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SUSTAINABLE FUTURES

CLIMATE ACTION, FOOD SECURITY, AND RURAL RESILIENCE

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September Focus: Climate Action, Food Security, and Rural Resilience

As we celebrate September's world days, we recognize their interconnectedness in building a sustainable future. From the ozone layer to bamboo's resilience, and the importance of food security, these observances highlight our collective responsibility in addressing global challenges.

Muhammad Khalid Bashir

9/1/2025

September offers the world a reflective pause, a chance to revisit our commitments to climate action, food security, and human well-being through globally recognized observances such as International Day for the Preservation of the Ozone Layer (September 16), World Bamboo Day (September 18), International Day of Peace (September 21), World Tourism Day (September 27), and the International Day of Awareness on Food Loss and Waste Reduction (September 29). For agriculture, these observances are not just symbolic dates; they carry urgent relevance to the lives of billions who depend on farming and food systems for sustenance, employment, and prosperity. This month, The Agricultural Economist turns its spotlight to the intersection of climate action, food systems, and rural resilience under the theme: *"Sustainable Futures: Climate Action, Food Security, and Rural Resilience."*

Agriculture remains the backbone of many economies, particularly in developing regions, but it also stands at the frontline of the climate crisis. Extreme weather, shifting rainfall patterns, pest invasions, and resource depletion threaten both yields and livelihoods. Yet, agriculture is not merely a victim, it is also a driver of change. With the right innovations, policies, and community-driven strategies, farming can transition from being a climate challenge to becoming a cornerstone of climate solutions.

Climate Action Through Agriculture

The preservation of the ozone layer reminds us that global action can yield results. Decades ago, humanity came together under the Montreal Protocol to curb harmful emissions. Today, we face a similar call: to reduce agricultural emissions and adapt to climate change. Agriculture contributes approximately one-quarter of global greenhouse gas emissions, with livestock, rice cultivation, and fertilizer misuse as key sources. However, through climate-smart agriculture, agroforestry, soil carbon sequestration, and renewable energy adoption, farming communities can help mitigate emissions while enhancing productivity.

In rural Pakistan, India, and across Africa, smallholders are adopting solar-powered irrigation, reducing dependence on diesel pumps, while biofertilizers and integrated pest management are lowering reliance on chemicals. These practices not only reduce emissions but also make farms more resilient to external shocks. The challenge, however, lies in scaling such solutions. Without adequate finance, infrastructure, and policy support, these initiatives remain isolated success stories rather than mainstream practices.

Bamboo, Biodiversity, and Rural Livelihoods

September 18, World Bamboo Day, highlights an often-overlooked ally in sustainable agriculture and rural development. Bamboo is more than a plant; it is a climate warrior. With its rapid growth, carbon sequestration potential, and versatility, bamboo offers solutions for both environmental and economic challenges. In countries like Ethiopia and India, bamboo is being promoted as a sustainable alternative to timber, while in rural Asia, it supports cottage industries ranging from handicrafts to furniture. Its role in soil conservation and erosion control is particularly valuable in fragile ecosystems.

For rural economies, bamboo farming presents opportunities for diversification. Smallholders can cultivate bamboo alongside staple crops, creating dual income streams while contributing to reforestation and carbon neutrality goals. Encouraging bamboo-based value chains could transform rural livelihoods while simultaneously addressing climate and biodiversity challenges.

Peace, Food Security, and Resilience

The International Day of Peace (September 21) serves as a reminder that food security and peace are deeply intertwined. Food insecurity often fuels unrest, while conflict disrupts farming, displaces rural populations, and destabilizes entire food systems. From Syria to South Sudan, conflict-driven hunger has become one of the most pressing humanitarian crises. But even outside war zones, inequality in land rights, lack of access to credit, and exclusion of women farmers create conditions for social tension.

Building peace requires building resilient agricultural systems. Community-based resource management, inclusive rural finance, and equitable access to land and water are critical. Moreover, food sovereignty, where communities have control over their own food systems, offers a pathway to both empowerment and peace. Resilient food systems reduce vulnerabilities and strengthen communities against the shocks of climate change, market volatility, and conflict alike.

Agro-Tourism: Linking Rural Development and Sustainability

World Tourism Day (September 27) invites us to rethink tourism beyond beaches and monuments, toward rural landscapes where agriculture, culture, and sustainability converge. Agro-tourism, or farm-based tourism, is gaining global

traction as travelers increasingly seek authentic, eco-friendly experiences. From vineyard tours in Europe to rice paddy stays in Southeast Asia, agro-tourism is reshaping rural economies by creating new income streams for farmers, reducing urban-rural divides, and promoting cultural preservation.

In Pakistan and India, agro-tourism has the potential to showcase traditional farming practices, handicrafts, and local cuisine while empowering women and youth. Moreover, agro-tourism aligns with sustainable development goals by promoting rural entrepreneurship, preserving biodiversity, and raising awareness about climate-friendly farming practices. It can serve as a vital bridge between rural and urban communities, fostering greater appreciation of the role farmers play in securing food and environmental security.

Tackling Food Loss and Waste

Perhaps the most urgent agricultural theme this September is the International Day of Awareness on Food Loss and Waste Reduction (September 29). Globally, one-third of food produced is lost or wasted annually, enough to feed 1.26 billion people. In Pakistan alone, nearly 26% of fruits and vegetables perish before reaching markets due to inadequate storage and transport facilities. Food loss not only undermines food security but also squanders water, energy, and land resources.

Solutions require both technological and behavioral shifts. Cold-chain infrastructure, better packaging, and improved logistics are critical investments. At the same time, consumer awareness campaigns, food redistribution systems, and value-added processing (such as turning surplus mangoes into jams or dried products) can help reduce waste. Policy frameworks that incentivize efficiency across value chains, from farm to fork, are essential.

The fight against food waste is not just about saving food, it is about saving livelihoods, conserving ecosystems, and mitigating climate change. By cutting food waste in half, Pakistan could significantly reduce its agricultural emissions while improving nutritional outcomes.

Public-Private Partnerships for Transformation

Best restaurants near me

None of these solutions, whether bamboo farming, climate-smart agriculture, or food waste reduction, can succeed in isolation. What is needed is a multi-stakeholder approach involving farmers, governments, businesses, and civil society. Public-private partnerships (PPPs) can accelerate change by pooling resources and expertise. For instance, telecom companies offering SMS-based advisories, or food companies investing in cold-chain facilities, can dramatically scale the reach and impact of agricultural innovations.

Similarly, international collaboration is vital. Just as the Montreal Protocol successfully united nations to protect the ozone layer, global cooperation can help drive climate-resilient agriculture. Shared data platforms, joint research initiatives, and technology transfers can ensure that even the smallest farmers benefit from the global knowledge economy.

A Call for Inclusive Growth

At the heart of September's theme lies the principle of inclusivity. Rural resilience cannot be achieved if women, who make up nearly half of the agricultural labor force in many countries, remain excluded from access to land, finance, and technology. Nor can climate action succeed without engaging youth, who represent the future of farming. Creating pathways for young entrepreneurs in agri-tech, agro-tourism, and climate-smart value chains is critical to building a sustainable future.

Governments must also take bold steps in policy design, expanding subsidies for climate-smart tools, introducing tax breaks for green technologies, and integrating climate risk assessments into agricultural planning. Farmers, too, must be empowered with training and access to information, ensuring they are not passive recipients but active agents of change.

Closing Reflections: Towards a Sustainable Future

As we mark September's world days, we must view them not as isolated observances but as interconnected pillars of a sustainable future. The ozone layer reminds us of the power of collective action in solving global crises. Bamboo symbolizes resilience and versatility in nature. Peace underscores the social dimensions of food security. Tourism highlights opportunities for sustainable rural economies. And food waste reduction calls attention to the urgent need for efficiency and responsibility in our food systems.

Agriculture, as the nexus of climate, livelihoods, and nutrition, holds the key to addressing these global challenges. By embracing innovation, inclusivity, and sustainability, we can transform food systems into engines of resilience and prosperity. The road is not easy, barriers of infrastructure, finance, and capacity remain formidable. But the rewards are profound: a world where farmers thrive, ecosystems regenerate, and future generations inherit not scarcity but abundance.

The challenge before us is to translate this vision into action. Let September be a month not just of awareness but of commitment, commitment to climate action, food security, and rural resilience. Only then can we truly secure sustainable futures for people and the planet.

Regards,
Muhammad Khalid Bashir
Managing Editor
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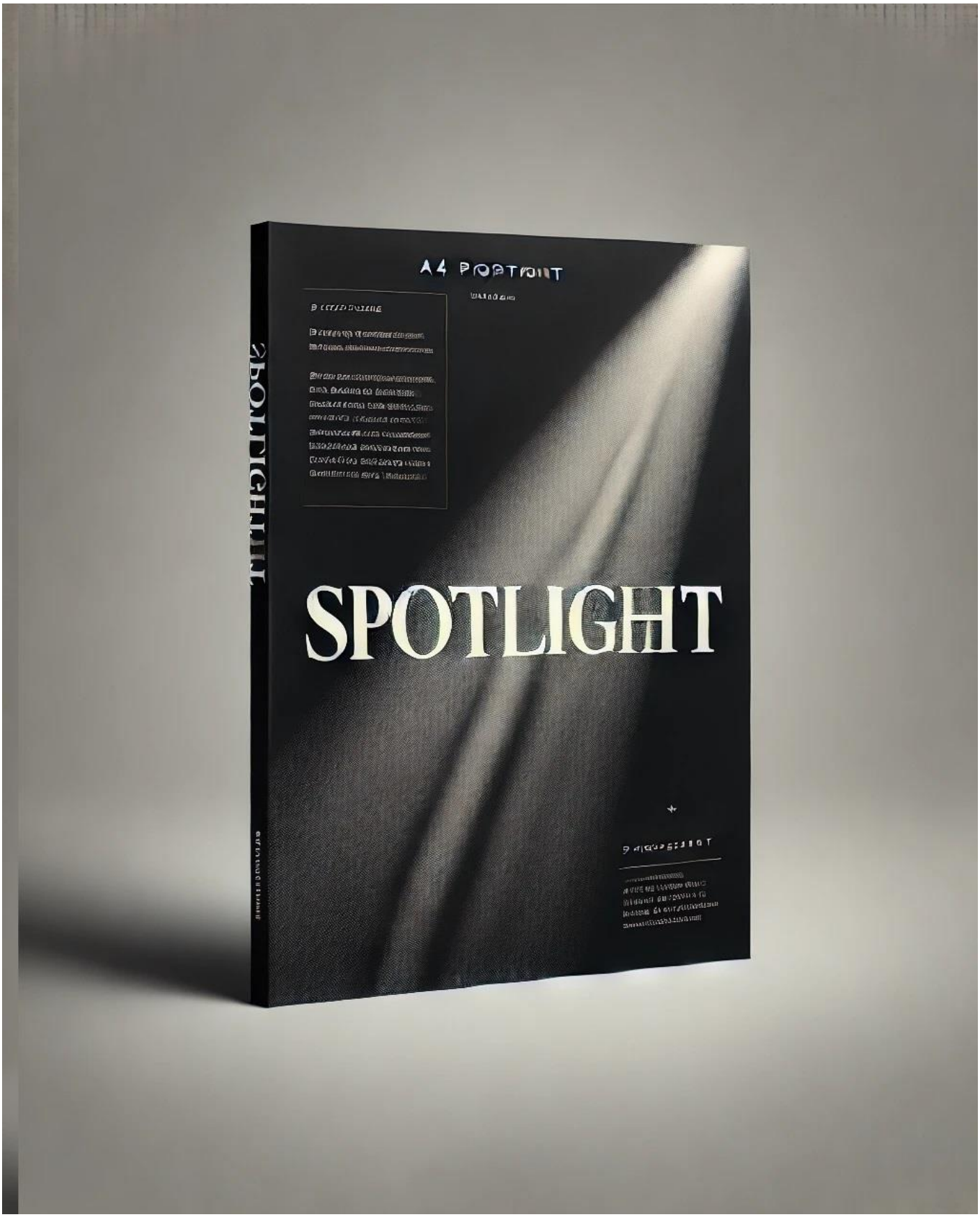
SPOTLIGHT

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Macroeconomic Policy's Impact on Land Sustainability

Explore the profound relationship between macroeconomic policy and land sustainability. Discover how economic decisions, subsidies, and trade agreements influence land management practices, often lead to soil degradation, reduced biodiversity, and accelerate unsustainable land conversion.

Nabeeha Tahir

9/4/2025

Macroeconomics, traditionally concerned with indicators such as GDP growth, inflation, and employment, exerts influence that reaches well into environmental systems. Decisions made at the level of fiscal policy, trade regulation, and monetary management shape incentives that drive how land is used and conserved. Soil degradation, deforestation, and unsustainable land conversion are not isolated environmental issues, they are deeply entwined with economic choices. Subsidies for specific crops or industries, for instance, can encourage intensive cultivation or expansion into marginal lands, accelerating soil erosion and loss of fertility. Similarly, trade liberalization may incentivize export-oriented monocropping, undermining biodiversity and increasing vulnerability to pests, disease, and climate shocks.

Land use change is particularly sensitive to macroeconomic signals. When credit policies, taxation, or infrastructure investments favor short-term profit over sustainable management, farmers and corporations may overexploit land, draining its ecological capital. Even seemingly neutral policies, such as broad economic stimulus programs or industrial incentives, can indirectly pressure forests, wetlands, and agricultural landscapes. The resulting environmental externalities, erosion, salinization, and loss of organic matter, feed back into the economy through reduced agricultural productivity, higher disaster recovery costs, and increased social vulnerability.

Addressing these challenges requires a recalibration of macroeconomic frameworks to integrate environmental stewardship as a core objective. Policies should align incentives with sustainable land management, such as redirecting subsidies toward conservation agriculture, implementing market-based mechanisms for ecosystem services, and embedding ecological risk assessment in trade and fiscal planning. By explicitly recognizing the environmental consequences of macroeconomic choices, governments can transform the economic-land nexus from a driver of degradation into a pathway for resilient, productive, and sustainable landscapes.

Macroeconomic Policies and Land Degradation: Unintended Consequences of Growth

National and international economic policies shape land use decisions in profound ways, often producing long-term environmental consequences. Efforts to promote agricultural exports, achieve food security, or drive urban and industrial expansion create incentives that prioritize short-term economic gains over soil health and ecosystem integrity. Subsidies are a key mechanism in this dynamic. Globally, agricultural subsidies amount to roughly $700 billion annually, with around $470 billion considered price-distorting and potentially harmful to the environment (OECD, 2023). These subsidies encourage monoculture systems and the intensive use of chemical fertilizers and pesticides, which maximize immediate yields but undermine soil fertility, reduce biodiversity, and accelerate land degradation. Commodities such as soy and palm oil, produced under such incentive structures, have driven deforestation at alarming rates, with approximately 10 million hectares of forest lost annually between 2015 and 2020, primarily for agricultural expansion (FAO, 2022).

Trade liberalization further compounds the problem. International agreements and export-oriented policies pressure countries, especially developing economies, to increase production for global markets. The urgency to compete internationally often overshadows sustainable practices, resulting in overexploitation of land resources and deferred investment in soil conservation measures. While these strategies may boost short-term economic performance, they heighten long-term vulnerability to soil degradation and reduce agricultural productivity.

Soil degradation is now a global crisis with direct implications for food security and ecosystem health. Over 33% of the world's soil is already degraded, and projections suggest that more than 90% could be compromised by 2050 if current practices continue (UNCCD, 2022). Erosion, driven by intensive tillage and loss of vegetative cover, removes 24 billion tonnes of fertile soil annually, often 10 to 40 times faster than natural replenishment (Borrelli et al., 2020). Continuous cropping without replenishing organic matter depletes soil structure and water retention capacity, while overuse of pesticides and fertilizers contaminates soil and waterways, undermining both biodiversity and human health.

Land use changes intensify these effects. Deforestation for agriculture or urban expansion destabilizes soils, increases erosion risk, and releases carbon, contributing to climate change. Urbanization and soil sealing, through the spread of concrete and asphalt, permanently remove fertile land from productive and ecological functions; in the EU, soil sealing eliminates areas larger than Berlin annually (European Commission, 2021), pushing agriculture onto marginal lands. Industrialization,

including mining and heavy manufacturing, disrupts soil structure and contaminates land, leaving large tracts unfit for productive use.

The cumulative impact of macroeconomic policies, trade pressures, and land use change underscores the urgent need to integrate environmental considerations into economic decision-making. Without proactive measures, economic growth continues to drive soil degradation, jeopardizing both food security and long-term sustainability.

Pathways to Sustainable Solutions: Aligning Macroeconomics with Ecological Stewardship

Addressing the intertwined crises of soil degradation and unsustainable land use requires a fundamental realignment of economic policy to prioritize regeneration over extraction. Reforming subsidies is a critical first step. Globally, roughly $470 billion in environmentally harmful agricultural subsidies could be redirected toward payments for ecosystem services, conservation agriculture, and agroecological practices. Incentivizing methods such as cover cropping, agroforestry, crop rotation, and organic farming strengthens soil structure, enhances biodiversity, and improves long-term farm resilience (IPES-Food, 2021).

