institutions in Sindh and Punjab shows that women borrowers reinvest up to 80% of their earnings into their families, directly improving food security, children's education, and household health. Moreover, access to credit enables women to adopt more sustainable agricultural practices, such as drought-resistant seeds, organic fertilizers, and efficient water use technologies, thereby enhancing climate resilience at the grassroots level.

However, significant challenges remain. High interest rates limited financial literacy, mobility restrictions, and lack of digital access hinder full participation. Many women also remain dependent on male intermediaries to access financial services, reducing their agency. Addressing these barriers requires gender-responsive financial products, tailored training, mobile banking outreach, and supportive legal frameworks that promote women's land rights and financial inclusion. With targeted interventions, microfinance can move beyond poverty alleviation and become a catalyst for women's empowerment, sustainable agriculture, and equitable rural development across Pakistan.

The Invisible Backbone of Rural Pakistan

In Pakistan's rural economy, women serve as the invisible backbone, working long hours on farms, managing livestock, collecting water and firewood, and sustaining households through informal labor. They contribute between 70% to 80% of total farm labor, including critical agricultural activities such as sowing, transplanting, weeding, harvesting, and post-harvest processing. Yet, their work remains largely unrecognized, unpaid, and excluded from official economic accounts. Despite their immense contribution, rural women face entrenched structural barriers that limit their economic agency and financial independence.

Only 4% of women in Pakistan possess agricultural land titles, effectively excluding them from asset ownership, credit eligibility, and decision-making within farming households. This legal and cultural marginalization reinforces a cycle of dependence on male family members for access to productive resources and financial services. Even when microfinance is available, women often require male intermediaries to co-sign loans or handle bank transactions, undermining their autonomy. Furthermore, only 7% of rural women have access to formal bank accounts, and even fewer are included in digital financial services or agricultural extension networks.

The consequences of this exclusion are especially severe in climate-vulnerable provinces like Sindh and Balochistan, where extreme weather, erratic rainfall, and rising food prices disproportionately affect women-led households. According to the World Food Program (2023), nearly 60% of female-headed rural households in these regions suffer from moderate to severe food insecurity. Without secure land tenure, financial literacy, or direct access to credit, these women are unable to invest in climate-resilient farming practices or build buffers against economic shocks.

Addressing the invisibility of women in agriculture requires transformative policies that go beyond microfinance to include land reforms, legal protections, targeted education, and gender-sensitive agricultural support systems. Recognizing and empowering rural women is not only a matter of equity but a strategic imperative for food security, poverty reduction, and sustainable rural development.

Microfinance as a Catalyst for Change

Microfinance has emerged as a powerful tool to transform the lives of rural women in Pakistan, offering them not just credit, but also a pathway to economic independence, improved livelihoods, and greater social empowerment. By expanding financial inclusion, microfinance institutions such as Akhuwat, Kashf Foundation, and Khushhali Bank have focused on women as agents of change within their communities. As of 2023, women constitute 62% of microfinance borrowers, according to the Pakistan

Microfinance Network, reflecting the growing emphasis on gender-focused lending.

Innovative lending models have played a key role in this progress. Group-based lending, as practiced by Kashf Foundation, replicates the Grameen model to ensure collective responsibility and high repayment rates. Collateral-free loans, typically ranging between PKR 30,000 to PKR 50,000, have enabled women to launch small-scale ventures like poultry rearing, tailoring, and handicrafts. Meanwhile, the rise of digital microfinance platforms such as JazzCash has brought financial services to over 15 million users, helping rural women overcome geographic and mobility barriers.

The impact has been substantial. A UNDP study in 2023 revealed that women borrowers reported a 43% rise in household income and a 28% increase in children's school enrollment. Notably, 67% of women said they had decision-making power over how the loan was used, an important marker of agency. In drought-prone Tharparkar, women used microloans to purchase drought-resistant goats, improving family nutrition and savings. In Punjab, women financed solar irrigation systems, reducing dependence on diesel and securing water access.

Microfinance is also helping build climate resilience. Green loan products are encouraging millet farming, which requires 30% less water than wheat, while weather-indexed insurance cushions smallholders against crop failure. Women-led cooperatives in Sindh producing biofertilizers are cutting input costs by 40%, all while promoting sustainable agriculture. These shifts underscore microfinance's evolving role in addressing both economic and environmental challenges.

Persistent Challenges and Way Forward

Despite notable strides in expanding women's financial inclusion through microfinance in Pakistan, a range of structural and operational challenges continue to hinder the full realization of its transformative potential. One of the most significant issues is male mediation. According to the State Bank of Pakistan's Gender Report (2023), nearly 35% of microloans disbursed to women are ultimately controlled by male relatives, undermining the empowerment objectives of gender-focused lending. This not only reduces women's autonomy but also distorts credit utilization and repayment accountability.

Another pressing concern is the lack of adequate training and capacity-building support for borrowers. Only 20% of women who access microloans receive any form of agricultural or business skills training (PMN, 2023). Without proper guidance, many borrowers struggle to invest their loans effectively or scale their enterprises. In areas like Balochistan and southern Punjab, this knowledge gap has led to underutilization of funds or dependence on middlemen who extract profits unfairly.

Over-indebtedness is an emerging risk, particularly among vulnerable populations facing climate shocks or economic downturns. Current data reveals a 12% default rate among rural women borrowers, often triggered by crop failures, sudden medical expenses, or familial pressure to take multiple loans.

To address these persistent challenges, several policy interventions are urgently needed. Mandating joint land titles for married couples can help women use land as collateral and increase their financial credibility. Expanding mobile banking infrastructure, with a target to reach 50% of rural women by 2025, would help bypass male intermediaries and improve direct access to funds. Lastly, integrating microfinance with agricultural extension services, like Punjab's "Kissan Card" model, can enhance the effectiveness of rural credit by bundling it with technical support, input subsidies, and insurance. Together, these measures can help microfinance deliver deeper, more sustainable impacts for rural women across Pakistan.

Conclusion

Microfinance holds transformative potential for empowering rural women in Pakistan, but it must be part of a broader, integrated strategy that addresses structural inequalities. As the data shows, when women gain access to credit, the benefits extend far beyond individual income, they ripple across families and communities through improved food security, health outcomes, and climate resilience. Microloans have enabled women to diversify livelihoods, invest in drought-resistant agriculture, and participate more fully in decision-making processes that shape their households and farms.

Yet microfinance alone cannot dismantle the deeply rooted barriers that constrain rural women. Landlessness, financial illiteracy, and male-dominated systems continue to limit the autonomy and effectiveness of many borrowers. For microfinance to evolve from a poverty alleviation tool into a vehicle for empowerment and sustainability, it must be supported by policy reforms that ensure land rights, expand digital financial access, and provide agricultural extension tailored to women's needs.

By recognizing rural women as farmers, entrepreneurs, and change-makers, not just recipients of aid, Pakistan can unlock a powerful force for equitable development. The path to sustainable agriculture and resilient rural economies lies in building systems that include, invest in, and trust women. Microfinance can light the way, but it must walk hand in hand with structural change.

References: Pakistan Bureau of Statistics; State Bank of Pakistan; UNDP; World Bank; Pakistan Microfinance Network; World Food Program; PMN

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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Agroforestry for Sustainable Rural Development in Pakistan

Discover how agroforestry, integrated with agricultural economics, offers Pakistan a viable pathway to sustainable rural development. It enhances productivity, boosts income, and strengthens climate resilience, providing a buffer against environmental uncertainties for smallholder farmers.

Aisha Iqbal

5/22/2025

Agroforestry offers a promising, climate-resilient solution to Pakistan's mounting agricultural and ecological challenges. By combining trees with crops and livestock on the same land, this approach enhances biodiversity, improves soil health, increases water retention, and diversifies farm outputs. When grounded in the principles of agricultural economics, agroforestry transforms from an ecological concept into a powerful tool for strategic rural development, resource optimization, and income stability. This integration enables evidence-based land-use planning that can simultaneously boost farm productivity and reduce rural poverty.

Pakistan's agriculture sector, which employs 37.4% of the labor force and contributes 22.7% to the GDP (Pakistan Economic Survey 2023–24), is under increasing threat from climate change, land degradation, and water scarcity. Traditional monoculture practices and short-term economic planning exacerbate vulnerability. Agroforestry, with its multi-functional benefits, can buffer smallholder farmers against market and climate shocks by creating multiple income streams, from timber, fruit, fodder, and medicinal plants, alongside staple crops. However, its adoption remains limited.

This gap stems partly from a lack of economic data and policy support. Agricultural economics can fill this void by applying tools like cost-benefit analysis, productivity metrics, and market forecasting to demonstrate agroforestry's long-term profitability. Risk assessment models can further help farmers and policymakers understand their resilience to climate variability. Moreover, market linkage studies and value chain analyses can identify new commercial opportunities in agroforestry-based products, encouraging private sector investment.

Global success stories, in countries like India, Kenya, and Brazil, show that with the right mix of economic incentives, technical support, and institutional backing, agroforestry can become mainstream. Pakistan needs a similar data-driven approach. By integrating agroforestry into agricultural policy through sound economic analysis, the country can move toward a more sustainable, productive, and inclusive rural economy.

Economic Gains and Climate Resilience Through Agroforestry

Agroforestry presents a transformative economic model for rural Pakistan, offering multiple layers of financial return while enhancing ecological stability. By integrating trees with annual crops and livestock, farmers diversify their income sources across short, medium, and long-term timeframes. Vegetables and grains provide immediate cash flow, while fruit-bearing trees and fodder crops offer medium-term returns. Over the long run, timber and medicinal tree species generate high-value products with strong market demand. According to the Food and Agriculture Organization (FAO, 2023), smallholder farmers practicing agroforestry report annual incomes 25-40% higher than those relying on monoculture systems. Additionally, agroforestry increases land-use efficiency by up to 80% and reduces chemical fertilizer use by 40%, especially when nitrogen-fixing species like *Leucaena leucocephala* are used (World Bank, 2022).

In arid regions such as Tharparkar and Cholistan, traditional agroforestry models incorporating native trees like *Prosopis cineraria* (jand) and *Acacia nilotica* (babul) support livestock, improve soil organic matter, and reduce land degradation (IUCN Pakistan, 2023). These systems not only enhance rural livelihoods but also build resilience against climate shocks. Pakistan, ranking 5th on the Global Climate Risk Index (2023), lost an estimated $30 billion to floods between 2022 and 2023. Agroforestry mitigates such losses by reducing soil erosion by up to 70%, increasing water infiltration by 30%, and storing 35–50 tons of carbon per hectare (ICIMOD, CIFOR, and World Agroforestry Centre, 2023).

Agricultural economics provides the tools to evaluate and scale these benefits. Through techniques like Net Present Value (NPV), Internal Rate of Return (IRR), and Benefit-Cost Ratio (BCR), economists quantify agroforestry's long-term gains. For instance, a 2023 study by the Punjab Agri-Research Council showed that a 4-acre agroforestry plot had a BCR of 2.1, substantially higher than the 1.3 BCR for monoculture. Integrating agroforestry into national agricultural planning can thus yield both economic resilience and environmental stability.

Global Lessons and Local Challenges in Scaling Agroforestry in Pakistan

Agroforestry's transformative potential has been realized globally through strategic policy interventions and localized innovation. India's pioneering National Agroforestry Policy (2014) serves as a model, expanding tree-based farming to over 14 million hectares and generating 50 million workdays annually under MGNREGA (ICRAF, 2023). This integration of agroforestry into rural employment and ecological restoration

demonstrates its value in both economic and environmental terms. In China, the "Grain-for-Green" Program (1999-2023) restored 32 million hectares of degraded land, delivering ecosystem services valued at $4.2 billion annually, including carbon sequestration, soil retention, and biodiversity enhancement (World Bank, 2023).

In Pakistan, localized efforts are showing promising results. Sindh's Social Forestry Program (2015–2023) introduced agroforestry to 15,000 acres, directly benefiting 5,000 farmers through improved yields and income diversification. In Gilgit-Baltistan, integrating walnut trees with vegetable cultivation increased per-acre incomes from PKR 70,000 to PKR 150,000 (GB Forest Department, 2023). Meanwhile, in Cholistan, agroforestry models incorporating *Acacia* and *Zizyphus* have buffered pastoralists against drought stress, enhancing livestock productivity and forage availability.

However, national adoption remains constrained by significant barriers. A 2023 survey by Sindh Agriculture University (SAU) revealed that 65% of farmers are unaware of agroforestry's long-term economic gains. Land tenure insecurity discourages investment in tree planting, with 50% of farmers fearing loss of land rights. Poor market integration means farmers earn only 40% of potential timber value, and just 5% of agricultural subsidies currently support agroforestry. Additionally, only 4 of Sindh's 40 districts have agroforestry officers, limiting technical support.

To overcome these challenges, policy reform is critical. A National Agroforestry Policy should align with climate and agricultural agendas. Economic incentives, like a PKR 7,000/acre/year tree subsidy and credit access via ZTBL, can boost adoption. Establishing agroforestry economics units at key research institutions, creating market cooperatives, and training 1,500 extension officers will provide the institutional infrastructure needed for scalable success.

Conclusion

Agroforestry, when strategically integrated with agricultural economics, offers Pakistan a viable pathway to sustainable rural development. It not only enhances farm productivity and household income but also fortifies resilience against climate shocks, critical in a country ranked among the most climate-vulnerable globally. By diversifying income sources and improving ecological services, agroforestry provides a buffer against environmental and market uncertainties that smallholder farmers increasingly face. The economic evidence is compelling: higher benefit-cost ratios, increased land-use efficiency, and substantial reductions in input costs make agroforestry not just an ecological solution, but a financially sound one.

However, realizing its full potential requires more than pilot projects or isolated successes. It demands a systemic shift, grounded in sound economic analysis, backed by policy support, and driven by institutional reform. National-level integration of agroforestry into agricultural and climate policy, coupled with financial incentives, market development, and capacity building, can help overcome persistent barriers to adoption. Global models from India and China, alongside local case studies from Sindh, Gilgit-Baltistan, and Cholistan, offer practical blueprints. If Pakistan embraces agroforestry not only as an environmental strategy but as a core component of its economic development agenda, it can pave the way for a more resilient, inclusive, and sustainable future for its rural communities.

References: FAO; World Bank; Pakistan Economic Survey; ICIMOD; IUCN Pakistan; Global Climate Risk Index; CIFOR; World Agroforestry Centre; ICRAF; GB Forest Department

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Boost Financial Inclusion for Equitable Growth

Explore how financial inclusion drives equitable growth and reduces poverty in low and middle-income countries. Learn about the impact of savings, credit, and digital payments on marginalized groups, particularly women and rural populations.

Hamna Jabbar

5/27/2025

Financial inclusion remains a cornerstone of economic and social development in low- and middle-income countries (LMICs). By providing access to essential financial services, such as savings, credit, insurance, and digital payments, financial inclusion empowers marginalized populations, reduces poverty, and stimulates economic growth. Recent data from the World Bank's Global Findex Database (2021) reveals that 76% of adults globally now have an account at a financial institution or mobile money provider, up from 51% in 2011.