True-cost accounting must be integrated into macroeconomic decision-making. Policies and incentives should reflect the full environmental and social costs of production, including soil degradation, water pollution, carbon emissions, and loss of ecosystem services. By internalizing these costs, governments can guide economic actors toward practices that sustain long-term productivity while minimizing ecological harm.

Strengthening governance and spatial planning is equally essential. Rigorous Environmental Impact Assessments (EIAs) for large-scale agricultural, urban, and industrial projects should be mandatory. Complementary zoning laws can protect high-quality agricultural land and critical ecosystems from encroachment, balancing economic growth with ecological preservation.

Promoting circular economic approaches in agriculture provides practical pathways for sustainability. Organic waste, crop residues, and livestock byproducts can be returned to the soil as compost, closing nutrient loops and reducing dependence on synthetic fertilizers. Such circular practices simultaneously conserve resources, reduce pollution, and enhance soil fertility.

Finally, international cooperation is indispensable. Global trade agreements should incorporate enforceable environmental clauses to discourage deforestation, overexploitation, and soil-degrading production methods. Multilateral platforms can also facilitate technology transfer, capacity building, and financing for sustainable land management (SLM), particularly in developing nations where pressures on land are acute.

By integrating these strategies, macroeconomic policy can transform from a driver of degradation into a mechanism for ecological stewardship, ensuring that agricultural development, economic growth, and environmental sustainability reinforce rather than undermine one another.

Conclusion

The relationship between macroeconomic policy and land sustainability is both profound and consequential. Economic decisions made at national and international levels, through subsidies, trade agreements, credit policies, and infrastructure investments, directly influence how land is used and managed. When these policies prioritize short-term economic gains, they often drive practices that degrade soil, reduce biodiversity, and accelerate unsustainable land conversion. Monoculture farming, intensive chemical inputs, and deforestation, frequently incentivized by trade and fiscal policies, contribute to erosion, loss of organic matter, and contamination, undermining the very resources that underpin long-term agricultural productivity and food security.

Addressing these challenges requires a systemic recalibration of macroeconomic frameworks. Redirecting environmentally harmful subsidies toward conservation agriculture, agroforestry, and ecosystem services can realign incentives with regenerative practices. True-cost accounting ensures that policies reflect the full ecological and social costs of production, making degradation economically visible. Strengthened governance, including rigorous environmental assessments, zoning protections, and participatory land-use planning, is essential to prevent uncontrolled urbanization, industrial encroachment, and deforestation. Circular economy approaches in agriculture, returning organic waste to soil and closing nutrient loops, enhance soil fertility while reducing dependence on synthetic inputs.

International cooperation further amplifies these efforts, embedding enforceable environmental standards into trade agreements and supporting the transfer of sustainable land management technologies. By integrating ecological considerations into macroeconomic planning, governments can shift the economic-land nexus from a driver of degradation to a pathway for resilience. This holistic approach ensures that economic growth, agricultural development, and environmental sustainability are mutually reinforcing, securing productive landscapes for current and future generations.

References: Borrelli et al.; FAO; IPBES; IPES-Food; OECD; UNCCD; European Commission; World Bank

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

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Climate Risks Impacting Pakistan's Agriculture

Explore the unprecedented climate-related challenges facing Pakistan's agriculture, including rising temperatures, erratic rainfall, and the devastating impact of floods. Discover how these factors threaten food security, disrupt livelihoods, and affect economic stability in the region.

Samreen Kanwal

9/9/2025

Climate change, driven by rising global temperatures, escalating greenhouse gas emissions, and the extensive reliance on fossil fuels, represents an existential threat to agriculture worldwide. For Pakistan, the stakes are particularly high. The country consistently ranks among the nations most affected by climate-induced disasters, placing 5th on the Global Climate Risk Index 2021 (Eckstein et al., 2021). This ranking underscores the acute vulnerability of Pakistan's ecosystems, communities, and economy to extreme weather events, including floods, droughts, heatwaves, and cyclones.

Pakistan's economy remains deeply dependent on agriculture, which employs over 37.4% of the national labor force and contributes 22.9% to GDP (GoP, 2023). The sector's reliance on predictable weather patterns makes it exceptionally sensitive to climatic fluctuations. Altered monsoon cycles, intensified heatwaves, and increasing frequency of cyclones have already disrupted rain-fed and irrigated farming systems, reducing yields of staples such as wheat, rice, and maize. Floods, like those witnessed in 2022, not only destroyed crops and arable land but also caused severe soil erosion, nutrient depletion, and long-term degradation, threatening future productivity.

Beyond physical losses, climate change imposes economic burdens. Higher temperatures and erratic precipitation patterns increase irrigation demands, fertilizer needs, and pest management costs, raising the cost of production while squeezing farmer incomes. Smallholder farmers, who dominate Pakistan's agricultural landscape, are particularly exposed, lacking the resources or technical capacity to adapt rapidly.

Addressing these challenges requires a multi-pronged approach: investment in climate-resilient crop varieties, modernization of irrigation systems, improved water management, and the integration of early warning and advisory services. By embedding climate adaptation into agricultural planning and policy, Pakistan can safeguard food security, stabilize rural livelihoods, and maintain the economic contributions of its vital agricultural sector even in the face of mounting climatic pressures.

The Impact of Climate Change on Pakistan's Agricultural Economy

Pakistan's agricultural sector is particularly vulnerable to climate variability due to its reliance on extensive irrigated systems, covering approximately 18.63 million hectares, predominantly in Punjab (PBS, 2023). These systems, alongside traditional practices like spate irrigation, sustain both Rabi (winter) and Kharif (summer) crops, forming the backbone of national food security and rural livelihoods. Yet, the sector's heavy dependence on water renders it highly sensitive to climatic shifts. Rising temperatures accelerate glacial melt in the northern mountains, which, combined with increased evaporation and higher crop water requirements, exacerbate water scarcity. Paradoxically, the country also faces extreme flooding events. The 2022 floods, which submerged nearly a third of Pakistan, exemplify this dual threat, causing an estimated $3.7 billion in agricultural damages, destroying standing crops, and depositing silt that rendered arable land infertile (World Bank, 2022).

The impact of climate change extends across all major crops. Wheat and rice, the nation's primary staples, are especially vulnerable. Projections indicate a potential temperature rise of 3°C by 2040 and 5–6°C by the end of the century (IPCC, 2022), which could reduce wheat yields by 14.7% and rice yields by 20.5% due to heat stress and water scarcity (Abbas et al., 2023). Maize, cotton, and sugarcane are similarly threatened, with sugarcane production alone expected to decline by 8–10% under projected climate scenarios (Ali et al., 2022). These reductions not only diminish domestic food availability but also constrain exportable surpluses, weakening the sector's contribution to the national economy.

The broader implications for food security are severe. Climate-induced crop losses and infrastructure damage disrupt supply chains, inflate prices, and push vulnerable communities toward poverty and malnutrition. During the peak of the 2022 flood crisis, over 36% of Pakistan's population experienced acute food insecurity (WFP, 2023). This rising vulnerability underscores the urgent need for climate adaptation strategies, including resilient crop varieties, efficient irrigation technologies, robust early warning systems, and strengthened disaster management frameworks. By proactively integrating these measures, Pakistan can protect agricultural productivity, stabilize rural livelihoods, and mitigate the economic and social consequences of climate change on its critical agricultural sector.

Strategies for Adaptation and Building Resilience

Addressing the mounting challenges posed by climate change in Pakistan's agriculture demands a comprehensive, multi-dimensional strategy that integrates technological, economic, and institutional measures. Central to this approach is the promotion of Climate-Smart Agriculture (CSA), which seeks to enhance productivity while conserving resources and reducing vulnerability. Technological

innovation is critical, particularly the development and dissemination of drought-resistant, heat-tolerant, and early maturing crop varieties, such as stress-tolerant strains of wheat and rice, which can sustain yields under extreme weather conditions. Precision farming techniques, including drip and sprinkler irrigation, offer a significant opportunity to optimize water use, cutting consumption by 30–50% compared to traditional flood irrigation methods (Qureshi, 2021), while simultaneously improving soil health and nutrient efficiency.

Economic and institutional measures are equally essential to bolster resilience. Crop diversification into less water-intensive and climate-resilient crops such as pulses, legumes, and orchards can reduce dependency on vulnerable staples and spread economic risk for farmers. Complementing this, index-based climate insurance schemes can provide financial safety nets, mitigating income losses from floods, droughts, or unseasonal weather events. Policy and investment support further amplify these efforts. Dedicated R&D funding can advance climate-resilient technologies, extension services can bridge knowledge gaps by educating farmers on sustainable practices, and market incentives can encourage the adoption of eco-friendly production methods.

Water resource management forms a critical pillar of adaptation strategies. Investments in large-scale water storage, harvesting rainwater, and modernized canal networks reduce losses from seepage and evaporation. Equitable water distribution policies and community-led management of local water resources can ensure that both irrigated and rain-fed systems remain productive even under constrained conditions. By combining CSA, economic safeguards, and robust water management, Pakistan can enhance the adaptive capacity of its agricultural sector, safeguard rural livelihoods, and maintain food security in an increasingly unpredictable climate.

Conclusion

Pakistan's agriculture faces an unprecedented confluence of climate-related risks that threaten both food security and economic stability. Rising temperatures, erratic precipitation, and extreme weather events, exemplified by the catastrophic 2022 and 2025 flash floods, have highlighted the sector's vulnerability, from water scarcity and soil degradation to reduced yields in staple and cash crops. These challenges not only disrupt livelihoods for millions of smallholder farmers but also amplify production costs and constrain the country's capacity to maintain domestic supply and exportable surpluses. The consequences extend beyond the farm gate, affecting national food prices, rural incomes, and socio-economic resilience.

Addressing these vulnerabilities requires a coordinated, multi-layered response. Climate-smart agriculture, including drought- and heat-tolerant crop varieties, precision irrigation, and diversified cropping systems, provides a pathway to maintain productivity under changing conditions. Economic and institutional measures such as index-based insurance, targeted subsidies, and market incentives can mitigate financial risks for farmers. Strategic investments in water resource management, infrastructure modernization, and community-led governance further strengthen adaptive capacity.

Ultimately, Pakistan's ability to safeguard its agricultural sector hinges on integrating these strategies into policy and practice. Proactive adaptation can preserve crop yields, stabilize rural livelihoods, and ensure national food security despite climate pressures. By embracing innovation, resilience, and sustainable management, Pakistan can transform climate challenges into opportunities, securing both the economic and ecological foundations of its vital agricultural economy for future generations.

References: Abbas et al.; Ali et al.; Eckstein et al.; Government of Pakistan; IPCC; PBS; Qureshi; World Bank; WFP

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Seeds: Türkiye's Genetic Homeland in Agriculture

Explore the rich history and potential of seeds in Türkiye, a genetic homeland that connects past harvests with future possibilities. Discover the evolution from traditional seed practices to modern seed industry.

Mithat Direk

9/12/2025

Life begins with a tiny seed marvel that contains within it the genetic blueprint of an entire plant. This silent capsule of life is the true foundation of agriculture, and by extension, of human civilization and food security. For thousands of years, farming communities understood this instinctively. Nowhere is this legacy more visible than in Anatolia, one of the cradles of agriculture, where the earliest farmers practiced seed saving. They carefully observed their fields, choosing the healthiest plants and saving their grains for the next season. This continuity ensured resilience, adaptation, and a living link between generations.

The image of the family "seed bucket," lovingly filled each year with carefully preserved seeds, carries more than nostalgia. It symbolizes self-reliance, community knowledge, and a deep respect for the cycles of nature. Farmers knew that the seed they saved was not just food for the next harvest but a promise of continuity for their families and villages. Plants chosen for seed were left unharvested until maturity, ensuring strong genetic traits were passed on. This traditional seed culture-built diversity and resilience into local farming systems.

Yet, much of this heritage has been eclipsed in the last fifty years. The global seed industry has professionalized, transforming seeds into commercial products. Farmers, except those in the most remote areas, now depend on specialized companies that breed, produce, and sell seed varieties. This shift has brought advances, uniformity, higher yields, and traits tailored to market needs, but it has also distanced farmers from the intimate practice of selecting and saving seeds. The humble "seed bucket" has been replaced by sealed company bags, a symbol of both agricultural progress and the erosion of local traditions that once defined the bond between people, land, and seed.

Türkiye's Role as a Genetic Homeland and a Modern Seed Industry

Türkiye holds a unique position in the global agricultural landscape as both a genetic homeland and a hub for a modern seed industry. Recognized as one of the Vavilov centers of biodiversity, the country is the cradle of vital crops such as wheat, barley, lentils, and chickpeas. These crops, domesticated thousands of years ago in Anatolia, still form the basis of global diets today. The preservation of these landraces is not merely a matter of national pride but a critical pillar of global food security. Their genetic diversity carries traits for drought tolerance, disease resistance, and climate adaptability, characteristics that modern breeding programs increasingly depend on. However, the introduction and spread of foreign species over the past century have gradually influenced and sometimes diluted native varieties, raising the urgency for proactive conservation policies.

The modern Türkiye seed sector is built on strong legal and institutional frameworks. The enactment of the Seed Law (No. 5553) in 2006 marked a turning point, introducing a comprehensive system for regulating seed production, certification, trade, and import. This law has helped establish a reliable structure that ensures farmers receive quality seeds meeting defined national standards. Alongside this, the Biosafety Law (No. 5977) provides an additional layer of protection by prohibiting the production and commercialization of genetically modified seeds. This deliberate ban on GMOs reflects Türkiye's emphasis on safeguarding its conventional seed stock and its biodiversity from potential genetic contamination.

Together, these measures reflect a dual commitment: to conserve Türkiye's unparalleled genetic resources and to foster a modern, organized seed industry that serves both domestic agriculture and global food systems. In this balance of heritage and innovation lies Türkiye's lasting importance as a guardian of crop diversity and a leader in regulated seed production.

Addressing Misconceptions and Highlighting the Realities of Türkiye's Seed Sector

The seed sector in Türkiye has long been surrounded by misconceptions, many of which distort public understanding of its role, methods, and achievements. One of the most common myths is that hybrid seeds are either sterile or harmful to human health. Hybrid seeds are produced through time-tested crossbreeding techniques that combine desirable traits such as higher yields, improved disease resistance, and better adaptability. They are not a health risk but a vital product of scientific progress in agriculture. Another misconception concerns genetically modified organisms. Contrary to speculation, GMO seeds are neither produced nor imported in Türkiye. The Biosafety Law (No. 5977) makes their use strictly illegal, ensuring that Türkiye's agriculture remains free from GMO-related concerns.

Equally important is the claim that the Türkiye seed industry is dominated by foreign companies. Data shows the opposite: over 90 percent of the more than 1,250 registered seed companies are domestically owned, actively engaged in research and development to create new local varieties. Similarly, the perception that Türkiye is dependent on seed imports

is outdated. Today, more than 96 percent of all seeds used by Türkiye farmers are produced domestically. Seed output has surged from just 145,000 tons in the early 2000s to over 1.5 million tons of certified seed in 2023, marking a dramatic transformation.

This growth has positioned Türkiye not only as self-sufficient but also as a competitive exporter. With over 10,000 registered plant varieties and certified seed production surpassing 1.5 million tons, the sector contributes more than $1.2 billion in foreign trade revenues. Türkiye seeds now reach more than 100 countries, signaling a successful balance between meeting domestic needs and establishing a strong global presence.

Conclusion

Seeds embody both history and possibility, carrying within them the memory of past harvests and the promise of future ones. In Türkiye, this duality is especially powerful. The country's role as a genetic homeland ties it to the earliest chapters of agriculture, while its modern seed industry reflects the advances of science, policy, and trade. The shift from the family "seed bucket" to regulated, certified seed production shows how far the sector has come yet also reminds us of what must be preserved: the diversity, resilience, and cultural heritage embedded in landraces.

Türkiye's seed policies, particularly the Seed Law and Biosafety Law, demonstrate a clear commitment to protecting biodiversity and ensuring the integrity of its agricultural systems. At the same time, the remarkable growth in domestic production, research, and exports highlights the sector's economic strength and its potential to support global food security. By addressing misconceptions, Türkiye has also strengthened public trust, proving that its seed sector is nationally driven, self-sufficient, and forward-looking.

Ultimately, the Türkiye seed story is one of balance, between tradition and innovation, local heritage and global engagement. As both custodian of genetic resources and a dynamic seed producer, Türkiye stands as a pivotal actor in shaping a secure and sustainable agricultural future.

References: Ministry of Agriculture and Forestry of Türkiye; Official Gazette of the Republic of Türkiye; Özkan et al.; TİM; TÜRKTOB; TÜİK

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

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The Endurance of Türkiye's Farmers

Discover the inspiring story of Türkiye's farmers who embody endurance and dignity. Despite facing rising costs and climate challenges, their unwavering spirit sustains both the nation and the global food system, creating value far beyond their fields.

Mithat Direk

9/19/2025

Farming is a difficult craft, yet it remains one of the most vital and dignified callings in human history. Agriculture is more than an occupation; it is a cycle dictated by the seasons, an endless chain of interdependent activities driven by humanity's most fundamental need. Unlike other professions, a farmer's life is not bound by fixed hours or predetermined schedules. There is no true season of idleness; even in the quiet of winter, when fields lie fallow, planning for the coming season is already underway. Each task, whether sowing, irrigating, or harvesting, seamlessly flows into the next, forming a rhythm as perpetual as life itself.