However, significant disparities persist, particularly in Sub-Saharan Africa and South Asia, where nearly 30% of adults remain unbanked (Demirgüç-Kunt et al., 2022). Gender gaps are also pronounced: women are 9 percentage points less likely than men to have an account, hindering their ability to save safely or access credit. Rural populations face additional obstacles, with lower internet connectivity and fewer physical branches, making digital and branchless banking solutions crucial.

Barriers to financial inclusion often include high transaction costs, lack of appropriate identification documents, low financial literacy, and distrust of formal institutions. For instance, in many rural areas, the cost of traveling to a bank branch outweighs the perceived benefits of having an account. To address these challenges, governments and development partners have expanded agent banking, whereby local shops and kiosks provide basic banking services. Mobile money platforms, such as M-Pesa in Kenya, have demonstrated how simple, reliable digital payment systems can rapidly increase account ownership and usage, particularly among low-income and female clients.

Microcredit and microinsurance products tailored to smallholder farmers and microentrepreneurs also play a vital role. By offering small loans with flexible repayment schedules, microfinance institutions enable farmers to purchase inputs and invest in productivity-enhancing technologies. Digital wallets linked to national ID systems facilitate secure, low-cost transactions and can help deliver social safety net payments directly to beneficiaries, improving transparency and reducing leakage. Financial literacy campaigns, often conducted via radio, community groups, or mobile apps, empower users to understand budgeting, saving, and the prudent use of credit.

As technology continues to evolve, blockchain-based identity solutions and biometric authentication may bridge gaps in documentation and security. Regulatory innovations, such as tiered Know Your Customer (KYC) requirements, allow for simplified account opening processes while managing risk. Ultimately, achieving universal financial inclusion in LMICs will require coordinated efforts across policymakers, financial service providers, and civil society to ensure that financial products are accessible, affordable, and tailored to the needs of the underserved.

The Importance of Financial Inclusion for Equitable Development

Financial inclusion plays a pivotal role in reducing poverty by providing individuals with tools to save, invest, and manage financial shocks. The World Bank (2023) estimates that access to formal financial services can lift 14% of the poorest households out of extreme poverty, those living below $2.15 per day. Microfinance programs exemplify this impact: Bangladesh's Grameen Bank has disbursed over $30 billion in microloans since its founding, with 97% of borrowers being women (Yunus, 2023). Female borrowers, on average, experience a 20% increase in household income within three years of receiving loans (Khandker, 2022). Similarly, mobile money platforms have enabled rapid poverty reduction in Sub-Saharan Africa: Kenya's M-Pesa increased per capita consumption by 22% and lifted 194,000 households out of poverty (Suri & Jack, 2021).

Beyond poverty alleviation, financial inclusion catalyzes economic growth and SME development. Small and medium enterprises drive roughly 40% of GDP in emerging economies (IFC, 2023), yet many are excluded from credit markets. In Pakistan, digital lending platforms like easypaisa and JazzCash have facilitated $12 billion in digital transactions, supporting 2.5 million SMEs (SBP, 2023). Empirical research suggests that a 10% increase in financial inclusion correlates with a 0.4% rise in GDP growth in LMICs (IMF, 2022). Enabling SMEs to access working capital and invest in expansion drives job creation, higher tax revenues, and more resilient local economies.

Financial inclusion also fosters social empowerment and gender equality. Globally, women in developing countries are 9% less likely than men to have a bank account (Global Findex, 2021). Targeted initiatives are successfully narrowing this gap. India's Jan Dhan Yojana has opened 500 million bank accounts, 55% of which belong to women (PMJDY, 2023). In Uganda, Village Savings and Loan Associations have increased women's business ownership by 34% (UNCDF, 2022), illustrating how access to collective savings can bolster women's autonomy and economic participation.

Moreover, financial inclusion enhances resilience to shocks by providing insurance and savings mechanisms. Togo's Novissi program distributed $34 million via mobile money during the COVID-19 pandemic, reaching 570,000 beneficiaries and preventing widespread destitution (World Bank, 2022). In the Philippines, disaster microinsurance has covered 2 million farmers against climate risks, enabling quicker post-disaster recovery and reducing reliance on debt (ADB, 2023).

Innovative models around the world are driving inclusion forward. Pakistan's Asaan Mobile Accounts have opened over 10 million accounts via USSD, and branchless banking now counts 65 million active mobile wallets (SBP; Karandaaz Pakistan, 2023). Togo combines AI and mobile data to target cash transfers, reducing exclusion errors by 50% (GiveDirectly, 2023). In Madagascar, the Réseau des Plateformes d'Épargne et de Crédit par les Femmes Rurales (RPGEM) has enabled 500,000 rural women to access savings and loans, strengthening community-based financial resilience (AFI, 2023). Through these diverse strategies, financial inclusion is transforming lives, fostering sustainable development, and building more equitable societies.

Addressing Barriers and Pathways Forward

Despite notable progress in expanding financial inclusion, significant challenges persist. The digital divide remains a major obstacle: only 25% of rural Africans have internet access, limiting their ability to use mobile money, digital wallets, or online banking platforms (GSMA, 2023). Without reliable connectivity and affordable smartphones, many remote communities remain cut off from formal financial services. Alongside technological barriers, regulatory gaps pose another hurdle. In 40% of low- and middle-income countries (LMICs), weak consumer protection frameworks leave users vulnerable to fraud, opaque fees, and data misuse (CGAP, 2023). This undermines trust in financial institutions and dampens uptake.

To bridge the digital divide, expanding mobile money interoperability is crucial. Uganda's Agent Banking model offers a workable template: by enabling community-based agents, local shopkeepers or post office operators, to act as physical service points, rural residents can deposit and withdraw cash, receive remittances, and pay bills without traveling to distant bank branches. Building on this, regulators and mobile network operators should collaborate to standardize APIs and settlement systems, allowing users to send money seamlessly across different mobile networks. Subsidizing basic smartphones and investing in affordable data plans for underserved regions can further enhance internet access.

Strengthening financial literacy programs is equally important. Brazil's Bolsa Família conditional cash transfer program integrates mandatory financial education workshops, teaching beneficiaries how to budget, save, and avoid predatory lenders. Adapting similar curricula, delivered through community centers, radio broadcasts, and SMS-based quizzes, can raise awareness among low-income populations about digital payment safety, loan terms, and basic investment principles. Partnering with local NGOs and microfinance institutions ensures materials are culturally relevant and reach women and youth, who are often most excluded.

Leveraging artificial intelligence (AI) for credit scoring provides another avenue to extend credit to unbanked and thin-file customers. India's e-RUPI voucher system exemplifies how digital identification and transaction data can create trust frameworks. By combining mobile usage patterns, utility bill payments, and alternative data sources, such as agricultural output or remittance flows, AI-driven platforms can generate reliable credit scores for those without formal collateral. Financial institutions should pilot such models in collaboration with telecom companies and fintech startups, using cloud-based machine learning to refine algorithms and mitigate biases.

By addressing connectivity, regulatory, and educational gaps, and integrating innovative solutions like interoperable mobile money, targeted financial literacy, and AI-based credit scoring, stakeholders can significantly advance financial inclusion. These coordinated efforts will not only expand access to savings, credit, and insurance but also empower marginalized communities to participate meaningfully in economic growth.

Conclusion

Financial inclusion is fundamental to driving equitable growth and poverty reduction in LMICs. By expanding access to savings, credit, insurance, and digital payments, countries can empower marginalized groups, particularly women and rural populations, to invest in health, education, and livelihoods. Data show that microfinance and mobile money platforms, such as Bangladesh's Grameen Bank and Kenya's M-Pesa, have meaningfully increased household incomes and consumption while lifting thousands out of poverty. Moreover, enabling SMEs through digital lending correlates with GDP growth and job creation, underscoring the broader economic benefits of inclusive finance.

Despite progress, with 76% of adults worldwide now holding financial accounts, substantial gaps remain. Nearly one-third of adults in Sub-Saharan Africa and South Asia remain unbanked, exacerbated by the digital divide and weak consumer protection in many LMICs. Overcoming these challenges requires targeted interventions: expanding mobile money interoperability to reach remote areas, strengthening financial literacy programs to build trust and capacity, and leveraging AI-driven credit scoring to serve thin-file customers. Regulatory innovations, such as tiered KYC requirements, can streamline account opening without sacrificing security.

Ultimately, achieving universal financial inclusion demands coordinated efforts among policymakers, financial service providers, and civil society. By tailoring financial services to local contexts,

through agent banking, community savings groups, and technology-enabled solutions, stakeholders can ensure that no one is left behind, fostering sustainable development and more resilient economies.

References: Demirgüç-Kunt, et al.; Suri & Jack; SBP; World Bank; Khandker; IMF; PMJDY; ADB; Karandaaz Pakistan; GiveDirectly; AFI; GSMA; CGAP; Yunus

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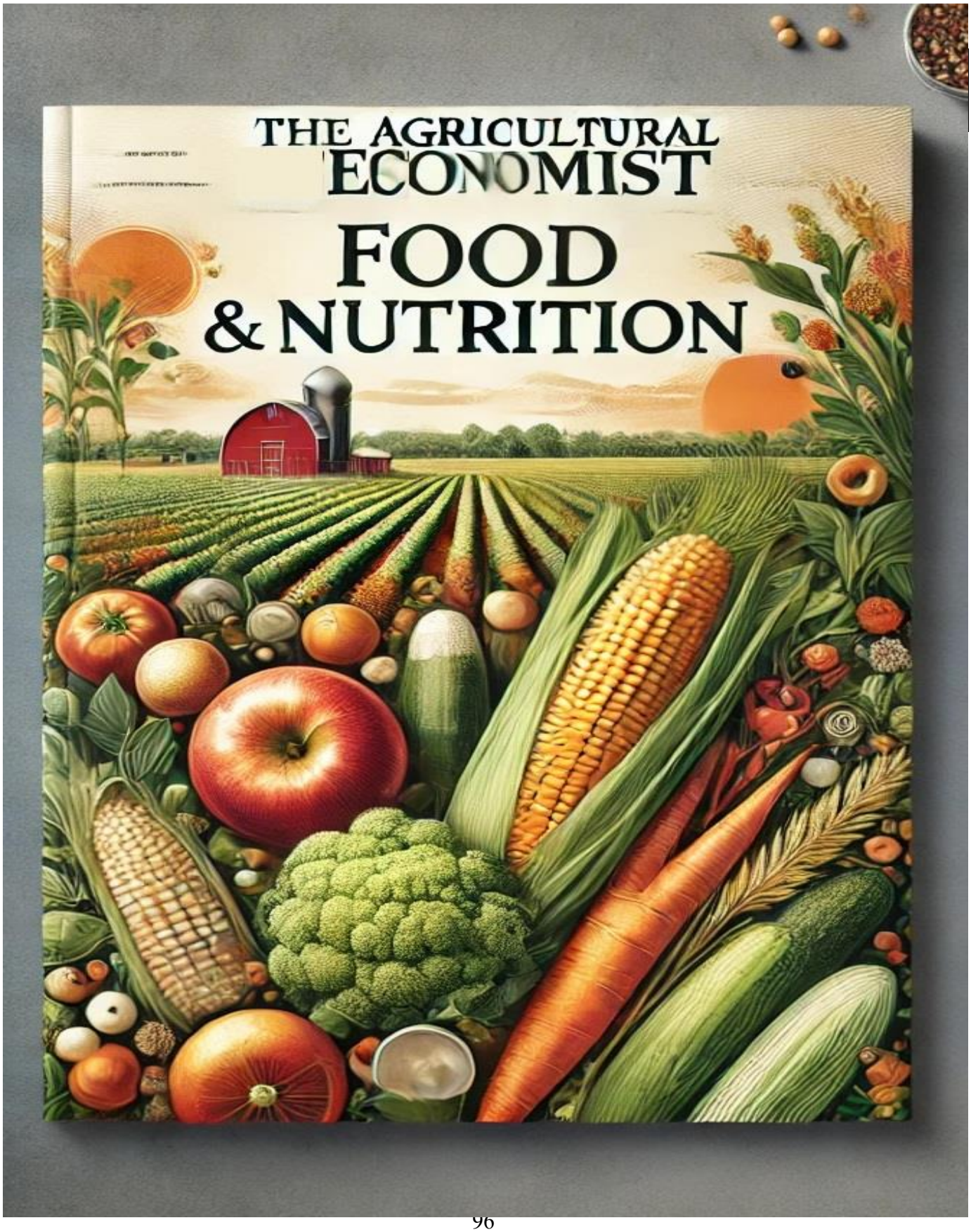
THE AGRICULTURAL
ECONOMIST
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Malnutrition Crisis in Sindh: A Stark Reality

Explore the malnutrition crisis in Sindh, a province rich in agriculture yet plagued by systemic inequalities and governance failures. Understand how abundant food production does not equate to human nourishment, leading to a public health emergency affecting millions.

Qadir Bux Aghani

5/7/2025

Sindh, Pakistan's second-most populous province and an agricultural powerhouse, presents a tragic paradox: despite its fertile lands and contribution to the national food basket, malnutrition continues to devastate its population. Home to abundant wheat, rice, and vegetable production, Sindh suffers from high rates of child malnutrition. According to the National Nutrition Survey (2018), nearly 48% of children under five are stunted, and more than 20% suffer from wasting, both indicators of chronic and acute malnutrition. The situation is equally dire for women, with 49% of pregnant and lactating women experiencing iron-deficiency anemia (UNICEF, 2022), impairing maternal and infant health outcomes.

This nutrition crisis is not rooted in food unavailability, but rather in deep-seated structural failures that prevent equitable access to food, clean water, healthcare, and social protection. Soaring inflation, reaching 38% in 2023 (State Bank of Pakistan), has pushed food out of reach for millions, while rural poverty, poor dietary diversity, early child marriages, and inadequate maternal care perpetuate intergenerational cycles of malnutrition. Inadequate public services and weak coordination between health, agriculture, and social welfare departments further exacerbate the crisis.

The impacts are far-reaching: malnourished children face impaired cognitive development, reduced school performance, and lower economic productivity in adulthood. Malnutrition also weakens immunity, increasing susceptibility to disease outbreaks and maternal mortality. Addressing these challenges requires comprehensive and cross-sectoral solutions. Scaling up nutrition-sensitive agriculture, expanding social safety nets, fortifying staple foods, and ensuring access to clean water and sanitation must become priorities. Community-based programs such as mother support groups, mobile health clinics, and local nutrition education can complement these efforts.

Ultimately, tackling malnutrition in Sindh demands political commitment, sustained investment, and grassroots engagement. Only by bridging the gap between food production and human nutrition can Sindh unlock its true agricultural and human potential.

The Alarming Scale of Malnutrition in Sindh

Malnutrition in Sindh has reached alarming levels, posing a critical threat to human development, public health, and long-term economic growth. Among children under five, stunting, a condition indicating chronic undernutrition that hampers physical and cognitive development, affects 48% in the province, significantly above the national average of 40% (National Nutrition Survey, 2018). Acute malnutrition or wasting stands at 23%, with districts such as Tharparkar and Umerkot experiencing the highest prevalence (Sindh Health Department, 2023). Micronutrient deficiencies, particularly in iron, vitamin A, and zinc, contribute to widespread immune deficiencies and are linked to high child mortality. Alarmingly, one in ten children in Sindh do not survive beyond their fifth birthday (WHO, 2022).

Maternal nutrition paints an equally grim picture. Around 41% of pregnant women are anemic, which increases the risk of delivering low birth weight infants and impairs neonatal development (UNICEF, 2022). The situation is worsened by the fact that only 18% of mothers receive adequate postnatal nutrition and care, perpetuating intergenerational cycles of malnutrition and poverty (World Bank, 2023).

Economic inequality and geographic vulnerability further compound these problems. Rural Sindh is disproportionately affected, with 60% of households facing food insecurity compared to 35% in urban areas like Karachi (WFP, 2023). The devastation caused by the 2022 floods has only deepened the crisis, 8.2 million people in Sindh are now in urgent need of nutrition assistance (NDMA, 2023). Crop destruction, displacement, and loss of livelihoods have sharply reduced food availability and affordability.

These figures underscore a silent emergency that demands immediate policy action. Without a coordinated and sustained response, Sindh risks a future marked by stunted generations, reduced workforce productivity, and deepening social inequality. Combating this crisis requires investment in maternal and child health, targeted food distribution, and climate-resilient support systems.

Root Causes of the Malnutrition Crisis

Sindh's malnutrition crisis stems from a convergence of deep-rooted structural, economic, environmental, and social failures. The province's economy has been severely impacted by inflation, with food prices rising by 45% in 2023, making everyday staples like wheat, milk, and vegetables unaffordable for much of the population (Pakistan Bureau of Statistics). For daily wage laborers, this means spending over 80% of their income on food, leaving almost nothing for healthcare or education (SPDC, 2023). Despite being a major agricultural producer—contributing 30% of

Pakistan's rice and 23% of its wheat—most smallholder farmers in Sindh remain impoverished. Water scarcity caused by reduced Indus River flows and widespread soil salinity (affecting 70% of agricultural land) has diminished productivity (PCRWR, 2023). The 2022 floods further devastated rural livelihoods, wiping out up to 90% of crops in certain districts and exacerbating hunger (NDMA, 2022).

Governance gaps further intensify the crisis. The Benazir Income Support Program (BISP), intended to assist the poorest, reaches only 30% of eligible families due to mismanagement and corruption (Transparency International, 2023). Healthcare systems are failing too, only 12% of government clinics in Sindh are stocked with therapeutic food needed for treating malnourished children (Sindh Health Report, 2023). Social and cultural issues also play a critical role. A staggering 62% of mothers in rural areas lack awareness of optimal child feeding practices (UNICEF, 2023). Gender inequality compounds this, with early marriages, 21% of girls marrying before the age of 18, resulting in undernourished mothers and low birthweight babies (PDHS, 2023). Together, these factors paint a grim picture of a province producing food yet unable to nourish its people. Tackling malnutrition in Sindh requires not only food but a complete overhaul of its economic, health, and social support systems.

Consequences of Inaction

Failing to address Sindh's malnutrition crisis will result in devastating and long-term consequences for both individuals and society. One of the most alarming outcomes is the irreversible loss of human capital. Malnourished children experience stunted physical and cognitive development, losing an estimated 10 to 15 IQ points, which severely impacts their learning capacity, future job prospects, and lifetime productivity (Lancet, 2021). Nationally, this translates into an economic loss of $7.6 billion annually, around 3% of Pakistan's GDP, due to decreased workforce efficiency, increased healthcare costs, and reduced educational attainment (World Bank).

The healthcare system is already under severe strain. In Sindh, 30% of pediatric hospital admissions are directly related to malnutrition, according to Jinnah Hospital (2023). Treating severely malnourished children requires costly, long-term care, which many families cannot afford. As a result, treatment expenses push already impoverished households deeper into debt and despair, creating a cycle of poverty that is difficult to break.

The social consequences are equally concerning. Hunger and economic desperation are pushing more rural families into cities, leading to rapid and unplanned urbanization. Karachi's slum population is expanding at a rate of 5% annually, according to UN-Habitat, creating pressure on already overburdened infrastructure and services. These urban migrations increase the risk of social unrest, crime, and deteriorating public health.

Ultimately, ignoring this crisis compromises national development, security, and equity. Without immediate and coordinated interventions, the province risks not only worsening health and economic indicators but also deepening inequality and instability. The cost of inaction is not just humanitarian, it is strategic and economic, undermining Pakistan's future at every level. Sindh stands at a crossroads, and failing to act decisively will leave generations trapped in preventable cycles of hunger, poverty, and lost opportunity.

Conclusion

The malnutrition crisis in Sindh is a stark reminder that food production alone cannot guarantee human nourishment or societal wellbeing. Despite being a key agricultural hub, the province remains burdened by systemic inequalities, governance failures, and climate-induced shocks that leave millions food-insecure and nutritionally deprived. The tragic contradiction of abundant harvests and empty plates highlights a broken system, one where structural poverty, inflation, inadequate healthcare, and social exclusion intersect to create a chronic public health emergency.

The consequences extend far beyond individual suffering, threatening to derail Pakistan's developmental trajectory by weakening its future workforce, increasing public health burdens, and fueling rural-to-urban displacement. Addressing this crisis demands more than piecemeal interventions; it requires bold, cross-sectoral reforms that integrate agriculture, health, social protection, and education. From empowering women and enforcing land rights to investing in nutrition-sensitive farming and expanding therapeutic food access, the pathway forward must be inclusive and sustained. Equally vital is political commitment, without which institutional inertia and inequality will persist. If Sindh is to reclaim its role as a breadbasket that nourishes its people, a comprehensive and rights-based approach to nutrition is essential. Ensuring every child grows up healthy, every woman receives adequate care, and every family can afford nutritious food must become a national imperative.

References: National Nutrition Survey; UNICEF; World Bank; FAO; NDMA; State Bank of Pakistan; Sindh Health Department; Pakistan Bureau of Statistics; SPDC; PCRWR; Transparency International; PDHS; Lancet

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Reducing Post-Harvest Losses for Food Security

Reducing post-harvest losses (PHL) is vital for achieving global food security, enhancing rural prosperity, and promoting environmental sustainability. With up to 40% of perishable crops spoiling, before reaching markets, the consequences cascade to farmers & consumers.

Atta U Rehman Chachar

5/13/2025

Post-harvest losses (PHL) represent one of the most pressing but under-addressed challenges in the global food system, especially in developing countries where agricultural livelihoods and national food security are tightly interlinked. According to the Food and Agriculture Organization (FAO, 2023), approximately 14% of the world's food is lost before it even reaches the consumer, with figures in developing regions rising to nearly 40% for fruits, vegetables, and other perishables. This loss is not merely a logistical issue, it reflects a broader structural failure across the value chain, from harvest practices and market access to infrastructure and policy support.

The primary causes of PHL include outdated harvesting techniques, poor post-harvest handling, insufficient cold chain infrastructure, and inefficient rural transportation networks. In tropical climates, where temperatures and humidity levels are high, crops like tomatoes, mangoes, and leafy greens can spoil within hours if not properly stored. Additionally, smallholder farmers often lack access to on-farm storage facilities, leading them to sell quickly at lower prices to avoid spoilage, thereby perpetuating income instability.

The consequences of PHL are far-reaching. Economically, they represent billions in lost revenue annually, up to $4 billion across sub-Saharan Africa alone (World Bank, 2023). Environmentally, wasted food translates into wasted water, land, and energy resources, exacerbating climate change. Socially, food that could nourish millions contributes to hunger and malnutrition.

Tackling PHL requires a multi-pronged strategy: investment in cold storage and solar-powered processing units, capacity building for farmers on best practices, improvements in rural road connectivity, and policies that promote aggregation and farmer cooperatives. Public-private partnerships and digital innovations, such as mobile-based market access platforms, can also play a pivotal role in improving supply chain efficiency. Reducing PHL not only enhances food availability but also strengthens the economic resilience of rural communities and promotes sustainable development.

The Economic Impact of Post-Harvest Losses

Post-harvest losses (PHL) are not just a food security issue, they represent a significant economic burden for farmers, agribusinesses, and national economies. Globally, the Food and Agriculture Organization (FAO, 2023) estimates that over $1 trillion worth of food is lost annually between harvest and consumption, with developing countries suffering the most due to inadequate infrastructure and limited access to preservation technologies. In Sub-Saharan Africa alone, PHL accounts for approximately $4 billion in yearly economic losses (AfDB, 2023), directly affecting the income and financial stability of millions of smallholder farmers.

In large agricultural economies like India, losses are equally staggering. Due to poor storage, insufficient cold chain logistics, and inefficient transportation systems, India loses between 6% and 18% of its grain production annually, translating into an economic loss of around $14 billion (NITI Aayog, 2022). These losses undermine government efforts to ensure price stability, increase farmer incomes, and reduce rural poverty.

PHL also drives market instability. Food shortages caused by loss-induced supply disruptions often lead to price volatility, with spikes of up to 30% observed in vulnerable markets (World Food Program, 2023). This inflation disproportionately affects low-income consumers, exacerbating food insecurity and malnutrition. Smallholder farmers, who produce 80% of the food consumed in Africa, are especially vulnerable, as they often lack access to modern storage facilities and preservation techniques. With 25–40% of their harvests lost to spoilage, many are forced into distress sales, accepting prices far below market value (IFAD, 2023).

These financial losses create a negative feedback loop: lower incomes reduce the ability to invest in improved technologies or infrastructure, perpetuating inefficiency. Addressing post-harvest losses, therefore, is not just about food preservation, it is a key to unlocking rural economic growth, reducing poverty, and stabilizing markets in agrarian economies.

Food Security, Environmental Costs, and Solutions to Post-Harvest Losses

Post-harvest losses (PHL) significantly undermine global food security, especially in regions already grappling with hunger and malnutrition. According to the United Nations (2023), over 800 million people suffer from chronic hunger worldwide, and food loss between harvest and market contributes directly to these shortages. In South Asia, 20–30% of fruits and vegetables perish before reaching consumers due to inadequate storage and logistics. These losses are particularly detrimental in a region where diets often lack essential micronutrients, thus exacerbating widespread deficiencies in vitamins A,

C, and iron (Global Panel on Agriculture, 2023).

Beyond human health, PHL imposes severe environmental costs. Wasted food accounts for 8–10% of total global greenhouse gas emissions, more than the entire aviation sector (WRI, 2023). Additionally, 45 trillion liters of water are wasted annually in growing food that never gets eaten, an amount sufficient to meet the annual water needs of 300 million people (WWF, 2023). The environmental footprint of lost food is unsustainable, contributing to climate change, water scarcity, and ecosystem degradation.

PHL results from a series of systemic failures. Poor harvesting and handling practices, such as bruising during manual picking or mechanical injury during machine harvesting, account for up to 50% of losses in developing countries (FAO, 2023). These problems are compounded by inadequate storage: nearly half of Africa's grains spoil due to pests, mold, and moisture in unsealed containers (AGRA, 2023), while only 10% of Indian farmers have access to cold storage (NABARD, 2022).

Transport and logistics also play a major role. In developing countries, 25–30% of perishables spoil during transit due to lack of refrigeration and poor road infrastructure (World Bank, 2023). Fragile produce like berries and leafy vegetables suffer the most. Additionally, limited access to processing facilities forces farmers to sell quickly at low prices, especially in peak harvest seasons. For example, Pakistan loses 35% of its mango crop each year due to a lack of processing capacity and export constraints (USAID, 2023).

Solutions are emerging. Technological innovations such as hermetic storage bags and solar-powered cold rooms can dramatically reduce losses. India's Kisan SAMPADA Yojana is improving processing infrastructure, while Ethiopia has saved $200 million annually through better grain storage. Expanding digital tools like mobile cold chain monitoring and market linkages via platforms like India's eNAM can further reduce losses and improve farmer incomes. With targeted investments, training, and policy reforms, post-harvest losses can be minimized—strengthening food security, reducing environmental harm, and improving livelihoods.

Conclusion

Reducing post-harvest losses (PHL) is one of the most impactful and achievable steps toward ensuring global food security, rural prosperity, and environmental sustainability. As the evidence from South Asia, Sub-Saharan Africa, and other developing regions shows, PHL is a multidimensional issue affecting not only farmers' incomes but also national economies, nutritional outcomes, and planetary health. When up to 40% of perishable crops spoil before reaching markets, the consequences cascade, farmers suffer financial setbacks, consumers face inflated food prices, and millions are deprived of essential nutrients. Meanwhile, the water, energy, and land used to grow wasted food contribute significantly to environmental degradation and climate change.

Addressing this issue demands a coordinated, multi-sectoral response. From improving harvesting techniques and expanding cold chain infrastructure to increasing processing capacity and investing in rural roads, every link in the agricultural value chain must be strengthened. Digital innovations like mobile-based market platforms, cold chain tracking, and weather-advisory services can empower farmers to make better decisions and reduce spoilage. Governments, development partners, and the private sector must work together to finance scalable solutions and support smallholders through training, subsidies, and cooperative models. Ultimately, reducing PHL is not merely a logistical challenge, it is a moral, economic, and environmental imperative. Prioritizing can unlock transformative gains for food systems and human wellbeing.

References: FAO; World Bank; WRI; NITI Aayog; AGRA; AfDB; NITI Aayog; World Food Program; IFAD; United Nations; Global Panel on Agriculture; WWF; NABARD; USAID

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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Malnutrition Crisis in Sindh: A Systemic Emergency

Sindh's malnutrition crisis isn't just about food scarcity, it's a result of deep-rooted poverty, poor governance, and climate shocks. Nearly half of children suffer from stunted growth, while malnourished mothers struggle to support their families. Without systemic fixes, this crisis will keep pushing vulnerable households deeper into hardship.

Qadir Bux Aghani

5/14/2025

Sindh, Pakistan's second-most populous province and a major contributor to national agricultural output, is paradoxically gripped by a deepening malnutrition crisis. Despite fertile lands, year-round crop cultivation, and strong contributions to the national food basket, especially in wheat, rice, vegetables, and fruits, thousands of children and women continue to suffer from chronic undernutrition and hunger. This is not a crisis of production, but a complex failure of distribution, economic access, governance, and resilience.

A significant portion of the population in rural Sindh, particularly landless laborers, sharecroppers, and flood-affected households, lacks the financial means to access a diverse, nutritious diet. Economic instability, inflation, and limited livelihood opportunities have pushed even food-producing families into cycles of food insecurity. According to the National Nutrition Survey (2018), stunting affects 50% of children under five in Sindh, while maternal malnutrition remains among the highest in the country. This alarming trend persists despite surplus grain production in the province.