What distinguishes agriculture is its remarkable ability to create surplus value. From a single wheat seed, fifty or more seeds may spring forth, multiplying themselves with every cycle. This unique productive capacity has ensured that agriculture has always been the foundation of civilization. Cities, trade, and cultures could only flourish once fields produced more than were immediately consumed. Ancient philosophers were keenly aware of this truth. Aristotle, for instance, deemed agriculture the only "real" sector of the economy, arguing that all other professions merely circulated the surplus generated by those who tilled the soil.

In Türkiye, farming is not only an economic necessity but also a cultural and spiritual inheritance. Deeply rooted in the belief that the first human, Prophet Adam, was a farmer, the act of cultivating the land carries profound meaning. Farmers are called by many names, *çiftçi*, *rençber*, *toprak işçisi*, yet behind each title lies a shared identity: resilience, humility, and an intimate connection to the earth. In the furrows of Anatolian soil, one can still feel this timeless bond between humanity and the land that sustains it.

The Profile and Pressures of the Türkiye's Farmer

According to the Türkiye's Statistical Institute (TÜİK), there were nearly 2.7 million agricultural holdings in Türkiye in 2021, the vast majority of which are small-scale, family-operated farms (TÜİK, 2022). These farmers remain at the frontline of vulnerability, directly exposed to the growing impacts of climate change. Rising temperatures, prolonged droughts, irregular precipitation, and more frequent extreme weather events have already begun to threaten agricultural yields, food security, and rural livelihoods.

Despite its indispensable role, Türkiye's agriculture is under profound structural and economic strain. The sector contributes around 6.2% to national GDP and continues to be a major source of rural employment (TÜİK, 2023). Yet rather than being rewarded fairly for their labor, farmers are often pressured into a paradigm that emphasizes *higher production* rather than *higher income*. This imbalance is aggravated by surging input costs—fertilizer, pesticides, feed, energy, and fuel, which have risen sharply in recent years. At the same time, the gap between producer and consumer prices has widened. Reports from the Institute of Agricultural Economics and Policy Development (TEPGE, 2023) point to a consistent squeeze on farmer margins, leaving many trapped in cycles of low profitability and rising indebtedness.

This paradox echoes the well-known parable of the fisherman: when urged to catch more fish, expand operations, and eventually retire in comfort, he responds, "But isn't that exactly what I am already doing?" The story's wisdom resonates in rural Türkiye today. The central dilemma is not whether farmers can produce more, they have repeatedly proven they can, but whether prevailing policies and market structures truly serve their welfare. Unless the system shifts toward improving farmer resilience and equitable returns, productivity gains may only deepen existing risks rather than secure rural prosperity.

The Endless Seasons of the Türkiye's Farmer

Summer marks the height of agricultural intensity in Türkiye, a season that demands vigilance, strength, and precision. Fields and orchards brim with life as farmers tend to crop that sustain households and feed global markets. Türkiye stands as a world leader in hazelnut, apricot, and fig production, while also ranking among the top producers of wheat, tomatoes, peppers, and cherries (FAO, 2022). Each crop requires meticulous care, irrigation, pest management, and timely harvesting, to ensure not just quantity, but quality. Yet, the ultimate worth of this tireless effort rests not solely in the soil, but in the uncertainty of fluctuating markets. When prices are favorable, farmers reap the full fruits of their labor, harvesting with precision and care. But when prices collapse, some crops are abandoned to rot in the fields, as the cost of harvest outweighs the return. It is in these moments that gleaning becomes a symbol of resilience and necessity, with farmers, neighbors, or the needy returning to gather what remains, hazelnuts fallen beneath trees, overlooked potatoes, or stray wheat stalks.

Winter, by contrast, is mistakenly imagined as a time of rest. For the farmer,

it is a season of preparation, not repose. Fields must be tilled and enriched, orchards pruned with precision to secure future yields, and, in warmer regions, second crops cultivated to maximize scarce resources. Even when snow or heavy rain halt outdoor activity, the farmer's mind is restless, preoccupied with debts, seed choices, weather forecasts, and the unpredictable prospects of the coming year. A Türkiye's proverb captures this ceaseless burden: *"When you cut open a farmer's belly, you will find forty thoughts about the next year."* Indeed, farming in Türkiye is a perpetual vocation, requiring not only unyielding arms but also tireless hearts.

The Path Forward: Policy Recommendations for a Sustainable Future

For Türkiye's agriculture to remain both resilient and rewarding, the policies guiding it must undergo a decisive transformation. The future cannot be secured by simply pushing for higher yields; instead, the focus must shift toward farmer welfare and sustainability. Income-oriented policies are a critical first step. Transitioning from generic production subsidies to targeted direct income support would insulate farmers from volatile market swings and rising input prices, ensuring a dignified livelihood even in unstable conditions.

Equally urgent is the need to reduce input costs. Energy, fertilizer, feed, and pesticide expenses have become overwhelming burdens, eroding farm profitability. Tax reductions on these essentials, coupled with incentives for domestic production of agricultural products, would significantly ease the financial strain. Beyond financial relief, empowering farmers through strengthened cooperatives offers a pathway to reclaiming bargaining power from intermediaries. Strong, well-supported cooperatives can streamline market access, stabilize prices, and distribute risk more equitably (İzmir Commodity Exchange, 2023).

Climate-smart agriculture must also become central to national strategy. Encouraging the adoption of drought-resistant seeds, rainwater harvesting, and efficient drip irrigation would not only protect yields but also align Türkiye's agriculture with global sustainability goals. At the same time, the demographic reality of an aging farmer population requires urgent attention. Comprehensive packages that include financial incentives, training programs, and access to modern technologies can make farming an attractive and viable profession for young people, ensuring continuity across generations.

Ultimately, the resilience of Türkiye's agriculture lies not only in the soil or the seasons, but in the unwavering spirit of its farmers, resilient, patient, and deeply bound to the land. Sound policy must honor that spirit by creating a future where farming yields not just sustenance, but prosperity and dignity.

Conclusion

The story of the Türkiye's farmer is one of endurance, dignity, and perpetual motion. Across the shifting seasons, farmers embody a rhythm as old as civilization itself, sowing in faith, laboring with resilience, and harvesting with hope, even under the shadow of uncertainty. Yet, despite their indispensable role in sustaining both the nation and the global food system, farmers remain burdened by rising input costs, volatile markets, and the deepening threats of climate change. Their labor creates value far beyond their fields, yet too often they are denied fair returns for the wealth they generate.

What emerges from this portrait is both a warning and a promise. Without systemic reform, the pressures that weigh on Türkiye's farmers risk undermining not only rural livelihoods but also food security and national stability. But with thoughtful, income-oriented policies, strengthened cooperatives, and a genuine embrace of climate-smart practices, agriculture can evolve into a sector that nurtures both people and the planet.

The Türkiye's farmer has always been more than a producer; they are guardians of heritage, soil, and sustenance. To honor their role is to ensure that agriculture continues to be not just a cycle of survival, but a foundation of prosperity and dignity for generations to come.

References: TÜİK; TEPGE; FAO; İzmir Commodity Exchange

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Integrated Solutions for Replenishing Sindh's Groundwater

Sindh faces a severe groundwater crisis threatening agriculture and rural livelihoods. Learn about drivers, impacts, and solutions for sustainable water security.

Attaullah Veesar

9/29/2025

Globally, arid and semi-arid agricultural regions, from Punjab in South Asia to California in the United States, are grappling with the depletion of underground aquifers, but the challenge in Sindh stands out as particularly severe. The province has become heavily dependent on groundwater extraction, with an estimated 1.2 million tubewells in operation, and the number continues to rise by tens of thousands each year (Sindh Irrigation & Drainage Authority [SIDA], 2023). This unregulated expansion of tubewells has placed unsustainable pressure on already fragile aquifers.

According to the Pakistan Council of Research in Water Resources (PCRWR), the groundwater table in critical agricultural districts such as Mirpurkhas, Hyderabad, and Sanghar is declining at an alarming rate of 1.5 to 3 meters annually (PCRWR, 2023). This rapid depletion poses a direct threat to the province's agricultural sustainability, food security, and rural livelihoods.

However, the crisis is not limited to groundwater quantity alone; quality has deteriorated just as severely. Excessive pumping has disturbed the natural equilibrium of aquifers, mobilizing salt and other pollutants. Recent assessments reveal that more than 75% of Sindh's groundwater is now classified as highly saline and unsuitable for most crops. Only about 25% remains within safe irrigation limits, defined as total dissolved solids below 1,000 mg/l (PCRWR, 2023). Farmers increasingly face declining crop yields and soil degradation as they struggle to irrigate with brackish water.

The situation is especially dire in the coastal districts of Thatta and Badin. Here, seawater intrusion, accelerated by both over-extraction and reduced freshwater flows in the Indus, has pushed brackish water as far as 70 kilometers inland. Combined with the natural salinity of the lower Indus Basin, this intrusion has further limited the availability of fresh groundwater. Left unchecked, these trends risk undermining the agricultural backbone of Sindh, with devastating social and economic consequences for its rural communities.

Drivers and Socio-Economic Impacts

The underlying driver of Sindh's groundwater crisis is the widening gap between irrigation water demand and the supply available from the Indus Basin canal system. Over time, multiple factors have compounded this problem. Heavy siltation reduces storage and conveyance capacity, while aging infrastructure and operational inefficiencies further constrain water delivery. Added to this are transboundary water dynamics, which have introduced uncertainty into surface water availability (World Bank, 2023). As canal water supplies become increasingly unreliable, farmers have been left with little choice but to rely on groundwater as a supplemental or even primary source of irrigation. This dependence creates a vicious cycle: farmers drill deeper to secure water, but the resulting extraction requires higher energy inputs, drives up production costs, and accelerates the withdrawal of poorer quality, saline water. The use of saline water, in turn, degrades soil fertility, undermines crop productivity, and erodes long-term agricultural viability.

The socio-economic repercussions of this crisis are far-reaching. The financial burden of groundwater extraction has escalated rapidly, with the World Bank (2023) documenting a 300% increase in pumping costs over the past decade. This surge disproportionately affects smallholder farmers, many of whom lack the capital reserves to absorb higher costs and are forced into cycles of indebtedness. At the same time, declining groundwater quality has reduced the profitability of agriculture itself. Research from the International Water Management Institute (IWMI, 2022) shows that cotton yields in central Sindh have fallen by 15–20% over the past 15 years, largely because of soil salinity linked to poor-quality irrigation.

Beyond agriculture, the implications are even broader. The shrinking freshwater lens has triggered a parallel crisis in drinking water supplies. Rural and peri-urban households face increasing exposure to unsafe water, fueling public health challenges such as water-borne diseases, malnutrition, and declining labor productivity—thereby deepening poverty and vulnerability in Sindh's rural economy.

A Pathway to Resilience: Integrated Solutions

Tackling Sindh's groundwater depletion requires more than piecemeal interventions; it demands a fundamental paradigm shift from unregulated extraction toward planned aquifer management, demand-side efficiency, and institutional reform. Successful experiences from other water-stressed regions offer valuable insights. Gujarat's large-scale community-led rainwater harvesting initiatives, which restored groundwater levels across tens of thousands of villages, demonstrate the power of collective action in aquifer recharge (Shah, 2023). Likewise, Israel's integration of drip irrigation with the reuse of treated wastewater showcases how innovation and regulation can work together to maximize agricultural water

productivity and reduce dependence on freshwater.

For Sindh, an integrated and multi-pronged strategy must be prioritized. First, strategic Managed Aquifer Recharge (MAR) offers a viable solution. The province loses vast volumes of monsoon floodwater to the Arabian Sea each year. By constructing recharge dams, spreading basins, and injection wells in identified permeable zones, these flows could be harnessed to replenish aquifers instead of being wasted. Second, regulatory governance is urgently required. A transparent tubewell licensing and zoning system, as envisioned in the National Water Policy (GoP, 2018), must be enforced to restrict new abstractions in critically over-exploited and saline areas. Without regulation, the current trajectory of unchecked drilling will accelerate aquifer decline and further marginalize smallholders who cannot afford deeper wells.

Third, scaling up high-efficiency irrigation systems (HEIS) is essential. Drip and sprinkler systems, supported through targeted subsidies and farmer training, can cut water application by 30–60% while improving yields compared to wasteful flood irrigation (FAO, 2021). Such systems not only conserve water but also reduce the energy burden of pumping groundwater. Finally, the modernization of canal systems can significantly alleviate groundwater dependency. By lining distributaries and watercourses to minimize seepage, and adopting digital allocation mechanisms for equitable distribution, surface water deliveries could become more reliable and efficient.

Ultimately, building resilience in Sindh requires integrating technical solutions with community participation and robust institutions. Without such coordinated action, aquifer depletion will continue to erode the province's agricultural base, compromise food security, and intensify rural poverty. With it, however, Sindh can chart a sustainable path that balances agricultural productivity with long-term water security.

Conclusion

Groundwater depletion in Sindh has emerged as one of the most urgent threats to agricultural sustainability, food security, and rural livelihoods. The province's heavy reliance on tubewell irrigation, compounded by the declining reliability of canal water, has pushed farmers into a cycle of deeper drilling, rising costs, and deteriorating water quality. This pattern has not only reduced soil fertility and crop productivity but has also undermined farmer incomes, worsened indebtedness, and exposed rural households to a parallel drinking water crisis. The socio-economic impacts are particularly severe for smallholders, who lack the financial capacity to adapt to higher pumping costs or invest in water-saving technologies.

Yet, as this study highlights, pathways to resilience are within reach. Lessons from international models show that collective action, technological innovation, and regulatory frameworks can reverse the trend of aquifer depletion. For Sindh, the strategic adoption of managed aquifer recharge, high-efficiency irrigation, regulatory governance of tubewells, and modernization of surface water systems together provide a holistic framework for sustainable water management. What is required now is the political will, institutional capacity, and community participation to implement these solutions effectively. Without decisive action, the province risks long-term ecological decline and worsening rural poverty; with it, Sindh can secure its agricultural future.

References: FAO; GoP; IWMI; PCRWR; Shah; SIDA; World Bank

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POLICY BRIEFS
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Food Imports and National Food Security

Food imports are crucial for national food security, acting as a safeguard against domestic production shortfalls and price volatility. They help governments manage climatic shocks and ensure access to food.

Muhammad Mohib Ladin

9/2/2025

Food imports play a vital role in ensuring national food security. By supplementing domestic production, they help stabilize supplies, prevent price volatility, and provide access to a wider variety of foods, enhancing nutritional outcomes. For countries with growing populations or climatic constraints that limit local production, imports are often essential to meet consumption needs. They also allow governments to respond to temporary domestic shortfalls caused by droughts, floods, or pest outbreaks, ensuring that markets remain functional and households maintain access to staple and high-value foods.

However, the reliance on imported food carries significant economic implications. Heavy imports can contribute to persistent trade deficits, exert pressure on the national currency, and reduce foreign exchange reserves. This dependence also exposes countries to global market fluctuations, geopolitical disruptions, and sudden spikes in international prices, as seen during recent global crises that affected wheat, rice, and edible oil markets. Using the GDP identity ($Y = C + I + G + (X - M)$), rising import bills (M) directly impact net exports, potentially slowing economic growth if not offset by higher exports or domestic savings.

Emerging technological solutions offer pathways to mitigate these risks. Innovations such as blockchain-based supply chain management can improve transparency, traceability, and efficiency in both imports and domestic distribution. By tracking provenance, verifying quality, and streamlining logistics, such technologies reduce losses, lower transaction costs, and enhance market confidence. Combined with predictive analytics, governments can better anticipate supply disruptions, optimize import volumes, and maintain price stability without excessive reliance on external markets.

Ultimately, balancing the benefits of food imports with macroeconomic stability requires a nuanced approach. Strategic import planning, investment in domestic production, and leveraging digital technologies can help nations secure food supplies while minimizing economic vulnerability, ensuring both short-term resilience and long-term sustainability.

Nigeria's Food Import Dependency and Regulatory Challenges

Nigeria, despite its vast agricultural potential, remains heavily dependent on food imports. Annually, the country spends over $10 billion importing staples such as rice, wheat, and poultry, a burden that has profound economic consequences (World Bank, 2023). This heavy reliance widens the trade deficit, creating a persistent negative net export position that constrains macroeconomic stability. It also exerts pressure on foreign reserves, particularly U.S. dollars, which are required for other critical imports, including fuel and industrial goods. The demand for foreign currency to finance these imports contributes to the depreciation of the Naira, which increases the cost of future imports and exacerbates domestic inflation. By January 2024, Nigeria's food inflation had surged to 35.4%, hitting households and low-income consumers hardest (National Bureau of Statistics, Nigeria, 2024).

The root causes of this dependency lie in inefficiencies in domestic agriculture. Poor infrastructure, limited access to affordable credit, and outdated farming techniques reduce productivity, creating a cycle of import reliance that is difficult to break. Investments in mechanization, rural logistics, and credit accessibility are critical to strengthening local production capacity.