Governance gaps compound the crisis. Weak safety nets, delayed food assistance, and insufficient investment in rural health and sanitation services leave millions vulnerable. Furthermore, climate change has intensified the fragility of food systems. Floods, droughts, and water salinity frequently destroy crops, reduce household incomes, and disrupt supply chains, worsening seasonal hunger and forcing families into distress coping strategies like cutting meal portions or removing children from school.

The malnutrition crisis in Sindh reflects a deeper socio-political imbalance, where agricultural abundance coexists with widespread food poverty. Addressing this disconnect requires not just food aid, but structural reforms in land rights, public health, market access, and climate resilience. Empowering women, expanding rural livelihoods, and ensuring equitable access to safe, nutritious food must be central to any sustainable solution. Sindh's agricultural potential can only translate into nutritional security through inclusive and accountable governance.

The Alarming Numbers: A Health Emergency

The alarming nutrition statistics in Sindh reveal not just a public health crisis, but a generational emergency with long-term socio-economic consequences. According to the National Nutrition Survey (2018), 48.6% of children under five in Sindh are stunted, significantly higher than the national average of 40.2%. Stunting is a marker of chronic undernutrition, often resulting from prolonged food insecurity, poor maternal health, and inadequate access to clean water and sanitation. In parallel, 19.5% of children are affected by wasting, a form of acute malnutrition that reflects severe nutrient deficiencies and recurring infections, as reported by UNICEF Pakistan (2023).

The crisis extends beyond children. Maternal malnutrition is equally dire: 42% of pregnant women in rural Sindh are anemic, primarily due to iron deficiency, poor dietary diversity, and limited access to antenatal care (World Food Program, 2022). These conditions increase the risk of low birth weight, maternal mortality, and complications during childbirth. Sindh's maternal mortality ratio (MMR) stands at 224 deaths per 100,000 live births, far above the national average of 186, according to the Pakistan Demographic and Health Survey (2022).

These interconnected indicators signal a deep-rooted cycle of vulnerability. Malnourished mothers are more likely to give birth to underweight babies who, in turn, face heightened risks of stunting, illness, and early mortality. The first 1,000 days of a child's life, conception to age two, are critical for brain development and physical growth. Deficits during this period result in irreversible cognitive impairments, reduced educational attainment, and diminished adult productivity.

Left unaddressed, Sindh's malnutrition crisis threatens not just public health but the province's economic future. Malnourished populations are less capable of contributing meaningfully to the workforce, leading to lower productivity, increased healthcare costs, and continued poverty. Urgent, multi-sectoral action is needed to break this cycle and secure healthier generations.

Economic Strain and Food Inflation

Pakistan's ongoing economic crisis has had a severe ripple effect on food security in Sindh, deepening existing vulnerabilities among low-income households. In 2023, food inflation soared to 47.1%, the highest in South Asia, according to the World Bank. Basic staples, particularly wheat, saw a 58% price hike in just one year, rendering everyday meals unaffordable for millions (Pakistan Bureau of Statistics, 2023). In rural Sindh, where unemployment exceeds 25% (ILO, 2023), families are increasingly forced to reduce food intake or rely on less nutritious diets, contributing to widespread malnutrition and hunger.

Climate-related disruptions compound these economic pressures. In 2022, floods and heatwaves devastated crops across Sindh, leading to a 40% drop in cotton yields (FAO, 2023). Erratic rainfall patterns and the depletion of groundwater resources continue to threaten food production, especially for smallholder farmers. With limited financial resilience, many are forced into debt or abandon agriculture altogether, further reducing local food availability.

Governance failures exacerbate the crisis. Despite the presence of federal programs like BISP and Ehsaas, only 32% of eligible households in Sindh reportedly receive full benefits (Centre for Economic Research Pakistan, 2023). Rural health infrastructure is weak: most centers lack trained nutrition staff, and only 15% offer therapeutic food for malnourished children (Sindh Health Department, 2023). The absence of a comprehensive provincial nutrition policy results in fragmented efforts and poor coordination between sectors.

To reverse these trends, a multi-sectoral response is critical. Strengthening social safety nets with inflation-adjusted cash transfers and targeted food subsidies for mothers and children is essential. Investment in healthcare and community-based nutrition services must include training frontline workers and expanding micronutrient programs. Agricultural resilience can be improved through promotion of drought-tolerant crops, efficient irrigation, and microfinance support for women farmers, who play a vital role in household food security. Finally, enacting a Sindh Nutrition Act and increasing transparency in subsidy programs will ensure accountability and sustained progress. Only through integrated, well-coordinated action can Sindh overcome its nutrition crisis and build a healthier, more resilient future.

Conclusion

The malnutrition crisis in Sindh is not simply a matter of food availability, it is a structural and systemic emergency rooted in poverty, governance failures, and climate vulnerability. Despite Sindh's abundant agricultural resources, nearly half of its children are stunted and a significant proportion of women are malnourished. These statistics are symptomatic of deeper inequalities: landless laborers, climate-affected households, and under-served rural communities remain excluded from essential services and stable livelihoods. Economic shocks, from food inflation to job losses, further compound the issue, pushing already fragile households into deeper nutritional deprivation.

The impacts of this crisis are generational. Malnourished children grow into less healthy and less productive adults, perpetuating cycles of poverty and undermining the province's economic potential. Tackling this challenge requires more than temporary relief measures, it demands transformative, multi-sectoral reforms. Expanding access to health and nutrition services, strengthening social protection programs, promoting climate-resilient agriculture, and improving governance and policy coordination are critical starting points.

Empowering women, improving education, and investing in rural infrastructure must be part of the solution. Only with sustained political will, inclusive planning, and transparent implementation can Sindh move from food abundance coexisting with hunger, to a future where agriculture truly nourishes all. The time to act, decisively and comprehensively, is now.

Reference: National Nutrition Survey Pakistan; UNICEF Pakistan; World Bank; Pakistan Bureau of Statistics; Food and Agriculture Organization; Sindh Health Department; Pakistan Demographic and Health Survey; Centre for Economic Research Pakistan

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Pakistan's Path to Food Security and Sustainability

Explore Pakistan's journey toward food security through innovative rural economic policies focused on sustainability and resilience. Learn how structural reforms and lessons from successful countries can help combat hunger and malnutrition.

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5/19/2025

Food security, defined as consistent access to safe, nutritious, and sufficient food, is not only a fundamental human right but also a cornerstone of national development, social stability, and public health. However, despite technological progress and global economic growth, the world continues to struggle with hunger. In 2022, over 828 million people faced food insecurity, with the vast majority residing in rural areas where livelihoods depend heavily on agriculture (FAO, 2023). This paradox is especially stark in Pakistan, a country whose economy is deeply rooted in agriculture, yet which ranks 92nd out of 116 countries on the Global Hunger Index (GHI, 2023). This ranking reflects critical challenges including poor food distribution, malnutrition, and declining agricultural productivity.

Pakistan's food security is undermined by a convergence of climate change, land degradation, water scarcity, and inconsistent policy implementation. Increasing temperatures and erratic rainfall are already reducing yields in key crops like wheat and rice, while soil fertility continues to decline due to overuse of chemical inputs and inadequate crop rotation. These environmental pressures are compounded by fragmented agricultural policies, limited investment in rural infrastructure, and weak support for smallholder farmers.

This study explores how targeted rural economic policies, such as climate-smart agriculture, farmer cooperatives, and price stabilization mechanisms, can improve resilience. Drawing on global best practices, particularly from countries like China and South Korea, it highlights how strategic state investment in rural development, research and extension services, and land reform played a transformative role in their food systems. In Pakistan's case, enhancing food security will require not just increased agricultural output, but a more equitable and sustainable system, one that empowers small farmers, invests in innovation, and integrates environmental and nutrition goals. Ultimately, food security must be viewed as both an economic strategy and a moral obligation to protect human dignity and national stability.

The Global and Local Context of Food Insecurity

Food insecurity has long been a global concern, with its roots traceable to historical debates such as those initiated by Thomas Malthus in 1798, who warned of population growth outpacing food supply. However, the modern concept of food security gained prominence in the 1970s following widespread food crises that prompted the international community to consider access, availability, and affordability of food as core development priorities. In recent years, the interplay of conflict, climate change, and economic instability has caused a resurgence of food insecurity globally. A stark example is North Korea, where 40% of the population was undernourished in 2022 due to a combination of international sanctions, droughts, and poor agricultural policies (WFP, 2023). This case illustrates how geopolitical and environmental pressures can compound governance failures to create widespread hunger.

In Pakistan, the situation is equally pressing but shaped by different dynamics. With a population growth rate of 2.4% per year, the country must increase its food production by at least 50% by 2050 to meet future demand (UNPD, 2023). This task is complicated by Pakistan's high vulnerability to climate change; ranked as the fifth most affected country globally by extreme weather events (Germanwatch, 2023). Crop yields, especially of staple grains like wheat and rice, have already suffered losses of up to 20% due to floods, droughts, and heatwaves (World Bank, 2023).

Moreover, economic pressures are pushing food further out of reach for many. Food inflation in 2023 peaked at 47%, driven by currency devaluation, global supply chain disruptions, and domestic production shortfalls (Pakistan Bureau of Statistics). These conditions have deepened both urban and rural hunger, increasing reliance on expensive imports and eroding household purchasing power. Addressing food insecurity in Pakistan thus requires systemic reforms that respond to both global trends and deeply entrenched local vulnerabilities.

Key Barriers to Rural Food Security

Rural food security in Pakistan faces multifaceted and escalating challenges, with climate change, soil degradation, water scarcity, and policy inefficiencies forming a complex web of interlinked barriers. Climate change remains one of the most pressing threats, with projections indicating that a 2°C rise in global temperatures could slash Pakistan's agricultural GDP by 8–10% (IPCC, 2023). The devastating 2022 floods serve as a stark reminder, having submerged over 4.4 million acres of cropland and inflicted $30 billion in damage (NDMA, 2023), crippling rural food systems and pushing millions into hunger.

Soil degradation further undermines agricultural productivity. According to

the Pakistan Council of Research in Water Resources (PCRWR, 2023), approximately 75% of the country's soils are deficient in essential nutrients. Soil erosion alone is estimated to reduce wheat yields by 3.5% annually (FAO, 2023), jeopardizing the staple food supply and rural incomes. Compounding this is a deepening water crisis. Per capita water availability in Pakistan has plummeted from 5,260 m³ in 1951 to less than 900 m³ in 2023, well below the scarcity threshold. Inefficient practices, like flood irrigation, waste up to 60% of available water (IWMI, 2023), further stressing an already fragile system.

Institutional and policy gaps significantly hinder effective response. Fertilizer subsidies, meant to support small farmers, are disproportionately captured by large landowners, 80% of benefits go to this group (IMF, 2023), exacerbating rural inequality. Simultaneously, agricultural research and development remains chronically underfunded, with less than 0.5% of agricultural GDP allocated to R&D (PARC, 2023). This stifles innovation and slows the dissemination of climate-resilient farming techniques.

Together, these barriers not only reduce food availability and affordability but also erode the resilience of rural communities, making food security an increasingly elusive goal without structural reforms and climate-smart investments.

Rural Economic Policies for Food Security

Rural economic policies form the foundation for achieving sustainable food security in Pakistan. Effective strategies must address immediate needs while laying the groundwork for long-term resilience. Direct policy interventions have already shown measurable impact. For example, targeted farmer subsidies in Punjab led to a 12% increase in wheat production in 2022, mirroring the success of India's PM-KISAN scheme. Similarly, Vietnam's 1993 land reforms transformed the country into a major rice exporter, boosting rice exports by 300% within a decade. Farmer education also proves vital: Bangladesh's Farm Field Schools have helped farmers adopt climate-smart practices, increasing yields by up to 30% (CIMMYT).

Infrastructure investments play a critical role. Efficient irrigation systems, such as drip irrigation, can reduce water usage by 50% (World Bank), essential in a water-scarce nation like Pakistan. Meanwhile, the lack of storage infrastructure results in the loss of 40% of perishable produce. Expanding cold storage facilities could save the economy $1 billion annually (POST, 2023), improve food availability, and stabilize prices.

Technological innovation further supports food security. With over 500,000 farmers now using mobile apps for weather forecasts and agronomic advice (PTA, 2023), tele-agriculture is bridging knowledge gaps. Biofortification, like zinc-enriched wheat developed by HarvestPlus, can reduce malnutrition by 20%, making crops both productive and nutritious.

Strategically, Pakistan must adopt phased policy implementation. In the short term (0–3 years), expanding social protection programs such as Ehsaas Ration to 20 million households and distributing heat-resistant seeds to one million farmers would provide immediate relief. In the medium term (3–10 years), land reforms capping landholdings at 50 acres and reforms in water governance, such as penalizing groundwater overuse and promoting solar-powered tubewells, can boost equity and sustainability. Over the long term (10+ years), integrating agro-ecology into school curricula and leveraging regional cooperation through China's Belt and Road Initiative for agri-tech transfers can future-proof Pakistan's agricultural sector.

Conclusion

Pakistan's journey toward food security demands a comprehensive rethinking of rural economic policies rooted in sustainability, equity, and resilience. Despite its agricultural base, Pakistan continues to face rising hunger and malnutrition due to climate stress, degraded soils, water shortages, and fragmented policies. Structural reforms are crucial, not just to increase production, but to build a more inclusive and climate-resilient food system. Lessons from countries like China, South Korea, and Vietnam demonstrate that targeted investments in land reform, farmer training, infrastructure, and technology can significantly improve food outcomes.

In Pakistan's context, policy must focus on empowering smallholder farmers, expanding rural infrastructure such as storage and irrigation, and investing in innovation including biofortification and digital agriculture. Short-term social protections must be paired with medium-term institutional reforms and long-term vision in education and regional cooperation. Only by aligning environmental sustainability with rural development and nutrition goals can Pakistan break the cycle of rural poverty and food insecurity.

Ensuring consistent access to nutritious food is not just a development challenge but a moral imperative tied to national stability, public health, and human dignity. A future of food-secure Pakistan lies in proactive, inclusive, and evidence-based policymaking that transforms rural landscapes into engines of resilience and prosperity.

References: FAO: World Bank: IMF; HarvestPlus; GHI; WFP; UNPD; Germanwatch; Pakistan Bureau of Statistics; NDMA; IPCC; PCRWR; IWMI; IMF PARC; CIMMYT; POST; PTA

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Ashwagandha & Nanotechnology in Cancer Therapy

Explore the promising combination of traditional herbal medicine and nanotechnology in cancer therapy. Discover the anti-cancer potential of ashwagandha and its bioactive compound, withaferin A, along with insights into its limitations like toxicity and bioavailability.

Areej, Mian Kamran Sharif, Tabana Naz & Muneeba Javed

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Advancements in research and medicine have significantly influenced cancer therapies thus enhancing the life expectancy of numerous individuals. Notwithstanding technological advancements, the condition continues to impact many persons worldwide and ranks among the primary reasons of mortality. Moreover, drug resistance is a significant challenge that influences cancer cell viability and recurrence. Consequently, the discovery of effective treatments that can influence tumor growth and cancer cell proliferation is of paramount significance. Ashwagandha Withaferin, a phytochemical extracted from the plant *Withania somnifera*, has garnered significant attention for its anticancer effects demonstrated in several murine models and tumor cell investigations.