Compounding these challenges are global regulatory standards. Food safety requirements, increasingly stringent in major markets, act as non-tariff barriers (NTBs) that influence import flows. China's response to past food crises, including the 2008 melamine milk scandal, exemplifies this trend. Following the 2015 Food Safety Law, countries with weaker food safety controls saw their agricultural exports to China decline by an average of 2.2%, while those with stronger systems experienced smaller declines of 0.8% (Li & Beghin, 2019). These standards demonstrate how regulatory frameworks can reshape global trade patterns, favoring exporters with advanced monitoring and quality assurance systems, while placing developing countries like Nigeria under increased pressure to meet compliance requirements.

South Asia's Food Security Challenge and the Role of Blockchain

South Asia, home to more than 21% of the world's population, continues to struggle with persistent food insecurity, despite notable economic growth. The region accounts for nearly 30% of the global undernourished population, highlighting a stark disconnect between growth and nutrition outcomes (FAO, 2023). Several factors exacerbate this crisis. Climate change increasingly disrupts agricultural production, with more frequent droughts, floods, and unpredictable rainfall patterns undermining crop yields. Global shocks, such as the Russia-Ukraine war, have disrupted wheat and fertilizer supplies, driving regional food prices upward. Structural weaknesses, including inadequate infrastructure, limited adoption of modern farming technologies, and insufficient government support,

further constrain productivity and resilience. Low intra-regional trade, less than 5% of total agricultural trade, represents a missed opportunity to balance regional supply and demand, particularly when climatic or geopolitical shocks affect production in specific countries (World Bank, 2022).

Technological innovations offer a pathway to improve efficiency and trust in supply chains. Blockchain has emerged as a tool for creating transparency from farm to fork. By maintaining an immutable ledger of product origin, handling, and safety, blockchain reduces information asymmetry that often undermines consumer confidence. Studies show that when blockchain is implemented, retailers can charge a premium for verified products, increasing profitability for producers, importers, and retailers alike (Azzi et al., 2019). Without blockchain, uncertainty about safety and origin forces actors to lower prices to ensure sales, reducing margins. While the benefits are most pronounced in contexts with low baseline trust, the technology is particularly valuable for high-risk or high-value products where verification is critical.

By combining domestic capacity-building with technological innovations like blockchain, South Asian countries can enhance food system transparency, strengthen consumer trust, and improve economic and nutritional outcomes, helping mitigate the region's persistent food insecurity.

Policy Recommendations for Balanced Food Security and Trade

Food imports play a crucial role in bridging gaps between domestic supply and demand, but overreliance can create significant macroeconomic pressures. Heavy import dependence can widen trade deficits, deplete foreign reserves, weaken local currencies, and contribute to inflation, ultimately undermining both economic stability and food security. To mitigate these risks, countries need a comprehensive strategy that balances immediate import needs with long-term domestic resilience.

The priority is boosting domestic productivity. Investments in rural infrastructure, such as irrigation, storage, and transport networks, can reduce post-harvest losses and enhance efficiency. Coupled with research and development for climate-resilient crop varieties, improved access to credit, and adoption of modern farming technologies, these measures reduce dependency on imports while strengthening farmers' capacity to respond to market fluctuations.

Strategic trade policies are also essential. Carefully designed tariffs, quotas, and trade facilitation measures can protect sensitive sectors without triggering retaliatory measures or harming consumers. Complementing this, regional trade integration in South Asia can leverage complementarities between countries, enhancing supply stability and reducing vulnerability to global shocks.

Finally, technology adoption can provide a competitive edge. Traceability platforms such as blockchain not only ensure compliance with international safety standards but also build consumer trust and enable value addition. Verified products can command premium prices in global markets, benefiting producers and exporters alike.

By combining domestic capacity-building, strategic trade management, regional cooperation, and technological innovation, countries can move from reactive import dependency toward a proactive food security framework that promotes both economic and nutritional resilience.

Conclusion

Food imports are an indispensable tool for maintaining national food security, offering a buffer against domestic production shortfalls, price volatility, and dietary limitations. They allow governments to respond to climatic shocks, natural disasters, and supply disruptions, ensuring that populations have access to essential staples and high-value foods. However, excessive reliance on imports carries significant economic risks. Large import bills can widen trade deficits, deplete foreign reserves, weaken local currencies, and fuel inflation, creating a cycle that undermines both economic stability and household food access.

Case studies from Nigeria and South Asia illustrate these dynamics. Nigeria's heavy dependence on imported staples has contributed to soaring food inflation, currency depreciation, and persistent trade deficits, reflecting structural inefficiencies in domestic agriculture. Similarly, South Asia faces chronic food insecurity despite economic growth, driven by climate impacts, global supply shocks, and underdeveloped infrastructure. Low intra-regional trade further compounds vulnerability, highlighting the need for coordinated policy responses.

Technological innovations, particularly blockchain, offer promising solutions. By ensuring supply chain transparency, traceability, and verification, blockchain reduces information asymmetry, builds consumer trust, and allows producers and retailers to capture higher value for verified products. When coupled with investments in domestic productivity, strategic trade management, and regional cooperation, these technologies enable a proactive approach to food security.

Ultimately, balancing imports with domestic capacity and innovation is essential. Countries that strategically integrate policy, infrastructure, and technology can achieve both nutritional security and macroeconomic resilience, transforming import reliance from a vulnerability into a managed, strategic component of sustainable food systems.

References: Azzi et al.; Behnke & Janssen; Bumblauskas et al.; FAO; Li & Beghin; National Bureau of Statistics, Nigeria; World Bank; Barkley & Barkley

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Sustainable Agriculture in Pakistan: A Necessity

Advancing sustainable agriculture in Pakistan is essential for environmental health and economic growth. Addressing challenges faced by smallholder farmers is crucial to ensure food security and maintain productivity. Learn about targeted interventions to overcome barriers in this vital sector.

Sajal Sohail

9/8/2025

Sustainable agriculture is not only an environmental necessity but also a socio-economic imperative, particularly in countries like Pakistan where agriculture underpins livelihoods, food security, and economic stability. Climate change, water scarcity, soil degradation, and fluctuating global markets present mounting challenges, making the adoption of environmentally responsible practices both urgent and complex. While sustainable methods such as precision irrigation, integrated pest management, crop rotation, and organic fertilization offer long-term benefits, farmers often face high upfront costs, uncertain returns, and limited access to technical expertise. Without targeted economic support, these barriers can slow adoption, leaving both ecological and economic vulnerabilities unaddressed.

Economic policies play a pivotal role in bridging this gap. Subsidies, when redirected toward sustainable practices rather than input-heavy conventional methods, can offset initial costs and encourage farmers to adopt regenerative approaches. Market-based incentives, including premium pricing for certified organic or sustainably grown produce, provide a direct financial rationale for eco-friendly farming. Public-private partnerships further amplify impact by combining government support with private sector innovation, offering technical training, financing mechanisms, and supply chain access.

In Pakistan, agriculture contributes 22.9% to GDP and employs 37.4% of the labor force (GoP, 2023). Beyond these direct figures, its influence cascades across the economy: robust agricultural growth stimulates demand in manufacturing sectors such as textiles and sugar, strengthens logistics and financial services, and reinforces trade competitiveness. By strategically deploying economic incentives, policymakers can promote sustainable agriculture while simultaneously enhancing productivity, farmer income, and national economic resilience. Integrating environmental sustainability into the economic fabric ensures that agriculture continues to serve as a foundation for both ecological health and socio-economic development in the decades to come.

Global Lessons in Overcoming Barriers to Sustainable Agriculture

The transition to sustainable agriculture faces a complex set of challenges, particularly in countries like Pakistan where smallholder farmers dominate the sector. High initial investment costs remain a primary barrier. Eco-friendly equipment, organic certifications, renewable energy systems, and precision irrigation technologies require significant upfront capital, often beyond the reach of small-scale farmers. Even when such technologies are technically accessible, limited access to finance compounds the problem. Many financial institutions perceive sustainable farming as risky due to market volatility, unfamiliarity with long-term returns, and the absence of collateral among smallholders.

Climate and environmental pressures further exacerbate these constraints. Farmers are increasingly exposed to extreme weather events such as floods, droughts, and heatwaves, which threaten both crop yields and long-term soil health. The catastrophic floods of 2022, which submerged nearly a third of Pakistan and caused estimated damages of $30 billion, illustrate the vulnerability of agriculture to climate shocks (World Bank, 2022). Soil degradation, water scarcity, and biodiversity loss add additional layers of risk, limiting the resilience of traditional and even modern farming systems.

Knowledge and technology gaps are another critical hurdle. While research institutions develop innovative sustainable practices, a disconnect often exists between these advancements and on-farm adoption. Lack of training, extension services, and localized technical support prevents farmers from effectively implementing modern methods like organic farming, precision agriculture, and water-efficient irrigation.

Comparative policy analysis offers valuable lessons. China has leveraged large-scale investment in agricultural research and water management, achieving a contribution rate of scientific and technological progress to agriculture of over 61% by 2021 (Wang et al., 2022). Thailand combines strong social security systems with promotion of organic farming, boosting both productivity and exports of sustainable products (FAO, 2021). Israel demonstrates efficient resource management through drip irrigation and wastewater recycling, channeling over 90% of treated wastewater into agriculture (OECD, 2023). Vietnam integrates sustainability into its rice export model, redirecting cultivation to higher-quality, eco-friendly varieties that improve farmer income and reduce environmental impact (World Bank, 2021).

For Pakistan, these global examples underscore the need for a holistic strategy: combining financial support, climate adaptation measures, technological transfer, and effective extension services. By addressing these intertwined barriers, the country can strengthen its agricultural

sector, improve rural livelihoods, and advance toward a sustainable and climate-resilient future.

Advancing Sustainable Agriculture in Pakistan

Pakistan has made significant strides toward embedding sustainability into its agricultural policies, recognizing the dual challenge of feeding a growing population while conserving natural resources. The Prime Minister's Agriculture Emergency Program exemplifies this approach, targeting key crops like wheat, rice, and sugarcane. Through input subsidies and support for water conservation projects, the program seeks to improve both productivity and profitability, ensuring that farmers can maintain yields without compromising long-term soil and water health.

Complementing these efforts, the Green Pakistan Initiative (GPI) leverages technology to modernize agriculture. By integrating AI-driven satellite monitoring, predictive analytics, and data-informed decision-making, the initiative aims to optimize resource allocation, reduce waste, and strengthen collaboration between government agencies, agribusinesses, and farmers. Such innovations are essential for managing the complexity of modern agricultural systems and responding to climate variability.

The Ten Billion Tree Tsunami Project (TBTTP) further underscores Pakistan's commitment to environmental restoration. Running from 2019 to 2023, the project has successfully restored over 1.36 million hectares, enhancing biodiversity, stabilizing soils, and improving resilience to climate shocks (MoCC, 2023). These efforts demonstrate how ecosystem restoration can be integrated with agricultural planning to generate long-term ecological and economic benefits.

The National Food Security Policy 2018 provides a broader framework, emphasizing efficient water use, the promotion of climate-resilient crops, and increased investment in agricultural research. Yet, despite these initiatives, implementation faces persistent challenges. Pakistan's population is projected to reach 310 million by 2050 (UN DESA, 2022), intensifying pressure on limited arable land and freshwater resources. Meeting rising food demand while maintaining environmental sustainability will require continuous adaptation, stronger institutional coordination, and investment in knowledge transfer, technology, and farmer training.

Together, these policies and programs provide a foundation for sustainable agriculture in Pakistan, but success depends on linking innovation, governance, and practical support for farmers to ensure productivity, resilience, and long-term ecological stewardship.

Conclusion

Advancing sustainable agriculture in Pakistan is both an environmental necessity and an economic opportunity. The sector's central role in national livelihoods, food security, and economic stability underscores the urgency of adopting practices that conserve resources while maintaining productivity. Challenges ranging from high upfront costs and limited access to finance to climate-induced shocks and knowledge gaps pose significant barriers, particularly for smallholder farmers who dominate the landscape. Without targeted interventions, these obstacles could slow the transition, leaving the country vulnerable to resource depletion, declining yields, and economic instability.

Global experiences from China, Thailand, Israel, and Vietnam illustrate the potential of combining policy support, technological innovation, and market incentives to enhance both sustainability and profitability. Lessons from these models demonstrate that strategic investments in research, water management, and climate-resilient practices can transform agricultural systems into resilient and knowledge-driven sectors.

Pakistan has made notable progress through programs such as the Prime Minister's Agriculture Emergency Program, the Green Pakistan Initiative, and the Ten Billion Tree Tsunami Project. These initiatives integrate financial support, technology, and ecological restoration to promote sustainable production. Yet, population growth and resource constraints demand continued adaptation, coordination, and knowledge transfer to ensure long-term impact.

Ultimately, the pathway to sustainable agriculture lies in harmonizing economic incentives with ecological stewardship. By empowering farmers, leveraging innovation, and embedding sustainability into policy frameworks, Pakistan can secure a productive, resilient, and climate-smart agricultural sector, one that sustains livelihoods, strengthens national food security, and preserves natural resources for future generations.

References: FAO; Government of Pakistan; Ministry of Climate Change; OECD; UN DESA; Wang et al.; World Bank

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Combating Climate Change with Carbon Pricing

Explore how carbon pricing addresses market failures caused by climate change, making polluters accountable and fostering sustainable economic growth through emissions trading systems.

Nazaina Noor

9/16/2025

Climate change represents the paramount market failure of our time, posing not only an existential environmental threat but also a profound and systemic economic challenge. Its effects are already reshaping global economic systems, damaging infrastructure through extreme weather, reducing agricultural productivity via shifting rainfall and rising temperatures, exacerbating health crises linked to pollution and heatwaves, and generating persistent financial uncertainty. For businesses and governments alike, the unpredictability of climate impacts undermines investment decisions and long-term planning, raising the stakes for effective policy responses.

At the core of the problem is the failure of markets to account for the social cost of greenhouse gas (GHG) emissions. Polluters emit freely while society bears the consequences in the form of environmental degradation, health burdens, and economic losses. Correcting this distortion requires instruments that internalize external costs and align private incentives with public well-being. Carbon pricing has emerged as the most direct and economically sound solution. By putting a price on emissions, either through carbon taxes or emissions trading systems (ETS), it compels firms to factor climate costs into their production and consumption choices. This creates a powerful incentive to innovate, invest in cleaner technologies, and shift toward sustainable energy sources.

Globally, carbon pricing has taken different forms. Some countries have adopted straightforward taxes that provide price certainty but less flexibility. Others rely on cap-and-trade systems, which fix total emissions while allowing market participants to trade allowances, fostering efficiency. Yet, both models face challenges in terms of political feasibility, competitiveness concerns, and ensuring fairness for low-income households. Despite these hurdles, the economic rationale remains strong: carbon pricing is not only about cutting emissions but about reshaping the foundations of economic growth to be resilient, equitable, and sustainable in the face of climate change.

The Macroeconomic Costs of Climate Inaction

The economic risks of unchecked climate change are no longer hypothetical, they are measurable, visible, and compounding with each passing year. At the heart of the problem lies the negative externality of greenhouse gas emissions. When firms or individuals emit carbon, the costs are borne not by the polluters but by society in the form of property destruction from extreme weather events, rising healthcare burdens, crop failures, and productivity losses. These socialized costs distort markets, undermining both efficiency and equity. The 2022 IPCC report makes it clear: global warming is already suppressing economic growth, and without significant mitigation efforts, the damage will escalate sharply over the century. Projections suggest that climate change could cut global GDP by 3–10% by 2100 relative to a world without warming, eroding decades of progress in economic development.

Economists have developed tools to put a monetary value on this damage. William Nordhaus's Dynamic Integrated Climate-Economy (DICE) model pioneered the concept of the Social Cost of Carbon (SCC), the present value of future economic harm caused by each additional ton of carbon dioxide. Recent revisions have pushed estimates higher, reflecting improved scientific understanding of climate impacts. The U.S. Environmental Protection Agency currently uses an interim SCC of $190 per ton, while the IMF suggests that a global benchmark of at least $85 per ton is necessary to keep the world aligned with the Paris Agreement. These figures highlight the enormous economic inefficiency of allowing emissions to continue unpriced.

Carbon pricing is widely recognized as the most effective mechanism to address this market failure. By embedding the cost of emissions into fossil fuel prices, it realigns private incentives with social welfare. Carbon taxes provide predictable price signals, encouraging long-term investment in clean energy, while cap-and-trade systems guarantee emissions reductions by fixing a maximum allowable quantity. Both approaches are grounded in efficiency: they let the market discover the cheapest abatement strategies, stimulating innovation rather than mandating specific technologies. Sweden's carbon tax, introduced in 1991, demonstrates how effective such instruments can be, pairing economic growth of more than 75% with a 30% reduction in emissions. The European Union's Emissions Trading System shows the complementary strength of market flexibility, as prices topping €100 per ton in 2023 pushed industries toward decarbonization.

Global adoption of carbon pricing has accelerated. As of 2024, there are 73 active carbon pricing instruments worldwide, with 37 more in development. Together, they cover about 24% of global greenhouse gas emissions. China's national ETS, the largest in scale, now regulates the world's most carbon-intensive power sector. Canada has implemented a federal backstop system, while Latin America and Southeast Asia are beginning to roll out their own mechanisms. Yet the gap remains stark: fewer than 5% of covered emissions are

priced at the $50–$100 per ton range considered necessary for achieving Paris-aligned targets.

The economic situation is unambiguous. The costs of inaction will dwarf the costs of implementing effective carbon pricing today. Without decisive measures, climate change threatens to destabilize financial systems, undermine food security, and lock vulnerable regions into cycles of poverty and instability. Correcting carbon externality is not just an environmental imperative, it is a macroeconomic necessity, the foundation for sustainable growth in the 21st century.

Key Challenges and Complementary Policies

Despite its efficiency and strong economic rationale, carbon pricing faces major obstacles that complicate its implementation and effectiveness. The political economy remains one of the toughest barriers. Fossil-fuel lobbies wield considerable influence, shaping public opinion and blocking legislation. At the same time, governments fear that higher carbon costs will undermine the competitiveness of domestic industries, encouraging firms to shift production to jurisdictions with weaker climate rules, a phenomenon known as carbon leakage. These pressures can stall or weaken policy design, limiting the impact of pricing schemes.

Equity concerns add another layer of complexity. Because low-income households spend a higher share of their budgets on energy, carbon pricing tends to hit them harder. If unaddressed, this regressive effect risks triggering public backlash, as seen in France's 2018 Yellow Vest protests. Revenue recycling mechanisms, such as carbon dividends where collected revenues are returned equally to citizens, offer a promising solution. They can offset costs for vulnerable groups while maintaining political legitimacy.

International fragmentation also undermines effectiveness. With dozens of carbon pricing systems operating at different rates and scopes, global markets face inefficiencies. The European Union's Carbon Border Adjustment Mechanism (CBAM) is a bold attempt to harmonize trade flows with climate ambition, imposing carbon costs on imports and pressure trading partners to adopt cleaner production. Yet scaling such initiatives requires delicate diplomacy and coordination.

Finally, the systemic nature of the energy transition means carbon pricing cannot stand alone. It must be supported by complementary policies: investment in renewable energy and storage, large-scale infrastructure upgrades, R&D for clean technologies, and targeted programs for workers and communities tied to fossil fuel sectors. Looking ahead, the evolution of carbon pricing will likely hinge on higher price floors, expansion into hard-to-abate sectors, digital innovations for monitoring and enforcement, and the emergence of "carbon clubs" where countries coordinate policies and border adjustments. Together, these steps will determine whether carbon pricing delivers on its transformative potential.

Conclusion

Climate change is no longer a distant possibility but a present economic reality, reshaping markets, damaging livelihoods, and straining public resources. At its core lies a profound market failure, the failure to price carbon. This distortion has allowed emissions to rise unchecked, externalizing costs that societies can no longer afford to bear. Carbon pricing directly addresses this gap by making polluters pay and creating powerful incentives for cleaner investment and innovation. The evidence is clear: countries that have adopted well-designed carbon taxes or emissions trading systems have managed to cut emissions while sustaining economic growth.

Yet effectiveness depends on political will, equitable design, and international coordination. Without complementary policies such as support for vulnerable households, investment in clean technologies, and mechanisms to prevent carbon leakage, carbon pricing alone cannot deliver the transition. The global momentum is encouraging, with coverage expanding year by year, but pricing levels remain too low to meet climate goals. The choice is stark: either act now with policies that correct the carbon externality or bear far higher economic and social costs in the decades ahead. Ultimately, carbon pricing is not just a climate tool, it is an essential foundation for building a sustainable, fair, and resilient global economy.

References: IPCC; EPA; IMF; NGFS; OECD; ICAP; World Bank

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The Importance of Sustainable Infrastructure

Explore how infrastructure serves as the backbone of economic activity, promoting sustainable growth and inclusivity. Discover the challenges faced, including financing gaps and climate vulnerabilities.

Laiba

9/17/2025

Infrastructure constitutes the fundamental backbone of a modern economy, encompassing the physical and organizational structures such as transportation networks, digital connectivity, energy grids, and water systems that enable productive activity. Its role in economic development is unequivocal, serving as a critical catalyst for growth, trade, productivity, and social well-being. Roads and railways reduce transaction costs and connect producers to markets, while ports and airports open doors to international trade. Similarly, reliable electricity networks and digital infrastructure expand the capacity for innovation, industrialization, and service-sector expansion.

In an era of rapid technological advancement and global interconnectedness, strategic investment in resilient and smart infrastructure is more crucial than ever. Without it, countries struggle to harness the benefits of globalization or adapt to the demands of a digital economy. Empirical studies consistently demonstrate a strong positive correlation between infrastructure development and economic growth. Nations with advanced infrastructure tend to experience higher productivity, improved competitiveness, and greater resilience to external shocks. For instance, investment in renewable energy grids and climate-resilient transport systems not only support sustainable growth but also reduces vulnerability to climate-related disruptions. Conversely, inadequate infrastructure acts as a bottleneck, stifling investment, widening inequality, and limiting opportunities for marginalized regions.

Yet, challenges persist. Financing large-scale projects remains a formidable hurdle for developing countries, where public budgets are often constrained and private investment hesitant. Issues of governance, maintenance, and environmental sustainability further complicate the picture. Rapid urbanization, technological change, and climate risks demand adaptive, forward-looking infrastructure strategies rather than short-term fixes.

Ultimately, infrastructure is more than bricks and mortality are the foundation upon which inclusive and sustainable growth is built. Prioritizing smart, resilient, and equitable infrastructure will determine not only the pace of economic progress but also its quality and long-term sustainability.

Typology of Infrastructure

Infrastructure can be broadly divided into two interdependent categories: economic and social. Economic infrastructure refers to systems that directly enhance productive capacity, including transport networks such as highways, ports, airports, and railways that enable the smooth movement of goods and people. Energy infrastructure ranging from power plants and renewable energy farms to pipelines and smart grids—provides the fuel for industrial and household activity. Digital infrastructure, including broadband, 5G networks, fiber optics, and data centers, is the backbone of modern economies, supporting e-commerce, digital services, and innovation ecosystems. Water and sanitation infrastructure, through treatment plants, distribution systems, and waste management, underpins both public health and industrial processes. On the other hand, social infrastructure improves human capital and quality of life. Schools, universities, and vocational training institutions shape the workforce of the future, while hospitals, clinics, and laboratories sustain health and productivity. Affordable housing and urban development projects ensure social stability and inclusiveness. The synergy between economic and social infrastructure is critical: transport without education or health systems leaves growth unsustainable, just as schools and hospitals cannot thrive without energy or digital connectivity.

Theoretical insights reinforce this view. Endogenous growth theory emphasizes that public capital, such as infrastructure and human resources, serves as a long-term growth engine by raising productivity and enabling innovation (Romer, 1990). Keynesian economics highlights the counter-cyclical role of infrastructure spending, which stimulates demand and employment during downturns. Meanwhile, New Structural Economics (Lin, 2012) underscores infrastructure as a precondition for industrial upgrading and diversification.

The mechanisms through which infrastructure drives growth are clear and multifaceted. First, productivity rises as better transport and logistics reduce bottlenecks. Efficient ports or highways lower shipping times, while digital networks speed up transactions. The IMF (2021) estimates that a 1% rise in infrastructure stock raises GDP by 0.15% in the short term and 0.8% in the long run. Second, infrastructure expands trade and market integration. OECD (2023) data shows that low-performing countries on the logistics index could increase trade volumes by 15% if they upgraded to top-tier standards. Third, infrastructure investment generates employment. The Global Infrastructure Hub (2022) calculates that each $1 million invested in traditional projects creates 15–20 jobs, many of which ripple across supply chains. Fourth, robust infrastructure attracts investment. A World Bank (2023) survey found that over half of firms in

developing economies identify poor infrastructure as a major obstacle to growth. Fifth, social infrastructure builds human capital: every additional year of schooling can boost individual income by up to 10% (UNESCO, 2022). Finally, infrastructure underpins climate resilience and sustainability. According to the IEA (2023), over 70% of emission reductions needed by 2050 rely on infrastructure investments such as renewable grids, EV charging networks, and climate-resilient water systems.

Empirical Evidence, Challenges, and Policy Directions in Infrastructure Development

Empirical evidence underscores the immense economic value of infrastructure investment while also highlighting the steep costs of neglect. A 2023 study by the McKinsey Global Institute estimates that closing the global infrastructure gap could raise world GDP by $3.7 trillion annually by 2040, underscoring the transformative potential of well-planned investment. In Africa, however, the African Development Bank (2023) warns that infrastructure deficits shave 2–3 percentage points off national growth rates each year while cutting business productivity by up to 40 percent. Asia shows a contrasting dynamic: according to the Asian Development Bank (2022), each dollar invested in infrastructure generates $1.5 to $2 in long-term output, making it one of the most productive forms of capital formation in the region. These numbers confirm that infrastructure is not merely a supporting factor but a key driver of productivity, competitiveness, and inclusive development.

Despite this, persistent challenges hold back progress. Financing remains the most critical hurdle. The Global Infrastructure Hub (2022) places the investment shortfall at $3.7 trillion annually through 2040, with developing nations facing the sharpest constraints. Governance and corruption compound the issue; the IMF (2022) estimates that inefficiencies and mismanagement erode up to 30 percent of infrastructure value in some countries. Maintenance neglect adds another layer of risk, as governments often favor new projects over upkeep. The American Society of Civil Engineers (2023) calculates that deferred maintenance will cost the US alone $2.6 trillion over the next decade. Climate vulnerability raises the stakes further: the Global Commission on Adaptation (2021) projects that unprotected infrastructure could put $4.2 trillion of global GDP at risk every year by mid-century.

Meeting these challenges requires rethinking policy frameworks for the 21st century. Blended finance and public-private partnerships can bridge funding gaps by leveraging public funds to attract institutional investors such as pension funds and sovereign wealth funds. Embedding smart technologies and green standards into all new projects will not only improve efficiency but also ensure alignment with climate goals. Strengthening institutions through transparent procurement and independent oversight can counter corruption and waste. Governments must also prioritize maintenance, dedicating steady budgets for repairs and retrofitting assets to withstand climate shocks. At the regional level, cross-border projects such as power pools or transport corridors can unlock economies of scale and foster integration. Finally, building local technical capacity and engaging communities ensures that infrastructure is sustainable, inclusive, and resilient.

Conclusion

Infrastructure is more than a facilitator of economic activity; it is the foundation that determines whether growth is inclusive, resilient, and sustainable. The evidence is overwhelming: countries that prioritize infrastructure enjoy higher productivity, stronger competitiveness, and greater social well-being. From roads that connect rural farmers to markets, to digital platforms that power innovation, to renewable grids that support climate goals, infrastructure shapes the pace and quality of development. Yet the challenges are equally clear. Financing gaps, governance failures, neglect of maintenance, and climate vulnerabilities all threaten to undermine progress. These are not peripheral issues but central obstacles that must be addressed if infrastructure is to fulfill its promise.

The way forward lies in rethinking how infrastructure is planned, financed, and maintained. Governments must embrace models that blend public and private capital, embed technology and sustainability into every project, and commit to transparent, accountable governance. Equally important is ensuring that social infrastructure, education, health, and housing, advances alongside economic networks so that growth benefits are widely shared. If nations succeed in building smart, green, and inclusive systems, infrastructure will not just support economic growth; it will define the trajectory of societies in the 21st century. This is where the real contest for future prosperity will be won.

References: AfDB; ADB; GIH; IEA; IMF; McKinsey Global Institute; OECD; World Bank; Lin; Romer

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Trend Analysis of Major Crops in Pakistan: Policy Insight

Explore Pakistan's crop trends Insights on wheat, rice, sugarcane, maize, and cotton with key policy implications for resilience and food security.

Zeeshan Ali

9/22/2025

Agriculture remains the cornerstone of Pakistan's economy, contributing approximately 22.9% to national GDP and employing 37.4% of the labor force (GOP, 2024). Despite the rapid growth of services and industry, agriculture continues to serve as the backbone of rural livelihoods, food security, and export earnings. The sector is dominated by a handful of major crops, i.e. wheat, rice, sugarcane, cotton, and maize, which collectively account for more than 75% of the value added in crop production.

Each of these plays a distinctive role within Pakistan's socio-economic fabric. Wheat, as the principal staple, underpins national food security. Rice, particularly basmati, not only fulfills domestic needs but also generates vital foreign exchange. Sugarcane sustains a large agro-industrial base, linking farmers to sugar mills and associated value chains. Maize has grown in importance as the primary input for the expanding poultry and animal feed industry, while cotton forms the foundation of the textile sector, the largest contributor to Pakistan's exports.

The period from 2000 to 2024 has been marked by both achievements and vulnerabilities. Agricultural performance has fluctuated under the influence of climate-induced shocks floods, droughts, heatwaves, and erratic rainfall patterns posing severe risks to crop yields. Persistent water scarcity, declining soil fertility, and recurrent pest infestations have further constrained productivity. At the same time, uneven technological adoption, from mechanization to improved seed varieties, has created a gap between progressive and resource-poor farmers. Policy inconsistency, with frequent shifts in input subsidies, support prices, and trade regulations, has compounded uncertainty.

Against this backdrop, the present study undertakes a systematic trend analysis of Pakistan's five key crops from 2000 to 2024. By examining output patterns, constraints, and emerging opportunities, it seeks to generate insights that can guide policymakers in strengthening resilience, enhancing productivity, and ensuring the long-term sustainability of Pakistan's agriculture.

Major Crops of Pakistan: Trends, Challenges, and Prospects

Wheat production in Pakistan has demonstrated a positive, though complex, growth trajectory over the last two decades. From approximately 21 million tonnes in 2000-01, production has risen to a record 32.2 million tonnes in 2023–24 (GOP, 2024). This steady increase reflects a combination of policy support and technological adoption. Minimum Support Prices (MSP) and procurement programs have offered farmers a degree of market certainty (Abbas et al., 2023), while the introduction of high-yielding varieties (HYVs), mechanization, and fertilizer use have contributed to productivity gains. Yet, this progress has not come without challenges. Heat stress during critical growth stages, erratic rainfall, water scarcity, and rising input costs increasingly threaten wheat's role as Pakistan's staple crop. Moving forward, the breeding and dissemination of heat- and drought-tolerant varieties, coupled with efficient irrigation techniques such as laser land leveling and drip systems, will be essential to safeguard future yields.

Rice, the second pillar of Pakistan's crop economy, has witnessed remarkable growth, rising from 3.8 million tonnes in 2000–01 to 9.9 million tonnes in 2023–24 (GOP, 2024). Basmati rice, renowned globally for its aroma and grain quality, remains a key export earner. The adoption of hybrid rice varieties and improved management practices has expanded production and export potential. However, the crop's high-water demand makes it increasingly unsustainable. Irrigated rice consumes a disproportionate share of Indus Basin water resources (Qureshi, 2020), placing immense pressure on national water security. Moreover, the crop is highly vulnerable to monsoon irregularities and catastrophic flooding, as seen in 2022. For sustainability, Pakistan must adopt water-saving practices such as alternate wetting and drying (AWD), diversify into high-value aromatic rice, and incentivize farmers to balance profitability with conservation.

Sugarcane has long been a cornerstone cash crop, producing 81 million tonnes in 2023–24 (GOP, 2024). Its guaranteed demand from sugar mills provides income stability and sustains rural employment. However, sugarcane's water intensity and entrenched governance problems are a source of growing concern. Cultivation in Punjab and Sindh consumes significant groundwater resources, contributing to depletion (Dawn, 2023). Chronic payment delays by mills, political interference, and volatile pricing systems undermine farmer confidence. In the long run, sugarcane's sustainability will depend on restructuring the industry to ensure timely farmer payments, reducing the area under cane in water-stressed regions, and promoting alternative crops such as oilseeds and pulses to diversify farm incomes and reduce resource pressure.

Maize represents perhaps the most dynamic success story in Pakistan's agricultural landscape. Production has surged from 1.7 million tonnes in 2000–01 to 10.2 million tonnes in 2023–24, more than doubling since 2008 (GOP,

2024). The rapid expansion has been fueled by rising demand from the poultry and livestock feed sectors and by the widespread adoption of hybrid maize seeds offering substantially higher yields (Ali et al., 2023). Farmers have increasingly shifted from traditional crops to maize due to their profitability and quick returns. Yet, challenges loom. Climatic fluctuations, particularly unseasonal rain during harvest, alongside pest and disease outbreaks, risk undermining these gains. To ensure resilience, investments in climate-smart hybrids, integrated pest management (IPM), and soil fertility management are urgently required. With the right support, maize could continue to serve as a growth engine, not only for farmers but also for Pakistan's rapidly expanding feed industry.

Cotton, once the backbone of Pakistan's agricultural economy, presents a far more troubling story. Production peaked at 14.3 million bales in 2004–05, but has since collapsed, plunging to a historic low of 4.91 million bales in 2022–23, with a modest recovery to 8.22 million bales in 2023–24 (GOP, 2024). This decline has jeopardized the textile industry, forcing heavy reliance on imports and undermining the competitiveness of Pakistan's largest export sector. The causes of this collapse are multifaceted. Repeated pink bollworm infestations, the emergence of resistance to Bt cotton, and the devastating Cotton Leaf Curl Virus (CLCuV) have eroded yields (Nazli et al., 2022). Climate change has further compounded the crisis, with rising temperatures and erratic rains damaging both crop quality and quantity. Frustrated by low returns and high risks, many farmers have abandoned cotton in favor of maize and sugarcane. Revitalizing the sector requires urgent interventions: the development and adoption of pest-resistant genetic varieties, strengthened extension services to manage outbreaks, and attractive pricing policies to make cotton competitive again. Without these steps, Pakistan risks losing its strategic advantage in textiles, a sector that employs millions and earns the bulk of foreign exchange.