Recent years have witnessed significant breakthroughs in nanotechnology aimed at improving the efficacy of phytochemicals. Nanotechnology enhances the bioavailability and stability of therapeutic plants, hence increasing targeted administration and addressing the limitations associated with traditional herbal preparations. The synergistic therapeutic potential of ashwagandha with nanoformulations enhances the treatment efficacy and offers an innovative strategy in cancer management, while also mitigating the long-term impacts of malignancy.

The Power of Ashwagandha

Withania somnifera, an evergreen shrub, commonly referred to as ashwagandha, is extensively utilized in ayurvedic medicines. Patients with various musculoskeletal diseases are prescribed for ashwagandha in different formulations. It is also taken as a general health tonic to boost energy and improve overall health and wellbeing. It is also recommended to the patients having bone diseases like arthritis, and during pregnancy. An extensive number of pharmacological studies have been conducted to investigate the properties of *Withania somnifera* in an attempt to substantiate its usage as a multifaceted medicinal agent. Various researches have documented its anti-cancer, anti-inflammatory, hemopoietic, and immunomodulatory properties. These rejuvenating characteristics of ashwagandha exerts beneficial effects on body's endocrine, central nervous system and cardiovascular system.

Withania somnifera contain several bioactive compounds such as withanolides like Withaferin A. Theses bioactive substances exerts strong anti-cancer potential and demonstrate significant effectiveness against various types of cancers, including breast, ovarian, cervical and endometrial malignancies. It not only provides prevention against reproductive system but also prevents cancers of urinary system and digestive system such as prostate, renal, colorectal, hepatic and gastric carcinomas. Ashwagandha treats cancer by inducing apoptosis, preventing angiogenesis, and suppressing metastasis. It suppresses pro-survival pathways like Akt/NF-κB/Bcl-2, cell proliferation, migration, and cancer stem cells, further suppressing angiogenesis and generating cell cycle arrest, autophagy, apoptosis and ferroptosis.

The Limitations of Traditional Herbal Use

Notwithstanding the extensive anti-cancer properties of Withaferin Ashwagandha (WA), there are several limitations, such as possible toxicity, inadequate oral bioavailability, and limited production. Withaferin A extract is the primary bioactive component of Withaferin Somnifera, and studies have shown that it is safe for all tested groups. The utilization on WA has shown some hazardous side effects in mice, with an LD50 of 54 mg/kg body weight. In order to mitigate these toxicity issues, scientists have investigated structural alterations to produce WA derivatives with similar but less hazardous action. For example, ASR488, 2-thiophene ester-linked derivative of WA, selectively suppressed bladder cancer cells without harming healthy cells. After oral administration, the compound often undergoes first-pass hepatic metabolism, significantly reducing its systemic circulation and, therefore, its effectiveness increase at the tumor site. According to a recent study published in Pharmaceuticals, WA's low solubility hinders its pharmacological efficacy *in vivo* by causing poor absorption and bioaccumulation.

A notable disadvantage is that when Withaferin Ashwagandha and other herbal compounds are administered using normal methods, their distribution is non-specific. Owing to their lack of specificity in targeting cancer cells, these chemicals often permeate healthy organs, resulting in unintended adverse consequences. The absence of tailored delivery necessitates higher doses, hence increasing the risk of systemic toxicity. Moreover, herbal formulations diminish in efficiency owing to enzymatic degradation in the intestines or physiological variables such as an acidic gastric pH. The cytotoxic efficacy of withaferin A against malignant cells cannot be fully harnessed without inflicting damage to normal tissues. This is attributable to the narrow therapeutic window of withaferin A. This underscores the need of developing contemporary drug delivery techniques, such as

nanoencapsulation, to bridge the divide between traditional herbal wisdom and contemporary cancer treatments, given the pharmacological and delivery-related problems.

Nanoencapsulation: A Modern Solution

Nanoencapsulation involves enclosing compounds within diminutive structures using nano-emulsification, nano-structuration, or nano-composites to facilitate the regulated release of the core material. Various nano-encapsulation methods, including liposomes, nanoparticles, micelles, nanospheres, nanoemulsions, and nanocochleates, have been employed depending on the applications. These can be employed as nutritional supplements to conceal undesirable flavors, enhance bioavailability, and facilitate the efficient distribution of insoluble supplements without the need for emulsifiers or surfactants. It has emerged as an innovative approach to overcome the limitations of conventional herbal compositions. Encapsulating bioactive compounds in nanocarriers improves their solubility, protects them from degradation, and facilitates targeted delivery to tumor sites. Various nanocarriers, including polymeric nanoparticles, liposomes, and solid lipid nanoparticles, have been explored for the administration of Withaferin A. For instance, Withaferin A-loaded nanosponges have demonstrated enhanced anticancer efficacy against MCF-7 human breast cancer cells, exhibiting effectiveness comparable to cisplatin in reducing tumor volume. Similarly, PEGylated nanoliposomes including WA have exhibited significant tumor growth suppression and improved survival in mice with Dalton Lymphoma Ascites tumors. These nanoformulations improve the pharmacokinetic profile of WA and promote its accumulation in tumor tissues, hence enhancing its therapeutic index.

Unlocking Therapeutic Potential of Ashwagandha Through Nanoformulation Techniques

Modern pharmaceutical advancements, especially nano-encapsulation techniques, have evolved as a game changer in the history of traditional herbal treatment. Nanoencapsulation of ashwagandha, enhance stability, solubility and effective administration. There are various delivery methods of nanotechnology that enhance the bioavailability and anti-tumor potential of Withaferin Ashwagandha such as nanostructured lipid carriers (NLCs), liposomal encapsulation, solid lipid nanoparticles (SLNs), polymeric nanoparticles, and nanoemulsions. These delivery techniques enable effective administration and release the bioactive compound at the specific tumor site. Nanoencapsulation enhances the residence time in the blood and at the tumor site and provide a shield against premature breakdown. For instance, PLGA-based nanoparticles (polylactic-co-glycolic acid) loaded with Withaferin A have shown promising results in both *in vitro* and *in vivo* cancer models by ensuring enhanced absorption in malignant cells while maintaining healthy tissues.

To deliver phytochemicals in the body, two major nanoformulation techniques i.e. liposomes and polymeric nanoparticles are commonly used to deliver bioactive compounds due to their ability to modify their surfaces and bioavailability. These two techniques allow for active targeting of cancerous cells. The process involves further improving site-specific accumulation and decreasing off-target toxicity by functionalizing nanoparticles with ligands such as monoclonal antibodies or folic acid. In one study, the scientists developed folate-functionalized WA-loaded PLGA nanoparticles; when compared to free WA, this showed a dramatic reduction of cell growth in breast cancer cells *in vitro* and enhanced apoptosis. One of the possible approaches is through the application of solid lipid nanoparticles, which ensure increased physical stability and scalability to commercial production. These nanoformulations increase therapeutic potency and open up new avenues for oral, intravenous, or transdermal delivery modalities in the near future pharmaceutical landscape. With these advanced technologies, Ashwagandha can be shifted from a traditional adaptogen to a scientifically validated nutraceutical or adjunct anticancer therapy.

Ashwagandha in Cancer Research: Global Progress

The discovery of effective tumor therapies is a tremendous challenge since cancer is the top cause of death globally and poses a huge danger to human health. In 2020, there were over 10.0 million cancer-related deaths and 19.3 million new cases worldwide, according to cancer statistics. It is anticipated that by 2040, there would be 28.4 million instances of cancer. The use of natural compounds in drug development is still highly important. Significant anti-tumor effectiveness is demonstrated by Withaferin A (WA), the most potent phytocompound that was isolated from the well-known nutritional supplement named as *Withania somnifera* Dunal commonly known as Ashwagandha.

The anticancer effects of ashwagandha and its nanencapsulation has drawn increasing attention from the global scientific community. The pre-clinical research on cancer has demonstrated that Withaferin Ashwagandha is effective against different cancer types, including breast, prostate, and lung cancers. Epithelial-mesenchymal transition is a crucial step in inducing cancer metastasis and ashwagandha obstructs the epithelial-mesenchymal transition (EMT) by controlling the signaling pathways such as TGF-β and NF-Kb. Withaferin ashwagandha has the ability to inhibit the synthesis of vascular endothelial growth factor (VEGF) and exhibits strong anti-angiogenic properties. The inhibition of VEGF prevents the formation of new blood vessels that promote tumor growth. The increasing preclinical data provides a strong argument for moving WA-based

nano-formulations to clinical trials, even if clinical studies are still in the early stages.

Opportunities for Nutraceutical and Pharmaceutical Industries

The growing public preference for food and drug is continuously changing and their inclination towards natural and plant-based medicines with advancements in nanotechnology, creates a favorable environment for the development of ashwagandha based products. Nanoencapsulation technology can benefit both pharmaceutical and nutraceutical industries. Pharmaceutical companies can develop more tailored and effective anti-cancer medications by employing nanoencapsulation technology. Nutraceutical industries can utilize techniques of nanoencapsulation for the development of dietary supplements designed to mitigate the risk of developing cancer and to support cancer treatment. To enhance the field of nanotechnology and their incorporation into traditional herbal treatments, there is a strong need of collaboration between researchers, medical professionals and industrial stakeholders. Collaborative efforts are essential for transforming preclinical findings into clinically approved therapies, especially the therapies for chronic diseases. The effective utilization of nanotechnology in the field of science can benefit patients globally.

Conclusion

The combination of traditional herbal medicine with contemporary nanotechnology offers a promising opportunity for improving cancer therapy. The bioactive compound present in Ashwagandha, Withaferin A, demonstrates this interaction. Withaferin Ashwagandha possesses strong anti-cancer potential, and its pharmacological characteristics have exhibited considerable anti-tumor potential across various types of cancer. Despite its notable anti-tumor activity, ashwagandha has some limitations, including possible toxicity and poor oral bioavailability, which must be addressed when evaluating it as an anti-tumor candidate drug. Nanoencapsulation technique not only alleviates the limitations but also improves the overall therapeutic effectiveness of withaferin A. Various oncologists have illustrated the intricate anticancer mechanism of Withaferin Ashwagandha and its nanoencapsulation, demonstrating promising positive results in standard cancer therapies. By implementing this nanoencapsulation technique, we may enhance the development of patient-centered cancer medicines with a more efficient and targeted approach. Nevertheless, owing to its potential anti-tumor characteristics, Withaferin Ashwagandha remains an intriguing candidate for further pharmacological investigation. As research in this field progresses, we expect a more precise understanding of the exact mechanisms of WA's effect, its toxicity profile, and enhancements in delivery methods.

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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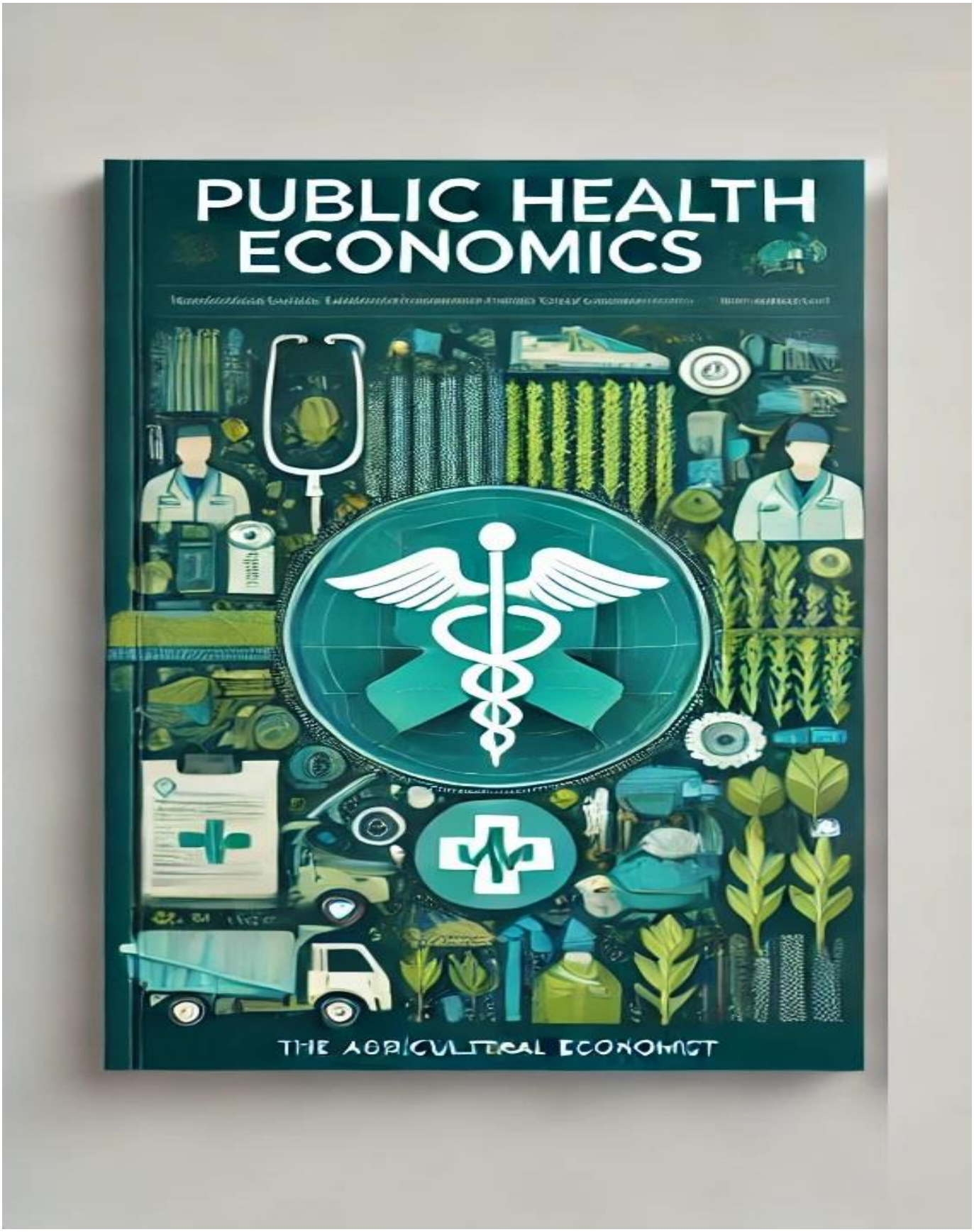
PUBLIC HEALTH
ECONOMICS
THE AGRICULTURAL ECONOMIST

Pollinators: Key to Pakistan's Agricultural Security

Discover how pollinators are essential for Pakistan's agricultural and nutritional security. The decline of bees and butterflies threatens crop yields, soil health, and food availability, exacerbating food insecurity and public health issues across the nation.