Taken together, Pakistan's major crops present a picture of resilience under strain. Wheat remains central to food security but is vulnerable to climate and input pressures. Rice brings foreign exchange but at an unsustainable cost to water resources. Sugarcane sustains incomes yet depletes groundwater and suffers from governance failures. Maize thrives as a success story, though climate and pest challenges remain. Cotton, once the pride of the sector, is in crisis and requires urgent revival. The trajectory of these crops underscores the need for a dual approach: technological innovation to enhance resilience, and policy reforms to align incentives with long-term sustainability. By addressing these issues strategically, Pakistan can protect farmer livelihoods, strengthen food security, and preserve its agricultural competitiveness in an era of mounting climate and market uncertainties.

Policy Pathways for Revitalizing Pakistan's Crop Sector

The analysis of major crop trends from 2000 to 2024 highlights both achievements and vulnerabilities in Pakistan's agricultural sector. Wheat, rice, sugarcane, and maize have demonstrated resilience and growth, underpinning food security, exports, and rural livelihoods. Yet, the catastrophic decline of cotton reveals the fragility of the system when confronted with climate variability, pest outbreaks, and structural inefficiencies. Without decisive policy action, these risks could jeopardize the long-term sustainability of Pakistan's agriculture and compromise national economic stability.

Water security emerges as the foremost priority. With agriculture consuming over 90% of freshwater resources, promoting and subsidizing high-efficiency irrigation systems (HEIS), including drip and sprinkler technologies, is essential to sustain rice and sugarcane cultivation while mitigating groundwater depletion. Equally urgent is the need for climate-resilient agriculture. Investment in breeding heat-tolerant, drought-resistant, and pest-resistant varieties can help safeguard yields against intensifying climate stresses.

Cotton requires special attention through a national-level revival program. This should combine biotechnological innovation to combat pink bollworm and Cotton Leaf Curl Virus, alongside assured procurement and financial incentives to restore farmer confidence. Strengthening agricultural research and extension services is another critical step. By closing the gap between research institutions and farmers, Pakistan can accelerate the adoption of improved seeds, water-saving practices, and integrated pest management.

Finally, market reforms must address inefficiencies that distort farmer incentives. Transparent pricing mechanisms guarantee timely payments particularly in the sugar sector and stronger farmer cooperatives would ensure fairer returns and more resilient rural incomes.

Conclusion

The trajectory of Pakistan's major crops from 2000 to 2024 reflects both resilience and vulnerability, underscoring the sector's critical importance to food security, livelihoods, and exports. Wheat and rice remain pillars of the agricultural economy, yet both face mounting challenges from climate variability and resource constraints. Sugarcane continues to sustain rural incomes but at an unsustainable cost to groundwater resources and institutional stability. Maize has emerged as a dynamic success story, driven by hybrid adoption and expanding demand, though its future hinges on resilience against climatic and biological stresses. Cotton, once the pride of Pakistan's agricultural and industrial base, now stands in crisis, threatening the country's textile competitiveness and rural employment.

These contrasting trends emphasize that Pakistan's agricultural future cannot rely solely on increasing production. Instead, it demands a strategic reorientation toward resilience, sustainability, and equity. Water-efficient technologies, climate-resilient crop varieties, and strong

research–extension linkages must form the foundation of this transformation. Equally vital are institutional reforms that ensure transparent pricing, timely farmer payments, and the revival of cotton through biotechnology and assured incentives. By pursuing these integrated strategies, Pakistan can not only stabilize crop production but also secure the dignity and prosperity of its farming communities in an era of intensifying uncertainty.

References: Abbas, et al; Ali et al; Dawn; GOP; Nazli et al; Qureshi, Ullah et al; World Bank

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Pakistan's Water Dilemma: Between Scarcity and Floods

Pakistan's water dilemma is one of the gravest challenges it faces in the 21st century. With every passing year, water scarcity deepens, while floods become more destructive. Both crises feed into one another, exposing the weakness of infrastructure, governance, and planning.

Nadeem Riyaz

9/24/2025

"First we drowned, now we are dying of thirst." These haunting words, uttered by a Sindhi farmer in the midst of the 2022 floods, encapsulate Pakistan's cruel irony. In a single year, a nation transitions from deluge to drought. That year, one-third of the country was submerged as villages vanished, crops drowned, and livelihoods were swept away. Yet, just months later, fields lay cracked, barren, and begging for irrigation.

This is not an isolated tragedy but a recurring national calamity in Pakistan. The World Bank warns that *"Pakistan's water crisis is not merely an environmental challenge; it is a fundamental threat to economic stability and human survival."* The stakes are existential. In the words of a water expert "the wars of the next century will be fought over water, not oil." For Pakistan, that war has already begun in fields, streets, and aquifers.

The Emerging Crisis of Water Scarcity

Water abundance seem assured when Pakistan was created in 1947. The Indus Basin provided vast irrigation potential, and per capita water availability was estimated at 5,260 cubic meters. Unfortunately, today, this figure has plummeted below 1,000 cubic meters which is the threshold for water scarcity according to the UN.

Several factors have driven this decline. Pakistan's population now exceeds 240 million, tripling demand. Nearly 90–93% of freshwater is consumed by agriculture, yet outdated flood irrigation loses 50–60% of applied water. Meanwhile, over 1.2 million unregulated tube wells have caused aquifer depletion and salinity. Seasonal surface-water storage remains arrested at merely 30 days, compared to 170 days in India.

The effects are already manifesting. Household tap water in Karachi delivers only hours per week, forcing residents to pay exorbitant rates to tanker operators. Rural women trek miles for water, and contaminated supply contributes to widespread disease and death. As one report summed up: water scarcity in Pakistan is no longer future, it is now.

The Paradox of Flooding

Yet scarcity tells only half the story. Pakistan is among the most flood-prone nations, where monsoon rains and glacial melt regularly conspire to wreak havoc.

The 2010 floods engulfed a fifth of the country, affecting 20 million people and inflicting $10 billion in damages. The 2022 deluge was even worse and damages were estimated at nearly $15 billion, economic losses to $15.2 billion, and reconstruction needs to $16.3 billion. The floods claimed 1,739 lives, left over two million homes destroyed, and displaced eight million people.

In addition, ongoing monsoon flows have proven lethal again in 2025. Over 780 people, including 200 children, have died following rapid floods in Khyber Pakhtunkhwa, where villagers describe torrents moving in "seconds". In Punjab, floods triggered by rising Ravi, Sutlej, and Chenab rivers have displaced over 28,000 people, and authorities have evacuated 150,000 more after dam-related warnings.

Why both Problems Persist Together

Pakistan's chronic struggle with both drought and deluge stems from a profound mix of natural vulnerabilities and man-made failures. At the core is an almost total dependency on the Indus River system which accounts for over 90% of the nation's water supply. Any deviation in its flow, whether from scarcity during drought or sudden inundation in the wet season, immediately threatens agricultural production, power generation, and the very survival of communities.

This fragile setup is further weakened by a glaring absence of water storage infrastructure. With few reservoirs, dams, or rainwater harvesting systems in place, the country is unable to retain surplus monsoon water allowing torrents to rush directly into the Arabian Sea, even as millions endure acute water shortages during the rest of the year.

Compounding the problem, environmental degradation runs unchecked. Deforestation in catchment areas accelerates runoff and siltation, undermining the ground's ability to absorb rainfall and recharge aquifers. Moreover, encroachments on floodplains obstruct natural drainage, turning seasonal floods into long disasters of human and economic toll.

Governance complicates matters further. The division of water management between federal and provincial authorities has spawned fragmentation and policy paralysis. Too often, Pakistan finds itself reacting to disasters deploying relief after the flood rather than preventing them through proactive planning and investment.

Rapid, unplanned urbanization has delivered its own crisis in the form of urban flooding. In Karachi, natural waterways have been reshaped by unregulated expansion. Entire bazaars, parking lots, residential blocks, and even

parts of a women's college now sit atop stormwater drains. This has choked the city's once-effective drainage system, turning monsoon rains into rivers inside streets and homes. As a scholar from Dawn noted, "Storm drains in Karachi no longer work well," and the dumping of solid waste, sand mining, and elevated road construction only exacerbate the risk.

These systemic faults are currently playing out in Punjab's river basins. In August 2025, unusually intense monsoon rains combined with upstream water releases led to torrents in the Ravi, Sutlej, and Chenab rivers. Over 150,000 people were evacuated, whole villages submerged, and critical roads and farmland devastated. The Army and civil authorities had to coordinate emergency evacuations.

Despite some evacuation successes, the human cost remains steep. This year hundreds of lives have been lost, infrastructure lies in ruins, and livelihoods have been shattered across KPK and Punjab's heartland. The merging of natural intensity with systemic breakdowns clearly demonstrates that Pakistan's water crisis is both a climatic and governance emergency.

The Way Forward

Pakistan's water crisis demands a phased response, beginning with urgent measures and extending into structural reforms. In the immediate term, authorities must scale up early warning systems and ensure drainage channels are cleared before the arrival of the monsoons. Swift action is also needed to support flood-affected farmers by providing drought-resistant seeds, fertilizers, and timely grants that can prevent households from slipping further into poverty.

Medium-term measures should focus on resilience at the community level. Building small to medium-sized dams, recharge wells, and village ponds will strengthen local water storage. Agriculture, which consumes the bulk of Pakistan's water, must also evolve toward efficiency. Techniques such as drip irrigation and laser land leveling can save significant volumes, while shifting cropping patterns toward less water-intensive species will further ease pressure on scarce supplies. Institutionalizing rainwater harvesting across both rural and urban settings can recharge aquifers and reduce dependence on dwindling groundwater.

Over the long term, however, only structural reforms can safeguard Pakistan's future. Integrated planning of the Indus Basin is essential to overcome provincial rivalries and foster cooperation. Rationalized water pricing can incentivize conservation, provided safeguards are built in to protect vulnerable communities.

At the same time, Pakistan must actively tap into international climate finance to fund resilience-building infrastructure, from glacier monitoring systems to modern irrigation networks. Yet reforms cannot succeed without a cultural shift. Public education, media campaigns, and even religious platforms must normalize water stewardship as a civic responsibility, instilling the idea that saving water is not simply an economic necessity but a moral and national duty.

Conclusion

Pakistan's water dilemma is one of the gravest challenges it faces in the 21st century. With every passing year, water scarcity deepens, while floods become more destructive. Both crises feed into one another, exposing the weakness of infrastructure, governance, and planning.

Water is life. For Pakistan, learning to manage both its abundance and scarcity is not just a policy option but a matter of survival. This dilemma is not insurmountable. With smart investments, stronger institutions, and community engagement, Pakistan can transform its water management from a liability into an asset. The choice is urgent and stark: either continue swinging between parched fields and drowned villages, or chart a sustainable path toward a water-secure future.

In Pakistan water is not just a resource, it is the lifeblood of its food, livelihoods, and its sovereignty. The country's future demands more than policy, it demands a national revival. Because in the end, it won't be just water at stake, it will be the fate of the nation.

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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Reviving Pakistan's Citrus Economy with Climate-Smart Solutions

Discover how climate change, pests, and water scarcity threaten Pakistan's kinnow industry, and explore policy solutions for a resilient citrus economy.

Muhammad Ather Nadeem

9/25/2025

The kinnow industry in Pakistan stands at a decisive crossroads, with its traditional hub in Sargodha losing ground. Once celebrated as the "citrus capital" of the country, Sargodha's orchards are shrinking as farmers shift toward safer and more predictable crops such as wheat, fodder, or even sugarcane. The reasons are clear: rising production costs, falling profitability, and climate-induced risks have made kinnow cultivation increasingly unviable (Pakistan Economic Survey, 2023–24).

Climatic stressors represent the most pressing challenge. Heatwaves coinciding with the flowering stage reduce fruit set, while irregular rainfall and recurring droughts compromise both fruit size and juice content. The delicate sugar-to-acid ratio that determines taste and export quality has also been disrupted, leaving Pakistani kinnow less competitive in global markets (Jain et al., 2025). At the same time, warmer winters, once rare, have intensified pest and disease outbreaks. Citrus Greening Disease (Huanglongbing or HLB), caused by a bacterial pathogen and transmitted by psyllid insects, has now reached alarming levels, infecting an estimated 30–40% of trees in some of the core growing regions. In addition, fruit fly infestations have become widespread, not only reducing yields but also directly undermining export eligibility, as international buyers impose zero-tolerance policies for fruit fly presence (Iqbal et al., 2024).

These interlinked pressures have curtailed access to lucrative export destinations such as the European Union, which enforce strict Sanitary and Phytosanitary (SPS) standards. As a result, Pakistan has been forced to rely heavily on lower-value markets in Central Asia, the Middle East, and Russia. This shift has limited foreign exchange earnings and eroded farmer incentives to sustain kinnow production. Without urgent interventions ranging from integrated pest management and disease-resistant varieties to climate-smart practices, the decline of the kinnow industry may accelerate, threatening both rural livelihoods and the country's export potential (World Bank, 2023).

Key Challenges

The kinnow industry in Pakistan faces a series of interconnected and systemic challenges that are eroding its long-term sustainability and export competitiveness. At the forefront is orchard decline, as farmers across the traditional citrus belt, particularly in Sargodha, are increasingly abandoning kinnow cultivation. This shift is largely driven by climate-induced stress, higher production costs, and declining profitability, which make alternative crops like wheat and fodder more attractive. The shrinking orchard base poses a serious threat to the sector's future production capacity.

Equally concerning is the degradation in yield and fruit quality. Rising temperatures, erratic rainfall, and persistent water shortages have collectively undermined both productivity and marketable quality. The sugar-acid balance, fruit size, and juice content, all critical for consumer preference and export standards, are adversely affected. Compounding this, post-harvest losses remain high, with an estimated 25–30% of fruit lost annually due to inadequate handling, lack of cold storage, and outdated transportation systems (FAO, 2023).

Pest and disease epidemics further intensify the crisis. Citrus Greening (HLB), one of the most destructive citrus diseases globally, has already infected a significant proportion of orchards, while fruit flies remain a persistent problem that undermines export eligibility. Left unmanaged, these biotic threats risk causing widespread orchard to decline and eventual collapse.

Water scarcity and soil salinization add another layer of complexity. The widespread reliance on flood irrigation, in an era of increasing water shortages, not only wastes resources but also worsens soil salinity. These conditions weaken trees, reduce productivity, and, in many cases, force farmers to abandon orchards altogether (Howlader et al., 2024).

Finally, the erosion of export competitiveness is perhaps the most visible symptom of these challenges. With fruit quality falling short of international Sanitary and Phytosanitary (SPS) standards, Pakistan has lost ground in high-value markets like the EU, leading to declining export volumes and revenues. Unless systemic reforms are undertaken, the sector risks further marginalization in global citrus trade.

Policy Recommendations

Reviving the kinnow industry in Pakistan requires a holistic and coordinated approach that addresses both immediate constraints and long-term structural challenges. A priority is orchard revitalization in Sargodha Division, the country's core kinnow belt. Many orchards are old, unproductive, and highly vulnerable to disease. A targeted Citrus Rejuvenation Program should be launched, providing subsidies for the removal and replanting of aging trees with certified, HLB-free, and climate-resilient rootstocks. Complementary practices such as crop rotation and intercropping with legumes can restore soil fertility

while generating interim income for farmers during the replanting phase.

Equally critical is climate-smart water management. With water scarcity intensifying, the widespread adoption of high-efficiency irrigation systems (HEIS), including drip and sprinkler systems, is vital. These technologies can cut water use by 40–60% while boosting yields (UN-Water, 2023). Additional measures such as mulching, cover cropping, and rainwater harvesting structures should be incentivized to conserve soil moisture, reduce heat stress, and enhance climate resilience at the farm level.

Combating biotic stress requires robust integrated pest and disease management (IPM). A real-time Citrus Disease Surveillance and Alert System across Punjab would enable early detection of HLB outbreaks. Simultaneously, IPM practices for fruit fly control, male annihilation, protein baiting, orchard sanitation, and biological control, must be scaled up. Training farmers in safe, targeted pesticide use will also ensure sustainability.

Strengthening the industry's competitiveness demands export-oriented infrastructure and compliance. Investments in modern packhouses, cold storage units, and logistics facilities in Sargodha can reduce post-harvest losses, currently estimated at 25–30%. Introducing a "Climate-Resilient Kinnow" certification protocol will reassure international buyers, while building exporter capacity to comply with EU cold treatment protocols can help Pakistan regain access to high-value markets.