Shahan Aziz

5/15/2025

Bees, butterflies, bats, and other pollinators form the invisible backbone of global food systems and ecosystems. Yet in Pakistan, where agriculture contributes 19.2% of GDP (World Bank, 2023) and employs 37.4% of the workforce (Pakistan Economic Survey, 2023), pollinator populations are collapsing at an alarming rate. This crisis threatens not just honey production but the very foundation of food security and biodiversity.

Pollinators are responsible for the reproduction of nearly 75% of all food crops globally, including fruits, vegetables, nuts, and oilseeds (IPBES, 2023). In Pakistan, their decline has already had visible impacts. Studies by the Pakistan Agricultural Research Council (PARC, 2023) show a 40% loss in wild bee populations since 2000. This drop correlates with significant reductions in fruit yields, up to 30% in mango and apple orchards that lack sufficient pollinator presence (University of Peshawar, 2023). This has cascading effects on farmer incomes, rural livelihoods, and national food supply chains.

Multiple stressors are driving pollinator decline in Pakistan: widespread pesticide misuse, monoculture cropping systems, habitat destruction due to urban sprawl, and climate change. The increasing frequency of heatwaves and erratic rainfall patterns disrupt pollinator breeding cycles and foraging behavior. Additionally, honeybee colonies, critical for commercial pollination, are being decimated by parasites like Varroa mites and diseases exacerbated by poor beekeeping practices.

Despite these challenges, Pakistan's policy and research response remains fragmented. While some provinces have initiated pollinator-friendly farming trials and agroforestry projects, there is no national strategy to protect or regenerate pollinator habitats. To reverse the trend, urgent measures are needed: reducing pesticide use through integrated pest management, preserving wildflower corridors, incentivizing organic farming, and training farmers in pollinator-friendly practices. Given the stakes for food security, climate resilience, and rural economies, safeguarding pollinators must become a core priority in Pakistan's agricultural and environmental policy frameworks.

The Economic and Ecological Value of Pollinators

Pollinators are vital to both the ecological health and economic productivity of Pakistan's agricultural sector. Their role in ensuring food security and crop profitability cannot be overstated, especially in a country where over 37% of the workforce is employed in agriculture and the sector contributes nearly one-fifth of the GDP. A growing body of national and international research confirms that the decline of pollinator populations would directly undermine the productivity of key crops that sustain both the rural economy and household nutrition.

In Pakistan, the contribution of pollinators is most visible in high-value crops. For example, bee pollination increases cotton boll weight by 18%, resulting in higher fiber quality and yield, which is crucial for the country's textile exports (Punjab Agriculture Department, 2023). Mango orchards in Sindh experience a 35% increase in yield and up to 50% improvement in fruit quality when pollinators are active, directly influencing export revenue and farmer income (Sindh Horticulture Report, 2023). Similarly, canola, an increasingly important oilseed crop in Khyber Pakhtunkhwa, sees a 40% production boost with sufficient pollinator activity (KP Agriculture Statistics, 2023).

Beyond economic gains, pollinators underpin human nutrition. According to the National Nutrition Survey (2023), pollinator-dependent crops supply 84% of vitamin C sources and 72% of iron-rich foods consumed in the average Pakistani diet. Without pollinators, access to nutrient-dense foods like citrus, leafy greens, and legumes would sharply decline, exacerbating the country's already high rates of micronutrient deficiency, anemia, and childhood stunting.

Pollinators, therefore, represent a dual-value asset, boosting crop productivity and ensuring the availability of nutrient-rich foods. Their preservation is not just an ecological imperative but a socio-economic necessity for a food-insecure and climate-vulnerable country like Pakistan. Investing in pollinator-friendly agricultural practices is critical for long-term sustainability and human development.

Drivers of Pollinator Decline

The alarming decline of pollinator populations in Pakistan is the result of multiple, interlinked environmental and policy drivers that jeopardize agricultural productivity, biodiversity, and food security. One of the most prominent causes is the widespread overuse of harmful pesticides, especially neonicotinoids. Since 2015, the use of these chemicals has surged by over 300% in Punjab alone (EPA Punjab, 2023). A recent PCSIR lab study found that 72% of honey samples tested

contained harmful pesticide residues, directly threatening bee health and pollination efficacy.

Another major driver is habitat destruction. Urban expansion has led to the elimination of 35% of natural pollinator habitats since 2000 (WWF-Pakistan, 2023). Simultaneously, the dominance of monoculture farming practices, particularly in Punjab, has reduced floral diversity by 60%, depriving pollinators of the diverse foraging resources they need to survive (UAF Study, 2023). Climate change compounds these threats. Shifting flowering periods by 2–3 weeks disrupts the synchrony between pollinators and plants (PMD Climate Report, 2023), while extreme heat events, like the 2022 heatwave, caused a 50% mortality rate among bee colonies (Beekeepers Association, 2023).

The effects are evident in regional case studies. In Punjab's cotton belt, native bee populations have plummeted by 70%, resulting in $47 million in annual agricultural losses (PARC, 2023). In Swat Valley, fruit orchards show 30% lower fruit set in pollinator-deficient areas, and 60% of farmers have reported declining yields (UoP & Swat Agri Survey, 2023).

Despite the scale of the crisis, policy responses remain fragmented and inadequate. There are no national pollinator protection laws, and only 12% of pesticides in use are properly regulated (EPA Report, 2023). Research infrastructure is weak: only three universities across Pakistan conduct dedicated pollinator research, and there is no national monitoring framework (HEC Report, 2023).

Nonetheless, promising solutions exist. Farmer education initiatives, such as Integrated Pest Management (IPM) training, have already reduced pesticide use by 45% in pilot programs (FAO, 2023). Planting flowering borders around crops increased yields by 22% in Sindh (Sindh Agri Project, 2023). Policy measures modeled after the EU, like banning five high-risk pesticides and offering tax incentives to pollinator-friendly farms, could accelerate change. Urban beekeeping in 12 cities and pollinator garden programs in schools are already raising awareness and building grassroots resilience. Reversing pollinator decline will require systemic, multi-sectoral commitment, but the tools are already within reach.

Conclusion

Pollinators are more than just ecological allies; they are keystones of Pakistan's agricultural and nutritional security. As this article demonstrates, the dramatic collapse of pollinator populations threatens both the economic viability of key crops and the nutritional well-being of millions. Without bees, butterflies, and other vital species, fruit yields will continue to drop, soil health will degrade, and nutrient-rich foods will become scarce, compounding the country's food insecurity and public health burdens.

The causes of pollinator decline, pesticide overuse, habitat destruction, monocultures, and climate change, are well documented and increasingly urgent. Their effects are already visible across cotton fields in Punjab and fruit orchards in Swat, where lower yields and biodiversity loss are undermining farmer livelihoods and national food chains. Yet despite this, Pakistan lacks a national strategy for pollinator protection. Regulatory gaps, poor research investment, and fragmented policy responses have left a critical ecological pillar dangerously exposed.

Solutions do exist. From training farmers in Integrated Pest Management to incentivizing pollinator-friendly farming and restoring wildflower habitats, Pakistan can act now to halt and reverse pollinator decline. The country must integrate pollinator conservation into agricultural, environmental, and climate resilience policies. Protecting pollinators is not optional, it is essential to safeguarding Pakistan's ecosystems, rural economies, and future food systems.

References: World Bank; PARC;IPBES; Punjab Agriculture Department Data; WWF-Pakistan Habitat Study; FAO Pakistan Program Reports; Pakistan Economic Survey; University of Peshawar; KP Agriculture Statistics; National Nutrition Survey; EPA Punjab; UAF Study; PMD Climate Report; Beekeepers Association; UoP & Swat Agri Survey; HEC 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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Public Health Interventions for Rural Health

Explore the economic and social benefits of public health interventions in rural areas. Discover how preventive strategies like clean water access and mobile health services can enhance rural resilience and improve health outcomes for agricultural workers.

Mehroz Ilyas

5/19/2025

Public health interventions aim to improve population health through proactive prevention, rather than relying solely on clinical treatment. These initiatives include efforts such as immunization drives, access to clean drinking water, sanitation improvements, health education, vector control, and occupational safety protocols. When effectively implemented, such programs not only reduce the incidence and severity of diseases but also lower healthcare costs for governments and individuals, improve worker productivity, and promote overall well-being. For rural communities, which are often heavily dependent on agriculture and informal labor markets, such interventions play a crucial role in ensuring the sustainability of livelihoods.

However, rural populations frequently face systemic barriers that limit the reach and effectiveness of public health efforts. These challenges include underfunded health infrastructure, limited access to qualified healthcare personnel, logistical hurdles related to geographic isolation, and entrenched cultural norms that may discourage preventive care. For example, rural workers often lack access to protective equipment or health screenings, increasing their vulnerability to occupational hazards such as pesticide exposure, waterborne diseases, and musculoskeletal injuries from manual labor.

Economically, investing in rural public health yields high returns. According to WHO estimates, every $1 invested in water and sanitation generates up to $4 in economic benefits due to reduced disease burden and time savings. Similarly, improving rural vaccination rates significantly reduces absenteeism in agricultural and school-aged populations, with cascading effects on productivity and educational outcomes. Evidence-based programs, such as mobile health clinics, community health worker models, and health insurance schemes, have shown success in addressing rural inequities.

To ensure these benefits are realized, policy interventions must be tailored to rural realities. This includes expanding rural health budgets, integrating occupational safety into agricultural extension services, and developing culturally appropriate health messaging. Bridging rural-urban health gaps is not only a public health priority but a strategic investment in equitable and sustainable development.

The Economic Case for Public Health Interventions

The economic case for public health interventions is both compelling and urgent, particularly in rural areas where preventable health burdens are disproportionately high. Global research consistently shows that preventive public health measures are not only effective in improving health outcomes but also highly cost-efficient. According to the World Health Organization (2023), every $1 invested in clean water and sanitation yields $4.30 in economic returns through reduced healthcare expenditures and enhanced labor productivity. This return on investment becomes even more critical in rural settings, where limited healthcare infrastructure and lower income levels exacerbate the economic impact of preventable diseases.

Rural populations experience significantly poorer health outcomes compared to urban residents, with 24% higher mortality rates from conditions that could be prevented or managed with early intervention (World Bank, 2022). In many low-income countries, an estimated 40% of rural healthcare budgets are spent treating avoidable conditions such as diarrheal diseases, which could be largely mitigated through basic sanitation and hygiene education (UNICEF, 2023). This inefficiency places a heavy financial strain on already under-resourced rural health systems.

Moreover, public health issues in rural areas often have unintended consequences. Agricultural workers face 3.5 times higher rates of dermatological and respiratory conditions due to prolonged exposure to pesticides and other harmful chemicals (ILO, 2023). At the same time, frontline health personnel such as Community Health Workers (CHWs) in rural areas report 50% higher stress levels than their urban counterparts, driven by poor support structures, overwork, and emotional fatigue (Frontiers in Public Health, 2022).

Addressing these issues requires proactive investment in rural public health infrastructure, education, and worker protections. By prioritizing preventive care and occupational health, governments can reduce treatment costs, improve labor productivity, and create healthier, more resilient rural communities. These investments are not merely expenses, they are foundational pillars of economic stability and social equity.

Barriers to Rural Health Access

Rural communities face layered and persistent barriers to accessing timely and quality healthcare, resulting in significant health disparities compared to urban populations. One of the most critical challenges is workforce shortages. In the United States, 63% of all primary care shortage areas are in rural regions (HRSA,

2023). Globally, rural areas account for half of the population but only 23% of the healthcare workforce (WHO, 2023). This gap severely limits access to basic medical services and contributes to preventable disease progression and mortality.

Financial and geographic barriers further compound the problem. Rural residents are 2.5 times more likely to lack health insurance, limiting their ability to afford care (Kaiser Family Foundation, 2023). In Sub-Saharan Africa, nearly 60% of rural patients must travel over 10 kilometers to reach a health facility, often without reliable transportation (The Lancet, 2022). Cultural norms such as self-reliance and skepticism toward medical institutions also delay care-seeking. A CDC (2023) study found that 40% of rural adults in the U.S. avoid medical visits due to cost or distance. Minority populations in rural areas, such as African Americans, face disproportionately high poverty levels, further limiting access (USDA, 2023).

To overcome these challenges, innovative solutions are gaining traction. Mobile health clinics have emerged as cost-effective tools for delivering preventive care. Maine's mobile program screened over 5,000 rural patients for chronic conditions and cut emergency room visits by 30% (JAMA Network, 2023). Similarly, tele-health expansion has proven effective, particularly for mental health and acute stroke care. Phone-based counseling reduced depression rates by 35% among rural U.S. women, and Michigan's tele-stroke network saved $12 million annually through faster interventions (NIH, 2023; AHA, 2023).

Community Health Workers (CHWs) have shown remarkable success in bridging access gaps. In rural India, CHWs boosted childhood vaccination rates by 58% (BMJ Global Health, 2022). However, the system remains fragile, as 70% of CHWs globally report burnout due to high workloads and inadequate support (Human Resources for Health, 2023). Expanding and properly supporting such programs is vital for sustainable rural healthcare delivery.

Policy Recommendations

To address the persistent gaps in rural healthcare, a set of strategic, evidence-based policy interventions must be prioritized to improve access, equity, and outcomes. One critical area is workforce development. Incentivizing healthcare professionals to serve in rural regions through loan forgiveness, salary enhancements, and career advancement opportunities has proven effective in countries like Australia under its "Rural Health Multidisciplinary Training Program." Additionally, task-shifting strategies, such as training nurses and mid-level practitioners to lead rural clinics, have expanded service delivery in resource-constrained settings. Canada's Northern Health Authority has successfully implemented this model, enabling communities to receive essential care despite physician shortages.

Technology offers a powerful tool to leapfrog infrastructure deficits. Expanding 5G networks can enable real-time teleconsultations, remote monitoring, and emergency interventions in hard-to-reach areas. Moreover, artificial intelligence (AI)-based diagnostic tools can support frontline workers in disease screening, triage, and maternal care. India's "ARMMAN" initiative demonstrates how AI-powered solutions can guide community health workers in providing safer maternal and child health services.

Cultural alignment is equally crucial. Community-led interventions ensure that health initiatives are rooted in local traditions and beliefs, enhancing trust and participation. Brazil's "Farmácia Viva" program incorporates herbal medicine into primary healthcare, increasing local engagement and sustainability. Faith-based organizations can also play a pivotal role, especially in areas where religious leaders hold strong influence. Successful HIV outreach programs in rural Africa illustrate how such partnerships can overcome stigma and improve health-seeking behavior.

By combining these three pillars, workforce incentives, technological investment, and cultural integration, policymakers can design comprehensive rural health strategies. These should not be isolated projects, but long-term commitments supported by cross-sector collaboration, data-driven evaluation, and adequate funding. Only then can rural populations access the care they need and deserve, contributing to healthier, more resilient communities.

Conclusion

The economic and social case for public health interventions in rural areas is unequivocal. As this analysis highlights, preventive strategies such as clean water access, mobile health services, and community-based care not only yield significant returns on investment but also foster long-term rural resilience. In regions where agricultural labor drives local economies, keeping rural workers healthy is not just a health priority, it is an economic necessity. Yet, persistent structural barriers, workforce shortages, limited insurance coverage, cultural divides, and technological deficits, continue to hinder equitable access to care.