Finally, enhancing resilience requires risk management and financial inclusion. Index-based crop insurance schemes tailored to citrus growers should be introduced, with payouts linked to weather parameters such as temperature extremes or rainfall deficits. A Citrus Resilience Fund, co-financed by the public and private sectors, can provide concessional loans for smallholders to adopt climate-smart technologies. Coupled with this, institutional strengthening and research are essential. Establishing a Citrus Research & Innovation Hub at the University of Sargodha will accelerate the development of heat- and disease-resistant varieties, while farmer-producer organizations (FPOs) and cooperatives can boost bargaining power, market access, and technology adoption.

Conclusion

The future of Pakistan's kinnow industry hinges on how effectively the country responds to the intersecting challenges of climate change, pest and disease outbreaks, and declining export competitiveness. Once a symbol of prosperity in Sargodha, kinnow cultivation now faces an existential threat as orchards shrink, yields decline, and farmers lose faith in citrus as a profitable enterprise. Left unchecked, this decline will not only undermine rural livelihoods but also weaken Pakistan's agricultural exports and its ability to earn much-needed foreign exchange.

Yet, this trajectory is not irreversible. The proposed set of reforms, orchard rejuvenation, climate-smart irrigation, integrated pest and disease management, modernized infrastructure, and inclusive financial mechanisms, offers a clear roadmap for revival. By investing in resilient rootstocks, sustainable water use, and farmer capacity-building, Pakistan can restore productivity and competitiveness. Equally important is regaining access to high-value markets through compliance with international quality and SPS standards.

The kinnow industry is more than a fruit sector; it is a cornerstone of rural economies, a source of employment, and a symbol of Pakistan's agricultural identity. With timely interventions and coordinated policy action, kinnow can once again thrive as a driver of resilience, profitability, and global recognition.

References: FAO; Howlader et al; Iqbal et al; Jain et al; PBS; GOP; SBP; TDAP; UN-Water; World Bank.

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Globalization's Impact on Small-Scale Farmers

Explore how globalization has reshaped agriculture for small-scale farmers, providing access to international markets and premium pricing. Discover the role of mobile platforms, cooperatives, and agroecological practices in enhancing resilience and sustainability in farming.

Muhammad Hammad Khan

9/2/2025

Globalization, the growing interconnectedness of nations through trade, investment, information, and cultural exchange, has dramatically transformed agriculture worldwide. For the over 570 million small-scale farmers who collectively produce roughly 35% of global food, these changes present both unprecedented opportunities and significant challenges (FAO, 2023; Lowder et al., 2021). On one hand, integration into global markets provides access to advanced agricultural technologies, improved inputs, and knowledge-sharing platforms that can boost productivity and efficiency. Farmers can potentially reach international buyers, diversify income sources, and participate in value chains that were previously inaccessible.

On the other hand, globalization exposes smallholders to intense competition from large-scale agribusinesses and multinational corporations. Price volatility, fluctuating demand, and global supply chain disruptions can disproportionately affect those with limited capital, technology, or bargaining power. Trade liberalization and liberalized markets may also reduce protective mechanisms such as local price support, leaving farmers more vulnerable to shocks. Climate change further amplifies these risks, as extreme weather events intersect with global market pressures, threatening both yield stability and income security.

Small-scale farmers are adopting diverse strategies to navigate this complex environment. Many form cooperatives to pool resources, share knowledge, and enhance market access. Others engage in niche or high-value crops, organic production, or direct-to-consumer marketing to capture premiums and reduce dependency on volatile commodity markets. Digital platforms and mobile technologies are increasingly used for market information, financial services, and climate-smart advisories, helping farmers improve decision-making and resilience.

Ultimately, globalization is neither inherently beneficial nor detrimental for small-scale farmers. Its impact depends on the extent to which they can access technology, markets, finance, and supportive institutions. Policies and interventions that strengthen these capacities will determine whether smallholders can turn global integration into sustainable growth and inclusive development.

Opportunities and Challenges for Small-Scale Farmers

Globalization has reshaped agriculture by intensifying production, promoting specialization, and favoring large, export-oriented farms. This process has deepened the divide between well-capitalized commercial operations and small, often family-run farms. Many smallholders are increasingly pushed into marginal lands or peri-urban areas, where soil fertility may be lower, markets are local, and pressures from urban expansion are rising (Zasada, 2011). This geographic and economic marginalization reflects a system that prioritizes economies of scale and standardized output for global supply chains, often at the expense of diverse, localized farming systems (Ouma, 2016; Ye, 2015).

Globalization has brought tangible benefits for some smallholders. Access to niche international markets for certified products, such as Fairtrade and organic goods, has grown to over €12 billion globally, offering premium prices to farmers participating in these markets (Fairtrade International, 2023). Coffee cooperatives in Latin America and cocoa producers in West Africa have leveraged these markets to improve incomes and strengthen local institutions. Digital technologies have also empowered smallholders. Mobile platforms like Esoko and iCow in Sub-Saharan Africa provide real-time market information, weather updates, and agronomic advice, helping farmers make more informed decisions and increasing incomes by 10–15% (World Bank, 2022).

Yet the negative consequences of globalization are pronounced. Small-scale farmers are price-takers and highly exposed to global commodity volatility. The 2007–08 and 2022–23 food crises revealed how speculation and export restrictions elsewhere can devastate households that rely on stable prices (IFPRI, 2023). Corporate consolidation in seeds and agrochemicals has raised input costs and created dependency, contributing to debt crises and high rates of farmer suicides in India, where over 10,000 deaths occur annually (National Crime Records Bureau of India, 2022). Environmental stress is another concern: in Punjab, India, water-intensive rice cultivation for export has over-exploited 78% of administrative blocks, threatening long-term sustainability (Central Ground Water Board, India, 2021). Meanwhile, structural adjustment programs and trade liberalization have reduced public support for agriculture, leaving governments in developing regions spending just 5.5% on agriculture, far below the 10% target of the Malabo Declaration (FAO, 2022).

Case studies illustrate these pressures. Smallholder coffee producers in Honduras and Mexico face climate change, rising costs, and volatile prices,

forcing some to abandon farming or migrate (Harvey et al., 2021). In South Asia, rice farmers confront competition from cheap imports and must meet strict international standards, often without adequate institutional support, threatening their viability (Das, 2022).

Globalization presents a dual-edged reality: it opens pathways for innovation and market access, yet it exposes small-scale farmers to vulnerability, marginalization, and environmental strain. Policy interventions, technological support, and inclusive market mechanisms are essential to ensure that smallholders can benefit from globalization without being left behind.

Strategies for Adaptation and Resilience among Small-Scale Farmers

Small-scale farmers, despite being highly exposed to the pressures of globalization and environmental change, actively develop strategies to adapt and strengthen their resilience. One key approach is collectivization. By forming cooperatives, producer organizations, or farmer networks, smallholders can pool resources, purchase inputs in bulk at lower costs, and negotiate better prices for their products. These collective structures also provide a platform for shared knowledge, risk mitigation, and access to financial services, helping farmers compete more effectively in both local and international markets.

Another critical strategy is the adoption of agroecological practices. Diversified farming systems that incorporate crop rotation, intercropping, organic fertilization, and soil and water conservation reduce dependency on costly external inputs while enhancing environmental sustainability. Agroecology not only improves soil fertility and biodiversity but also strengthens resilience to climate shocks such as droughts, floods, and temperature fluctuations. International bodies, including the UNFCCC, now recognize agroecology as an essential approach for climate adaptation in agriculture.

Digital inclusion has also emerged as a transformative tool. Mobile phones, apps, and online platforms enable farmers to access real-time market prices, weather forecasts, climate-smart advisory services, and mobile financial solutions. Such tools improve decision-making, reduce post-harvest losses, and facilitate access to credit and insurance, empowering smallholders to manage risks more effectively.

Finally, policy advocacy is a vital long-term strategy. Small-scale farmers and their organizations increasingly engage with policymakers to secure land tenure, influence trade regulations, and advocate for public investment in infrastructure, research, and extension services tailored to their needs. By participating in policy dialogues and leveraging networks at national and international levels, farmers can push for institutional reforms that recognize their contributions and safeguard their economic viability.

Conclusion

Globalization has transformed agriculture into a double-edged arena for small-scale farmers. On one hand, it offers unprecedented opportunities: access to international markets, premium prices through ethical and certified products, modern inputs, and digital tools that enhance decision-making and financial inclusion. Initiatives like mobile platforms, cooperatives, and producer organizations enable smallholders to capture these benefits, build capacity, and improve resilience. Agroecological practices further strengthen their ability to withstand climate shocks while promoting sustainable production.

On the other hand, globalization exposes farmers to volatility, corporate consolidation, environmental stress, and policy neglect. Smallholders often operate at the margins of fertile lands, face competition from well-capitalized commercial farms, and confront fluctuating global prices that can wipe out incomes overnight. Reduced public investment, dependence on proprietary seeds, and environmental degradation exacerbate their vulnerability. Case studies from Latin America, South Asia, and Sub-Saharan Africa illustrate that without strategic support, globalization can drive marginalization, debt crises, and even migration away from farming.

The path forward requires a proactive, multi-dimensional approach. Strengthening cooperatives, adopting climate-resilient and diversified farming practices, ensuring digital and financial inclusion, and engaging in policy advocacy are critical. Governments, development partners, and market actors must support smallholders with infrastructure, credit, training, and market access, while safeguarding environmental and social sustainability.

Ultimately, globalization is neither inherently positive nor negative for small-scale farmers. Its impact hinges on the capacity to navigate complex markets, leverage technological tools, and participate in inclusive institutions. With the right mix of strategies and supportive policies, smallholders can transform global integration into a source of sustainable growth, economic inclusion, and resilient rural development.

References: African Union; FAO; Central Ground Water Board, India; Das; Fairtrade International; Harvey et al.; IFPRI; Lowder et al.; NCRB, India; Ouma; World Bank; Ye; Zasada

References: Carbon Robotics; FAO; Google AI Blog; IWMI; Zhang & Wang; United Nations; World Bank

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Water Scarcity in Pakistan: A Growing Crisis

Explore the critical issue of water scarcity in Pakistan, driven by population growth and climate change. Learn how the Indus River basin's declining water availability affects agriculture, economy, and food security, and discover the challenges faced by Punjab and Sindh.

Muneeb ur Rahman

9/3/2025

Water is the cornerstone of human survival, economic stability, and agricultural productivity. In Pakistan, where agriculture contributes nearly 23% to GDP and employs over a third of the workforce, water scarcity is an urgent and growing concern. The country faces a precarious balance between rising demand and declining availability, exacerbated by rapid population growth, urbanization, and industrial expansion. Climate change compounds the problem, altering rainfall patterns, accelerating glacial melt in the northern mountains, and intensifying the frequency of floods and droughts. These shifts threaten crop yields, livestock productivity, and ultimately food security.

Agriculture accounts for approximately 90% of Pakistan's water consumption, yet inefficient irrigation practices, outdated canal systems, and high rates of water loss through seepage and evaporation undermine effective utilization. Over-extraction from rivers and groundwater further depletes reserves, creating long-term sustainability risks. Compounding these technical challenges are socio-economic and policy factors, including fragmented water governance, limited investment in infrastructure, and inequitable distribution among provinces and smallholder farmers.

Addressing Pakistan's water crisis requires integrated and multi-level solutions. Modernizing irrigation through precision techniques such as drip and sprinkler systems can dramatically reduce wastage. Strengthening water governance, including equitable allocation policies and participatory management frameworks, is essential to balance agricultural, industrial, and domestic needs. Investments in water storage infrastructure, rainwater harvesting, and groundwater recharge can buffer against seasonal variability. Additionally, promoting crop diversification towards less water-intensive varieties and integrating climate-resilient agricultural practices can enhance efficiency.

Ultimately, sustainable water management in Pakistan is inseparable from national food security, economic resilience, and social stability. By combining technological innovation, policy reform, and stakeholder engagement, the country can safeguard its freshwater resources, ensuring that agriculture continues to support livelihoods and development in an increasingly water-constrained future.

Irrigation and Water Management

Agriculture forms the backbone of Pakistan's economy, contributing 22.9% to GDP and employing 37.4% of the workforce (Pakistan Economic Survey, 2023-24). Its productivity hinges on irrigation, with over 90% of agricultural output and 80% of export earnings dependent on the Indus River Basin's extensive canal network (World Bank, 2022). Despite hosting the world's largest contiguous irrigation system, Pakistan has shifted from water abundance to scarcity. Per capita water availability has declined from over 5,000 cubic meters in 1951 to less than 900 cubic meters today, well below the global scarcity threshold of 1,000 cubic meters (PCRWR, 2023). This decline reflects increasing population pressure, rising industrial demand, climate variability, and inefficiencies in water management.

The Indus Basin Irrigation System (IBIS) spans 1.12 million square kilometers and forms the hydrological backbone of the country. Under the 1960 Indus Waters Treaty (IWT) with India, Pakistan controls the western rivers, Indus, Jhelum, and Chenab, while the eastern rivers flow to India. The system comprises three major dams, Tarbela, Mangla, and Chashma, with a combined live storage capacity of only 14.3 Million Acre Feet (MAF), far below the annual river flow of approximately 145 MAF (IRSA, 2023). Additionally, 19 barrages, 12 link canals, over 58 main canals, and 100,000 watercourses distribute water across 18 million hectares. Aging infrastructure and transmission losses exceeding 40% due to seepage and evaporation dramatically reduce the water that reaches farms (Qureshi, 2020).

To compensate for inconsistent canal supplies, farmers increasingly rely on groundwater. Pakistan ranks as the fourth-largest global user of groundwater, with over 1.2 million tube wells extracting water at unsustainable rates (Qureshi & Ashraf, 2019). Water tables in Punjab and Sindh are declining by 0.5 to 1.0 meters annually (PCRWR, 2023). Moreover, in more than half of the Indus Basin, groundwater is brackish or saline, threatening soil fertility and long-term agricultural viability.

These challenges underscore the urgent need for integrated water management strategies. Modernizing canal infrastructure, promoting efficient irrigation technologies such as drip and sprinkler systems, regulating groundwater extraction, and implementing watershed management can help sustain agricultural productivity. Without immediate reforms, Pakistan's agriculture and by extension its economy and food security faces increasing vulnerability to water scarcity, climatic shocks, and environmental degradation.

Challenges and Pathways in Pakistan's Water Resource Allocation

Water allocation and management in Pakistan face a complex web of interrelated challenges, threatening both agricultural productivity and national food security. Climate change stands as a foremost driver of uncertainty. Pakistan ranks among the top ten countries most vulnerable to climate-related hazards. Altered monsoon patterns, coupled with accelerated melting of Himalayan glaciers that supply up to 80% of the Indus River's flow, have amplified variability in water availability, creating alternating extremes of floods and droughts (IUCN, 2022).

Agriculture, consuming 93% of national water resources, suffers from extremely inefficient use. Flood irrigation dominates 90% of farms, resulting in substantial wastage. Consequently, Pakistan's water productivity, crop yield per unit of water, is among the lowest globally (World Bank, 2022). Compounding these technical inefficiencies are institutional and governance issues. Inter-provincial disputes over water allocations are recurrent, with provinces contesting allocations during critical periods, accusing one another of theft or mismanagement. Despite the National Water Policy (2018), weak implementation, nominal pricing, and limited institutional capacity hamper effective water management. Coordination between federal and provincial agencies remains fragmented, leaving systemic gaps in policy enforcement.

Addressing these challenges requires a multi-pronged approach. Modernizing irrigation infrastructure is vital; lining canals and promoting High-Efficiency Irrigation Systems (HEIS) such as drip and sprinkler irrigation can save 30–50% of water compared to flood irrigation (PM's National Agriculture Emergency Program, 2023). Expanding storage capacity through projects like the Diamer-Bhasha Dam can help manage floodwaters, mitigate droughts, and stabilize supply. Groundwater regulation, including licensing and promoting solar-powered, water-efficient extraction technologies, is essential to prevent over-abstraction.

Integrated Water Resource Management (IWRM) offers a framework for sustainable allocation, using tools such as Water Evaluation and Planning (WEAP) to simulate distribution scenarios under varying climate and usage conditions. Governance reforms are equally critical. Strengthening IRSA's technical capacity and authority, revising water pricing to incentivize conservation while safeguarding smallholders, and empowering Water User Associations (WUAs) to manage local resources can create a more equitable, efficient, and resilient system.

Conclusion

Water scarcity in Pakistan has emerged as a defining challenge for the country's agriculture, economy, and food security. Despite the historical abundance of the Indus River Basin, per capita water availability has fallen below the global scarcity threshold, driven by population growth, industrial expansion, and climate variability. Agriculture, consuming over 90% of national water resources, faces acute inefficiencies due to outdated irrigation methods, aging canal infrastructure, and excessive reliance on groundwater. The resulting over-extraction has caused declining water tables, soil salinity, and long-term threats to productivity, particularly in Punjab and Sindh.

Addressing these pressures requires integrated and multi-level interventions. Modernizing irrigation infrastructure, including the widespread adoption of high-efficiency systems such as drip and sprinkler irrigation, can substantially reduce water wastage. Expanding storage through large dams, coupled with watershed management and rainwater harvesting, would buffer against seasonal variability. Effective groundwater regulation, including licensing, monitoring, and promotion of solar-powered efficient pumping systems, is essential to prevent over-abstraction.