Innovations like telemedicine, AI-driven diagnostics, and community health worker models are proving that rural health solutions can be both cost-effective and impactful. However, these efforts must be scaled thoughtfully, with attention to cultural relevance and the sustainability of frontline services. The success of policy interventions will depend on a commitment to holistic planning: incentivizing rural healthcare providers, upgrading digital infrastructure, and empowering communities to take ownership of their health outcomes.

In an era where rural populations are increasingly vulnerable to climate change, economic shocks, and public health threats, investing in inclusive, preventive healthcare is a strategic imperative. By addressing rural health inequities now, we lay the groundwork for stronger economies, healthier communities, and more just and

sustainable development for generations to come.

References: WHO; HRSA; The Lancet; NIH; UNICEF; World Bank; ILO; Frontiers in Public Health; Kaiser Family Foundation; USDA; JAMA Network; AHA; Human Resources for Health

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Improving Rural Healthcare Against Epidemic Diseases

Addressing epidemic diseases in rural areas requires a multifaceted approach that tackles economic vulnerabilities and healthcare deficiencies. The COVID-19 pandemic highlighted the challenges faced due to limited infrastructure, under-resourced medical services, and fragile local economies.

Maryam Jamil

5/22/2025

Epidemic disease control in rural areas presents a distinct set of economic, logistical, and infrastructural challenges. Rural communities often face limited access to healthcare facilities, shortages of trained medical personnel, and inadequate transport and communication networks. These structural barriers are compounded by poverty, lower health literacy, and high out-of-pocket health expenditures, making rural populations especially vulnerable during epidemics. The COVID-19 pandemic (2020–2023) starkly illustrated these inequalities: according to the World Health Organization (2023), rural regions in low-income countries experienced 30–50% higher mortality rates compared to urban counterparts, largely due to delayed diagnoses, lack of intensive care, and logistical hurdles in vaccine delivery.

Despite these challenges, cost-effective interventions have demonstrated significant promise in closing the rural health gap. Targeted vaccination campaigns, coordinated through local governance bodies and community health workers, can achieve high coverage at lower cost, especially when bundled with existing services like maternal and child healthcare. The expansion of telemedicine has further enabled remote diagnosis, triage, and follow-up care, reducing the need for long-distance travel and easing the burden on under-resourced clinics.

Additionally, community-based disease surveillance systems have proven effective in early outbreak detection. Training local volunteers and utilizing mobile technology for real-time data collection not only enhances epidemic response but also builds local capacity for future health crises. Economically, these approaches are scalable and sustainable, offering high returns on investment through reduced disease burden, improved labor productivity, and lower emergency health spending.

Integrating such strategies into national public health policy, backed by rural-focused budget allocations and economic analysis, can transform epidemic control in marginalized regions. By addressing both the economic and social determinants of health, Pakistan and other developing countries can build a more equitable, resilient rural health infrastructure capable of withstanding future outbreaks.

Economic Challenges in Rural Epidemic Control

Rural regions face disproportionately high risks during epidemics due to deep-rooted economic and healthcare disparities. A critical barrier is the widespread lack of healthcare infrastructure. According to the World Bank (2023), 60% of rural populations in Sub-Saharan Africa and South Asia do not have access to basic primary healthcare facilities. In Pakistan, the rural doctor-to-patient ratio is 1:10,000, starkly contrasting with 1:1,200 in urban centers (Pakistan Medical Association, 2024). These shortages hinder timely diagnosis, treatment, and outbreak containment, allowing diseases to spread more rapidly and severely among rural populations.

In addition to infrastructural deficits, rural economies are highly vulnerable to the economic shocks caused by epidemics. The International Monetary Fund (2023) estimates that pandemics reduce rural GDP growth by 2-4% annually, primarily due to labor shortages, market closures, and the disruption of agricultural value chains. Health shocks exacerbate poverty, with 70% of rural households in India and Pakistan incurring catastrophic healthcare expenditures during outbreaks (Lancet Global Health, 2023). These costs often push families into long-term debt or force them to forgo treatment altogether.

Despite these challenges, cost-effective strategies can significantly mitigate epidemic impacts in rural areas. Targeted interventions such as mobile vaccination units have shown great success; for instance, in Bangladesh, such units raised rural immunization coverage from 62% to 88% between 2020 and 2023 (UNICEF, 2024). Community health workers (CHWs) are another effective solution. In rural Rwanda, CHWs helped reduce malaria cases by 40% through proactive detection and localized treatment (WHO AFRO, 2023). These examples underscore that with strategic investment and grassroots engagement; rural epidemic control can be economically viable and impactful. Scaling such models requires coordinated policy support, improved funding mechanisms, and integration into broader rural development frameworks.

Strengthening Rural Health Systems for Epidemic Resilience

Improving rural health systems is essential for mitigating the disproportionate burden of epidemic diseases on remote and underserved populations. Strategic interventions, especially those tailored to resource-constrained environments, can significantly enhance healthcare delivery, surveillance, and treatment outcomes. Telemedicine is one such

intervention that has revolutionized rural health access. By reducing unnecessary referrals by 50%, it not only saves time and travel costs but also improves clinical efficiency. Economically, telemedicine programs cost between $150 and $300 per life saved, making them a cost-effective solution for geographically isolated regions (BMJ, 2023).

Investments in cold-chain logistics also yield substantial health gains by ensuring vaccine integrity in remote areas. These systems have improved vaccine uptake by 30% and cost approximately $200–$500 per DALY (Disability-Adjusted Life Year) averted, especially in mountainous and hard-to-reach areas (Gavi, 2024). Furthermore, training community health workers (CHWs) has emerged as one of the most scalable and cost-efficient interventions. With an impact cost of just $50–$100 per case prevented, CHW programs enable 25% faster outbreak detection and response (Johns Hopkins University, 2023), especially for diseases like cholera, malaria, and respiratory infections.

Case studies from countries with successful rural health initiatives offer valuable lessons. India's *Mission Indradhanush* achieved 90% full immunization coverage in rural districts by mobilizing Accredited Social Health Activists (ASHAs) and utilizing digital tracking tools. This program delivered a return on investment of $16 per $1 invested by reducing long-term disease burdens (World Bank, 2023). Similarly, Ethiopia's Health Extension Program (HEP), which trained and deployed 40,000 rural health workers, halved child mortality between 2000 and 2023. At an annual cost of just $5 per capita, the benefits exceeded costs by a 9:1 ratio (BMJ Global Health, 2024). These models demonstrate that low-cost, high-impact interventions can fortify rural health systems and improve resilience against future epidemics.

Policy Recommendations for Strengthening Rural Epidemic Preparedness

Effective epidemic control in rural regions requires bold, targeted policy reforms that address funding bottlenecks, technological disparities, and logistical hurdles. Decentralized epidemic financing should be a cornerstone of national health strategies. Allocating at least 5% of health budgets specifically to rural preparedness can ensure timely resource availability for outbreak prevention, detection, and response (UNDP, 2023). This shift from reactive to proactive funding empowers local health authorities to develop context-specific solutions, maintain essential supplies, and sustain disease surveillance systems year-round.

Public-private partnerships (PPPs) also offer scalable models for improving rural health communication. Collaborating with telecom companies to deploy mobile health (mHealth) alerts can bridge the rural-urban information gap during crises. For instance, Pakistan's Sehat Kahani initiative connects rural patients to urban doctors via mobile platforms, providing real-time health guidance and reducing misinformation. Expanding such models nationally can enhance awareness, compliance with health advisories, and vaccination uptake.

Ensuring vaccine equity requires innovation in last-mile delivery. Subsidizing technologies like drone-based transport, modeled on Ghana's Zipline program, can overcome geographic barriers, particularly in mountainous or flood-prone areas. These interventions minimize vaccine spoilage and improve coverage in the hardest-to-reach populations, especially during time-sensitive outbreaks.

Upgrading epidemiological surveillance is equally essential. Integrating AI-driven outbreak prediction models, such as the SORMAS system used by Africa CDC, can enhance early warning capabilities in rural districts. These tools analyze real-time data from health facilities, schools, and community workers to flag anomalies that may signal emerging health threats. Embedding such systems into national disease monitoring frameworks can drastically reduce response time and outbreak severity. Collectively, these policy measures, if implemented with political will and cross-sector collaboration, can build resilient rural health systems capable of managing current and future epidemics with equity, efficiency, and innovation.

Conclusion

The control of epidemic diseases in rural areas demands a multidimensional approach that addresses both economic vulnerabilities and systemic healthcare deficiencies. As evidenced by the COVID-19 pandemic and supported by global case studies, rural communities suffer disproportionately from epidemic shocks due to limited infrastructure, under-resourced medical services, and fragile local economies. However, these challenges are not insurmountable. With well-targeted, cost-effective interventions, such as mobile vaccination campaigns, telemedicine, and the deployment of community health workers, rural health outcomes can be significantly improved.

The economic viability of these strategies is clear: they deliver high returns on investment through disease burden reduction, increased productivity, and lower emergency response costs. Moreover, successful programs in countries like India and Ethiopia illustrate that scalable rural health systems can be built through community engagement, data-driven planning, and sustained public funding.

To institutionalize these gains, strong policy action is essential. Governments must commit to decentralized epidemic financing, foster public-private partnerships, promote vaccine equity through innovative delivery systems, and integrate AI-enabled surveillance into rural health planning. By embedding these measures into national public health strategies, countries like Pakistan can ensure that rural populations are no longer the most vulnerable when epidemics strike, but instead become

resilient, empowered frontlines in the global fight against disease.

References: WHO; World Bank; Lancet Global Health; Gavi; Pakistan Medical Association; International Monetary Fund; UNICEF; WHO AFRO; BMJ; BMJ Global Health; UNDP

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Investing in Agricultural Worker Health Benefits

Investing in agricultural worker health is crucial for ethical and economic reasons. Farmworkers face serious health risks like pesticide poisoning and respiratory illnesses. Every dollar spent on safety can yield $4-7 in returns, improving productivity and reducing healthcare costs.

Zoya Sameer

5/26/2025

Agriculture is a cornerstone of Pakistan's economy, contributing 22.7% to the GDP and employing 37.4% of the labor force (Pakistan Economic Survey, 2022–23). Globally, farming remains a vital sector: more than 1.3 billion people work in agriculture, providing food, fiber, and raw materials to the world (ILO, 2023). Yet, despite its critical importance, agriculture is also among the most hazardous industries. Farmworkers in Pakistan and other low- and middle-income countries routinely face pesticide exposure that can lead to acute poisoning, chronic neurological disorders, and even cancer.

Physical labor often involves repetitive bending, lifting heavy loads, and awkward postures, resulting in high rates of musculoskeletal injuries and chronic back pain. Moreover, field laborers are exposed to extreme temperatures, which can cause heat exhaustion, heatstroke, and dehydration, risks that climate change are only intensifying. Respiratory diseases also remain prevalent, driven by dust inhalation, exposure to agrochemicals, and, in some regions, indoor biomass burning for cooking.

Despite these well-documented hazards, occupational health policies in agriculture are frequently underfunded, poorly enforced, or entirely absent, especially in low- and middle-income countries. In Pakistan, there is no unified framework ensuring pesticide safety training, provision of personal protective equipment, or routine health screenings for rural workers. As a result, agrarian communities often bear the economic burden of lost workdays, reduced productivity, and mounting healthcare expenses. Families may be pushed into poverty due to medical bills or the permanent disability of a breadwinner. For the agricultural sector at large, neglecting worker health erodes long-term sustainability; labor shortages can emerge as younger generations avoid farming careers perceived as dangerous.

Conversely, robust occupational health policies yield substantial benefits. Investing in safety training, regular medical check-ups, and improved working conditions can reduce injury-related costs, boost productivity, and improve morale. When farmers and laborers remain healthy, agricultural output is more consistent, and healthcare systems avoid the strain of preventable ailments. Ultimately, ensuring strong occupational health protections in agriculture is not just a moral imperative, it is an economic necessity for safeguarding both worker well-being and the sector's future viability.

The Economic Toll and Rationale for Occupational Health in Agriculture

Agricultural workers face numerous health risks that translate directly into substantial economic costs. Pesticide exposure alone causes an estimated 385 million acute poisonings each year, with long-term effects ranging from cancer to neurological damage, heavily straining both individuals and healthcare systems (Boedeker et al., 2020). Respiratory diseases such as asthma and chronic obstructive pulmonary disease (COPD), driven by dust and chemical exposure, add another $10 billion in global healthcare costs annually (ILO, 2023). In low- and middle-income countries (LMICs), fewer than 20% of agricultural workers have access to health insurance, forcing families to shoulder steep out-of-pocket medical expenses (World Bank, 2022). When a farmworker falls ill, entire households risk slipping into poverty.

Beyond direct medical expenses, productivity losses and absenteeism impose serious economic burdens. Musculoskeletal disorders (MSDs) afflict between 60% and 90% of farmworkers, reducing their productivity by 15–20% (EU-OSHA, 2022). In tropical regions, heat stress can further diminish labor capacity by the same margin, making it difficult to maintain planting or harvest schedules (Kjellstrom et al., 2021). Absenteeism due to injury or illness costs the U.S. agricultural sector roughly $8 billion annually (NIOSH, 2023); in LMICs, these figures are comparable when adjusted for local market values and productivity levels. Additionally, pesticide-related illnesses alone cost India an estimated $1.1 billion each year in combined healthcare expenses and lost wages (UNEP, 2021). Disability and premature deaths stemming from agricultural hazards reduce GDP growth by 0.5-2% across many LMICs, magnifying the sector's vulnerability (ILO, 2023). Environmental contamination from agrochemicals, meanwhile, inflicts an estimated $200 billion in global public health costs each year (UNEP, 2023), illustrating the wider social consequences that ripple from individual health risks.

Given this landscape, investing in occupational health policies for agricultural workers is not merely a moral imperative but an economic necessity. Provision of personal protective equipment (PPE) and promotion of safer pesticide application methods can reduce poisoning cases by up to 70% (FAO, 2022). Ergonomic interventions, such as redesigned tools

and mechanized assists, can lower MSD treatment costs by 30–50% (EU-OSHA, 2023). Healthier workers consistently deliver higher yields: the World Bank (2023) estimates a 10–25% boost in farm output where comprehensive health measures are in place. Moreover, reducing turnover through safer workplaces saves an average of $4,000 per replaced worker in recruitment and training costs (USDA, 2023). Cost-benefit analyses reveal that every dollar spent on farm safety measures yields $4-7 in economic returns, underscoring the compelling financial rationale (ILO, 2023). In the European Union, implementation of robust occupational health regulations reduced agricultural injuries by 40% since 2010 (Eurostat, 2023), demonstrating that strategic policy interventions can meaningfully lower both human and economic losses. Investing in the health of agricultural workers thus protects livelihoods, strengthens rural economies, and promotes sustainable productivity across the sector.

Addressing Barriers to Agricultural Worker Safety

Small-scale farmers and laborers in low- and middle-income countries confront numerous obstacles to implementing effective occupational health measures. First, limited awareness of hazards leaves many without basic safety knowledge. To overcome this, governments, NGOs, and agricultural cooperatives can partner to deliver targeted training programs. These might include demonstration plots where farmers learn to handle tools ergonomically, and mobile extension services that visit villages to demonstrate proper pesticide mixing, protective clothing, and safe field practices. Incorporating safety modules into existing farmer training, such as micro-loan workshops or seed distribution events, ensures the information reaches even remote communities.

Second, cost constraints prevent roughly 60% of small farms from purchasing personal protective equipment (PPE). Addressing this gap requires creative financing solutions. Local governments can subsidize PPE through voucher schemes, allowing farmers to obtain masks, gloves, and goggles at a fraction of their market price. Microfinance institutions can offer low-interest loans explicitly earmarked for safety equipment, bundled with financial literacy training to ensure loans are used correctly. Agricultural input suppliers might also offer bulk discounts to cooperatives, reducing the unit cost of protective gear.

Third, weak enforcement of safety regulations, where only 30% of countries adequately enforce agricultural safety laws, diminishes compliance. Strengthening enforcement can begin with joint task forces that include labor inspectors, community leaders, and agricultural extension officers. Governments must allocate dedicated funding to train inspectors in rural areas and ensure regular inspections of farms. Incentivizing compliance through public recognition, awards or certifications for "Safety-Compliant Farms", can encourage voluntary adherence even where formal enforcement remains challenging. Penalties for noncompliance should be fair and graduated, coupled with support for farmers to remedy unsafe practices rather than simply imposing fines.

Finally, migrant and seasonal laborers, who make up 80% of the workforce in some regions, rarely have health coverage. To protect these vulnerable workers, policymakers can establish portable insurance schemes that follow laborers seasonally. Employers can be required to contribute to a pooled health fund, enabling migrants to access basic medical care regardless of their location. Mobile health clinics can travel with harvest crews, offering vaccinations, first-aid training, and basic check-ups directly in the fields. Collaborating with local NGOs and faith-based organizations can help raise awareness among migrants about their rights and available health services.

By combining education, financial support, stronger enforcement, and targeted services for migrants, these practical strategies can transform workplace safety in agriculture, improving both worker well-being and long-term sector productivity.

Conclusion

Investing in agricultural worker health is both an ethical obligation and an economic imperative. As this review highlights, farmworkers in Pakistan and other low- and middle-income countries face acute risks, from pesticide poisoning and respiratory illnesses to musculoskeletal injuries and heat stress, resulting in high healthcare costs, lost productivity, and reduced sector resilience. The data are clear: every dollar spent on safety measures can yield $4-7 in return through fewer poisonings, lower treatment expenses, and improved labor capacity.

Yet, widespread barriers persist limited awareness of hazards, prohibitive PPE costs for smallholders, weak regulatory enforcement, and lack of health coverage for migrant laborers. Overcoming these challenges requires coordinated action. Governments, NGOs, and cooperatives must expand safety training and integrate it into existing agricultural programs. Subsidized PPE, microloans for protective gear, and bulk purchasing schemes can make equipment affordable. Strengthened inspection regimes and incentive-based recognition, such as "Safety-Compliant Farm" certifications, can bolster compliance. Portable health insurance and mobile clinics are critical for safeguarding seasonal and migrant workers.

Ultimately, robust occupational health policies not only protect individual workers and their families but also underpin sustainable productivity and rural economic growth. By prioritizing worker safety, Pakistan and similar economies can secure healthier, more motivated labor forces and ensure agriculture remains a viable, resilient backbone of national development.

References: ILO; WHO; World Bank; FAO; Pakistan Economic Survey; Boedeker et al.; EU-OSHA; Kjellstrom et al.; NIOSH; UNEP; USDA; Eurostat

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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GROWTH
GROOMING
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GROWTH
GROOMING
INSIGHTS
82

Protecting Animals During Eid-ul-Azha in Pakistan

As heatwaves in Pakistan intensify, protecting animals during Eid-ul-Azha becomes a vital moral and religious duty. With extreme temperatures risking livestock lives, it's essential to follow Islamic teachings on kindness to animals. Learn more about safeguarding our animals this Eid.

Syed Ibtihaj Ahmed

5/30/2025

Pakistan's increasingly severe heatwaves, with temperatures frequently soaring between 40 °C and 50 °C in provinces such as Sindh, Punjab, and Balochistan (PMD, 2024), impose grave welfare risks on both humans and animals. During Eid-ul-Azha, when millions of goats, sheep, and cattle are concentrated in urban environments for sacrifice, the dangers multiply. Over 20 percent of livestock deaths in Pakistan during summer months are directly attributed to heat stress and associated complications (Pakistan Veterinary Medical Association, 2023).

Dehydration manifests rapidly: goats and sheep subjected to prolonged sun exposure can lose up to 15 percent of their body weight in water within 24 hours, while cattle, especially high-yield dairy breeds, face a higher metabolic heat load, rendering them more susceptible to heatstroke (FAO, 2023). The urban heat island effect further exacerbates conditions in cities like Karachi, Lahore, and Multan, where concrete surfaces and sparse vegetation cause ambient temperatures to rise an additional 2-3 °C, leading to record levels of animal heat exhaustion cases (WWF-Pakistan, 2024).

Transport conditions are also problematic: livestock penned in overcrowded trucks without adequate ventilation can experience internal temperatures exceeding their thermoneutral zone within hours. Once offloaded in holding pens or temporary urban shelters, animals often lack sufficient shade or cooling systems. Moreover, water provision is frequently inadequate; many sacrificial sites rely on intermittent municipal water supplies, causing prolonged thirst. Heat-induced immunosuppression further heightens vulnerability to secondary infections, respiratory and digestive disorders surge as stressed animals' feed intake drops, weakening overall resilience. Urban stray dogs and cats, as well as wild birds forced from natural habitats, tumble into similar predicaments: heatstroke and dehydration have led to spikes in animal rescue calls and wildlife mortality reports during peak summer months.

Mitigating these risks necessitates preemptive measures. Stakeholders must ensure the availability of shaded, well-ventilated holding areas equipped with multiple watering stations, ideally supplemented by misting fans or evaporative cooling pads. Transport vehicles should be retrofitted with insulated roofs and side openings to maintain air circulation during transit. Veterinary services need to establish mobile response units at large sacrifice centers to monitor animal health, administer electrolyte solutions, and provide on-the-spot cooling interventions such as cold-water hosing for heat-stricken livestock. By implementing such strategies, Pakistan can significantly reduce heat-related animal distress and mortality during critical summer periods.

Islamic Teachings on Animal Welfare During Eid-ul-Azha

Islamic teachings consistently emphasize compassion and mercy toward animals, especially during Eid-ul-Azha when countless believers perform sacrificial rites. The Prophet Muhammad (PBUH) declared, "Whoever is kind to Allah's creatures, Allah will be kind to him" (Sahih Bukhari), underscoring that kindness to animals reflects one's faith. Additionally, he instructed, "Do not treat animals harshly; slaughter with kindness" (Sunan Ibn Majah), guiding Muslims to ensure that the act of sacrifice is swift and minimally distressing. These directives establish that Eid-ul-Azha transcends mere ritual: it mandates ethical treatment, responsible care, and the avoidance of unnecessary suffering.

Accordingly, the Pakistan Islamic Ideology Council (2023) has issued practical guidelines to uphold these values. Owners are urged to provide adequate shade and clean water prior to sacrifice, acknowledging that, in Pakistan's extreme heat, dehydration and overheating can cause severe distress. Animals should not be overcrowded in confined enclosures; rather, sufficient space allows them to remain calm and reduces the risk of trampling or panic. When the time for sacrifice arrives, using sharp, clean knives is essential to achieve an immediate severance of major blood vessels, minimizing pain and ensuring a quick loss of consciousness. Moreover, it is recommended to position the animal facing the Qibla, recite "Bismillah Allahu Akbar," and perform the cut with a single, unhesitating stroke. Any hesitation or multiple cuts contradicts the principle of a merciful sacrifice.

Beyond procedural norms, Islam also forbids sale of live animals in markets under the blazing sun without water and rest and condemns capture of stray animals for ill-treatment. Communities are encouraged to organize designated, hygienic sacrifice sites away from residential areas, staffed by trained handlers and veterinarians who can monitor animal health, administer electrolytes if need, and intervene promptly if distress arises. By adhering to prophetic guidance and institutional

recommendations, Eid-ul-Azha becomes an expression of devotion that honors both divine command and the sanctity of animal life.

Recognizing and Managing Heatstroke and Dehydration in Animals

Heatstroke and dehydration can strike animals quickly under intense summer conditions, so caregivers must remain vigilant for early warning signs. An animal suffering from severe dehydration often exhibits a dry nose and sunken eyes, indicating excessive fluid loss. Excessive panting, drooling, or lethargy are clear indicators that an animal is struggling to regulate its body temperature. Loss of appetite and generalized weakness further suggest the animal is in distress. To confirm dehydration, perform a simple skin-tenting test: gently pinch the skin between the shoulder blades and release it. If the skin does not snap back into place immediately, this delayed response signals that the animal's fluid levels are dangerously low.

If heatstroke is suspected, immediate first aid can be lifesaving. Move the animal to a shaded or ventilated area without delay. Encourage the animal to take small sips of cool water; adding an oral rehydration solution (ORS) or a pinch of salt and sugar can help replace lost electrolytes. To lower body temperature, apply wet towels around critical areas, especially the ears, neck, and legs, while avoiding the use of ice-cold water, which may shock the animal's system and worsen its condition.

Preventive measures play an equally crucial role in protecting animals from heat-related emergencies. Provide ample shade using tarps, jute sacks, or temporary shelters that block direct sunlight. To enhance evaporative cooling, wet the surrounding ground so that animals can lie on cooler surfaces. Ensuring proper airflow, whether through open-sided shelters or electric fans, helps reduce ambient temperatures. Hydration must be continuous: place multiple water bowls in shaded spots and change the water frequently to maintain a cool supply. Birds, in particular, benefit from shallow dishes placed at height to protect them from ground predators while they drink.

Adjust feeding practices to support hydration. Offer water-rich foods such as cucumber slices, watermelon rinds, or soaked fodder, and avoid heavy grains during peak heat hours between 10 AM and 4 PM. Mint-infused water or lemon-salt water can act as refreshing hydrators. During the hottest part of the day, refrain from walking or feeding animals; instead, schedule these activities for early morning or late evening. Do not tether animals in direct sunlight and keep living spaces clean by removing waste daily to prevent flies and infections. Sprinkling neem leaves around shelters serve as a natural insect repellent.

Special consideration should be given to stray animals, following the Prophet Muhammad's (PBUH) example of compassion. Placing water bowls outside homes or community centers allows strays to hydrate. Unseasoned leftover food can offer much-needed nourishment. Community efforts, such as mosques and welfare groups establishing animal cooling stations, can significantly reduce heat-related suffering. Simple home remedies also offer relief: hanging wet jute sacks near shelters encourages evaporative cooling, and wiping animals with damp cloths, particularly around the ears and underbelly, helps lower their body temperature. By recognizing early warning signs, administering prompt first aid, and implementing practical cooling strategies, caregivers can safeguard animals from the dangers of heatstroke and dehydration.

Government and NGO Initiatives in Pakistan

In response to escalating heatwave conditions, the Punjab Livestock Department (2024) has instituted a series of advisories aimed at guiding farmers through extreme temperature events. These advisories emphasize the importance of providing additional shades such as temporary canopy structures over animal enclosures, and suggest adjusting feeding schedules to cooler parts of the day. Farmers are encouraged to monitor their herds for early signs of heat stress, including rapid breathing, drooping ears, and reduced feeding intake. The Department also distributes pamphlets detailing the preparation of simple electrolyte solutions, ensuring that livestock can maintain hydration when water sources become scarce. Extension officers travel to rural districts, demonstrating low-cost techniques such as constructing mud walls around animal pens to lower ambient temperatures and using gel packs or damp cloths as localized cooling aids.

Meanwhile, WWF-Pakistan has advocated for the establishment of urban animal shelters to protect both stray and domestic animals from the urban heat island effect. Through partnerships with municipal authorities, WWF has identified vacant warehouses and large public halls that can be retrofitted with ventilation fans and insulated roofing materials. Volunteers and veterinary students staff these shelters, offering routine health checks and administering oral rehydration solutions. Educational campaigns organized by WWF encourage communities to install shaded water stations outside homes and parks so that animals on the streets have reliable access to clean water. Additionally, WWF connects local veterinarians with community leaders to coordinate mobile animal care units, which periodically patrol neighborhoods to distribute water bowls, conduct medical triage, and relocate severely heat-stressed animals to cooler environments.

Civil society organizations such as the Edhi Foundation and Al-Khidmat have also launched free, temporary water stations across major cities like Karachi, Lahore, and Peshawar. These stations, set up at strategic intervals along busy roadways and in underserved urban

slums, consist of large water tanks with multiple troughs lowered to ground level so that stray dogs, cats, and birds can drink without disturbance. Trained volunteers refill these tanks twice daily, early morning and late afternoon, to ensure the supply remains cool. Al-Khidmat teams go further by distributing inexpensive “cooler boxes” filled with ice packs near high-traffic animal areas and providing awareness leaflets in local languages about how citizens can create their own low-cost watering points. Edhi ambulances are on standby for animal rescue calls, transporting dehydrated or heat-afflicted animals to partner clinics for emergency care. Collectively, these government and NGO efforts create a multilayered safety net, combining proactive advisories, dedicated shelters, and community-based water relief points to alleviate the impact of Pakistan’s brutal summer heat on vulnerable animal populations.

Conclusion

As Pakistan faces intensifying heatwaves, protecting animals during Eid-ul-Azha is both a moral obligation and a religious duty. Extreme temperatures exceeding 40-50°C (PMD, 2024) pose life-threatening risks to livestock, with 20% of summer livestock deaths linked to heat stress (Pakistan Veterinary Medical Association, 2023). Islamic teachings mandate mercy, Prophet Muhammad (PBUH) urged kindness to animals, emphasizing that "a good deed done to a living creature is as meritorious as one done to a human" (Sahih Muslim).

Practical measures, shade, hydration, and cooling interventions can save lives. Government and NGO initiatives, such as Punjab’s livestock advisories and WWF’s urban shelters, provide critical support, but community action is paramount. Placing water bowls, using wet jute sacks for cooling, and avoiding midday exposure are simple yet impactful steps.

This Eid let us honor the spirit of sacrifice by ensuring no animal suffers unnecessarily. By combining Islamic ethics, scientific care, and collective effort, we can transform Eid-ul-Azha into a model of compassionate stewardship, aligning ritual with responsibility for all of Allah’s creations.

References: PMD; FAO; Pakistan Veterinary Medical Association; WWF-Pakistan; Islamic Ideology Council of Pakistan; Punjab Livestock Department

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