Equally important are governance reforms. Strengthening the technical capacity and authority of IRSA, implementing data-driven allocation models, revising water pricing to incentivize conservation, and empowering Water User Associations to manage local resources can foster equitable and sustainable water distribution.

Ultimately, water security in Pakistan is inseparable from national food security and economic resilience. By combining technological innovation, infrastructural investment, and institutional reform, Pakistan can safeguard its freshwater resources, enhance agricultural productivity, and ensure that its agrarian economy continues to support livelihoods and development in the face of mounting environmental and socio-economic pressures.

References: Government of Pakistan; IRSA; PCRWR; Qureshi; Qureshi & Ashraf; World Bank; IUCN

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Transforming Agriculture with Renewable Energy Solutions

Explore how renewable energy, including solar, wind, biomass, and geothermal technologies, is revolutionizing agriculture by reducing costs, enhancing efficiency, and promoting sustainable farming practices. Discover the benefits of integrating renewables for a climate-resilient future.

Raana Awab Sarfraz

9/8/2025

Energy forms the backbone of modern economies, driving industrial growth, transportation, and essential services, while underpinning socio-economic development at both national and local levels. Agriculture is an energy-intensive sector. Irrigation systems, mechanized plowing, harvesting machinery, cold storage, and processing facilities consume vast amounts of electricity and fuel, much of it derived from non-renewable fossil sources. This heavy reliance creates multiple challenges: farmers and agribusinesses remain exposed to fluctuating fuel prices, operational costs rise unpredictably, and greenhouse gas emissions accumulate, contributing to climate change.

Renewable energy (RE) technologies offer transformative solutions. Solar photovoltaics can power irrigation pumps, cold storage, and greenhouse systems, reducing dependency on diesel generators and grid electricity. Wind energy, biomass digesters, and geothermal systems provide decentralized, reliable energy for on-farm operations while creating additional income streams, such as selling surplus energy to local grids. Beyond decarbonization, integrating RE enhances resource efficiency by enabling precision irrigation, reducing post-harvest losses, and lowering operational costs.

Globally, numerous case studies demonstrate the potential of RE adoption in agriculture. India and China have successfully deployed solar irrigation programs, cut diesel consumption and improving water-use efficiency. European countries utilize wind and biomass energy for integrated farm operations, while Israel combines solar power with drip irrigation to achieve high yields under water-scarce conditions.

The future of sustainable agriculture depends on scaling these innovations. Policy incentives, public-private partnerships, and access to financing are essential to support farmers in adopting renewable energy solutions. By embedding RE into agricultural systems, the sector can mitigate climate risks, enhance energy security, and strengthen both economic resilience and environmental stewardship. Renewable energy is not just a technical upgrade, it is a strategic pathway toward a resilient, productive, and sustainable agricultural future.

The Energy Imperative in Modern Agriculture

Global energy demand continues to rise, and agriculture represents a significant share, accounting for roughly 30% of total energy use when both direct and indirect consumption are considered (FAO, 2022). Traditionally, this demand has been met almost entirely through fossil fuels, exposing farmers to volatile fuel prices, operational uncertainty, and long-term environmental consequences. Agriculture alone contributes over 20% of global greenhouse gas emissions, highlighting the sector's central role in climate change mitigation (IPCC, 2022).

Energy use in agriculture can be categorized as direct and indirect. Direct energy powers machinery, irrigation pumps, transportation, and on-farm processing such as drying and refrigerating. Indirect energy encompasses the embedded energy in inputs like synthetic fertilizers, pesticides, and other agrochemicals. Notably, nitrogen-based fertilizer production accounts for more than half of the energy used in crop production (IEA, 2021), illustrating the intensity of conventional practices. With the global population projected to approach 9.7 billion by 2050 (UN DESA, 2022), pressure to expand food production will further intensify energy demands, making energy efficiency and renewable adoption critical to sustainability.

Renewable energy technologies can transform agricultural production while mitigating costs and environmental impact. Solar-powered irrigation pumps eliminate diesel dependency and enable cultivation in remote areas. Hybrid solar and geothermal systems regulate greenhouse climates, reducing energy costs and emissions. Precision agriculture benefits from solar-powered IoT sensors, enhancing real-time monitoring of soil and crop health. Post-harvest processes, including solar dryers and biomass-powered heaters, minimize losses while decreasing reliance on grid electricity. Anaerobic digesters convert agricultural waste into biogas, producing heat, electricity, and organic fertilizer, creating closed-loop, circular systems. Solar-powered cold storage preserves perishable goods, reducing food waste and extending market reach.

Across the globe, countries like Israel, India, and China have demonstrated the effectiveness of integrating renewable energy into agriculture. From solar irrigation to biomass waste conversion, these innovations enhance productivity, reduce costs, and strengthen resilience against climate variability. For Pakistan and other energy-intensive agricultural economies, embracing renewable energy is not merely an environmental choice, it is a strategic pathway to energy security, economic stability, and long-term sustainability. By embedding renewables throughout the sector, agriculture can evolve into a resilient, climate-smart, and efficient engine for national growth.

Case Studies in Renewable Energy Integration for Agriculture

Agriculture's heavy reliance on conventional energy sources has long posed economic and environmental challenges. Solar and biogas technologies provide practical pathways to reduce dependency on fossil fuels, enhance productivity, and promote sustainability. In Punjab, Pakistan, farmers historically relied on diesel pumps or grid electricity for irrigation, both of which were costly and unreliable. The introduction of solar photovoltaic (PV) irrigation pumps, supported by government and international development programs, has transformed water access for these farms. Recent studies indicate that solar pumps reduce energy costs by up to 70% compared to diesel alternatives (WWF, 2023). Reliable, cost-effective water availability allows farmers to increase cropping intensity, diversify cultivation, and achieve higher incomes. Beyond financial benefits, the solar system contributes to lower greenhouse gas emissions, improved resource efficiency, and greater resilience against fuel price volatility.

In Europe, biogas technology demonstrates another successful application of renewable energy in agriculture. A dairy farm in Germany implemented an anaerobic digester to convert cow manure and crop residues into biogas. The system generates enough electricity to power the entire farm, with surplus energy fed into the local grid. The digestate produced serves as a high-quality organic fertilizer, reducing dependence on synthetic alternatives and completing a circular nutrient cycle (European Biogas Association, 2022). This model exemplifies sustainable resource management, energy self-sufficiency, and environmentally responsible farming.

The benefits of renewable energy in agriculture are multifaceted. Economically, farmers reduce energy expenditure and shield themselves from market fluctuations. Environmentally, emissions decrease while air and water quality improve. Resource management gains include off-grid energy access and enhanced water security. Productivity improvements arise from reliable irrigation, cold storage, and post-harvest processing. However, challenges persist. High upfront costs, technical skill shortages, intermittency of solar and wind energy, and limited policy support constrain wider adoption.

To scale these technologies, governments must offer policy incentives such as subsidies, tax rebates, and feed-in tariffs. Financial institutions should provide low-interest green loans targeted at smallholders. Capacity-building initiatives are critical to develop local expertise in installation and maintenance. Continued research and innovation in energy storage and hybrid systems will enhance efficiency and affordability. By aligning renewable energy adoption with agricultural development, countries can simultaneously achieve energy security, food security, and environmental sustainability, ensuring resilient farming systems for the future.

Conclusion

Renewable energy has emerged as a transformative force for agriculture, offering solutions to some of the sector's most pressing economic, environmental, and social challenges. By replacing fossil fuels with solar, wind, biomass, and geothermal technologies, farms can significantly reduce operational costs, mitigate exposure to volatile energy markets, and lower greenhouse gas emissions. The integration of renewables also enhances resource efficiency, enabling precision irrigation, on-farm processing, cold storage, and the conversion of agricultural waste into energy and organic fertilizers. These innovations not only support productivity but also promote circular, climate-resilient farming systems.

Case studies from Pakistan, Europe, Israel, India, and China demonstrate tangible benefits: solar-powered irrigation pumps reduce energy costs and enable reliable water access; biogas digesters provide electricity while closing nutrient loops; hybrid systems maintain optimal greenhouse conditions. Across these contexts, renewable energy strengthens farm profitability, secures energy supply, and improves environmental outcomes.

Despite these advantages, adoption remains constrained by high upfront costs, technical skill gaps, intermittency of solar and wind resources, and limited policy or financial support. Overcoming these barriers requires coordinated action: targeted subsidies, green financing, capacity-building programs, and research into affordable storage and hybrid systems.

Ultimately, embedding renewable energy into agricultural systems is more than a technical upgrade, it is a strategic pathway toward sustainable, resilient, and climate-smart agriculture. For energy-intensive agricultural economies like Pakistan, renewables offer the dual promise of economic stability and environmental stewardship, ensuring that farming continues to feed populations while safeguarding natural resources for future generations.

References: European Biogas Association; FAO; IEA; IPCC; UN DESA; WWF

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Controlled Environment Agriculture in Pakistan

Explore how Controlled Environment Agriculture (CEA), including hydroponics and aquaponics, can revolutionize farming in Pakistan by addressing water scarcity, limited land, and soil degradation. Discover the benefits of year-round crop production and sustainable practices.

Laiba Zahoor

9/9/2025

Global food systems face mounting pressure from a combination of population growth, environmental degradation, and resource constraints. With the world population projected to reach 9.7 billion by 2050 (UN DESA, 2022), traditional agriculture struggles to meet rising demand, especially in regions like Pakistan where arable land is limited, water resources are under stress, and soil quality is declining. Conventional farming methods, heavily dependent on unpredictable weather and extensive water use, are increasingly vulnerable to climate-induced disruptions. In this context, Controlled Environment Agriculture (CEA) presents a compelling alternative by enabling precise management of growing conditions, maximizing resource use efficiency, and reducing dependency on land and climatic factors.

Hydroponics, which allows soilless cultivation of crops using nutrient-rich water solutions, and aquaponics, which integrate fish farming with hydroponic plant production, offer multiple advantages. These systems can significantly increase yield per square meter, reduce water consumption by up to 90% compared to traditional irrigation, and allow year-round crop production independent of seasonal fluctuations. For small-scale farmers, CEA reduces exposure to unpredictable weather events and can diversify income streams through high-value crops and fish production.

However, adoption comes with economic considerations. Initial investment costs for infrastructure, nutrient solutions, lighting, and climate control can be substantial. Operational costs, particularly energy for pumps and LED lighting, also affect profitability. Careful financial planning, access to low-interest green loans, and government incentives are essential to make CEA economically viable for smallholders. With supportive policy frameworks, training in system management, and integration into local markets, hydroponics and aquaponics can become scalable, profitable, and sustainable approaches, bridge food security gaps while promoting resource-efficient farming in Pakistan.

Hydroponics and Aquaponics: Modern Approaches to Sustainable Agriculture

Hydroponics is a soilless cultivation technique where plants grow in nutrient-rich water solutions. By controlling nutrient composition, pH, and environmental factors such as temperature and light, hydroponics allows for precise, optimized growth. While initial setup costs for infrastructure, grow lights, pumps, tanks, and climate control systems, are substantial, the system provides consistent, high-quality yields, reduces pest and disease risks, and enables year-round production independent of seasonal variations or soil constraints.

Aquaponics builds on this concept by integrating aquaculture with hydroponics, creating a mutually beneficial closed-loop ecosystem. Fish are raised in tanks, and their waste provides an organic nutrient source for plants. In return, plants filter and purify the water, which is recirculated back to the fish tanks. This symbiosis reduces water usage, minimizes chemical fertilizers, and creates a diversified revenue stream from both fish and crop harvests. The core principle is simple: aquaculture plus hydroponics equals aquaponics.

The economic advantages of these systems are significant. Hydroponics can reduce water use by up to 90% compared to conventional agriculture, a critical factor in water-scarce regions like Pakistan (FAO, 2021). Optimized growing conditions and year-round production can boost yields by 30–50% over soil-based methods (Goddek et al., 2019). Globally, the hydroponics market reached USD 9.5 billion in 2023 and is projected to more than double to USD 20.3 billion by 2029, growing at a CAGR of 13.4% (Mordor Intelligence, 2024). Aquaponics are also expanding rapidly, fueled by consumer demand for organic, sustainable, and locally sourced food.

However, these systems face notable economic and operational challenges. High upfront capital costs, including infrastructure, pumps, and climate control systems, remain a barrier for small-scale farmers. Energy-intensive operations further increase costs, particularly for lighting, water circulation, and temperature regulation. Technical expertise in plant biology, aquaculture, and system engineering is essential, requiring training or skilled labor. Success also hinges on market access, as profitability often depends on reaching consumers willing to pay a premium for high-quality, sustainably produced crops and fish. Despite these challenges, hydroponics and aquaponics offer a sustainable pathway to increase productivity, conserve resources, and meet growing food demands, making them increasingly viable for innovative agricultural enterprises.

Commercial Viability of Hydroponics and Aquaponics for Small-Scale Farmers in Pakistan

Hydroponics and aquaponics hold substantial promise for Pakistan, a country facing acute water scarcity, with per capita availability falling below 1,000 cubic meters (PCRWR, 2023). For

smallholder farmers, the adoption of these systems could transform productivity and profitability, but success depends on navigating a complex landscape of economic, technical, and infrastructural constraints.

The potential advantages are clear. These systems dramatically reduce water use, making them ideal for water-stressed regions like Balochistan and southern Punjab. They also enable year-round production of high-value crops such as lettuce, bell peppers, herbs, and strawberries, which can command premium prices in urban markets. Moreover, hydroponics and aquaponics are land-efficient, allowing cultivation on non-arable plots or in urban areas, expanding opportunities for farmers with limited landholdings.

Yet, significant challenges remain. The initial investment for a small-scale commercial setup range from PKR 500,000 to over PKR 2 million, a prohibitive cost for many smallholders without access to credit or grants (Hussain et al., 2022). Reliable energy supply is critical; power outages can cripple systems, while solar alternatives, though effective, further increase upfront costs. Technical knowledge gaps are another barrier. The successful operation of these systems requires expertise in plant nutrition, water chemistry, and aquaculture, yet local extension services and training programs are scarce. Input supply chains for specialized nutrients, growing media, and fish feed are underdeveloped, adding another layer of difficulty.

Pathways to commercial viability hinge on creating a supportive ecosystem. Government and NGO interventions such as subsidies for imported technology, low-interest green loans, and grants for pilot projects are essential. Collaborative models, including farmer cooperatives or partnerships with agri-tech companies, can help pool resources, reduce costs, and improve market access. Prioritizing high-value, short-duration crops ensures faster returns, while targeted technical training through universities and vocational programs builds local capacity for CEA management.

In Pakistan, interest in soilless farming is growing. Universities like UAF and PMAS-Arid are advancing research, and private startups are demonstrating small-scale commercial success. Future directions must emphasize localized, low-cost systems resilient to Pakistani climates, integration of CEA into agricultural education, and a national policy framework offering financial incentives, technical support, and quality standards. With these measures, hydroponics and aquaponics can become a viable, sustainable, and profitable option for small-scale farmers, transforming the country's approach to modern agriculture.

Conclusion

Controlled Environment Agriculture (CEA), encompassing hydroponics and aquaponics, presents a promising avenue for addressing Pakistan's mounting agricultural challenges. The country faces acute water scarcity, limited arable land, and soil degradation, all of which constrain traditional farming systems. CEA systems mitigate these constraints by enabling precise control over growing conditions, reducing water usage by up to 90%, and allowing year-round production of high-value crops. Aquaponics further adds economic and ecological benefits by integrating fish production into plant cultivation, creating a closed-loop system that reduces chemical inputs and diversifies revenue streams.

Despite their promise, widespread adoption among small-scale farmers faces significant hurdles. High initial investment costs, energy dependency, technical knowledge gaps, and underdeveloped input and supply chains remain major barriers. Success depends on building an enabling ecosystem that combines government support, low-interest financing, training programs, and market access initiatives. Collaborative models such as farmer cooperatives or partnerships with agri-tech firms can help smallholders pool resources and share expertise.

Emerging interest from universities, research institutes, and startups demonstrates that hydroponics and aquaponics are not only technologically feasible but increasingly commercially viable. With targeted policy incentives, investment in capacity building, and localized technology development, these systems can scale sustainably. For Pakistan, adopting CEA represents more than an innovative farming technique; it is a strategic pathway to enhance water efficiency, secure food production, diversify incomes, and promote sustainable, resilient agriculture for the future.

References: FAO; Goddek et al.; Hussain et al.; Mordor Intelligence; PCRWR; UN DESA

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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Engaging Youth for Pakistan's Agricultural Future

Explore how engaging youth in agriculture can transform Pakistan's farming sector. Addressing barriers to farming profitability and innovation is crucial for enhancing agricultural productivity and sustainability in a competitive global market.

Raheela Shehzad

9/15/2025

Pakistan's agriculture sector is the bedrock of its economy, contributing 22.9% to the national GDP and employing 37.4% of the country's total labor force (Economic Survey of Pakistan, 2023–24). Yet, despite this critical role, the sector faces a pressing concern: its growing inability to attract and retain young people. For many, agriculture carries the stigma of being an occupation of last resort, marked by high underemployment, low wages, and limited opportunities for professional growth. Young people increasingly associate farming with drudgery, outdated practices, and vulnerability to risks such as climate shocks, market volatility, and land fragmentation. The lack of financial security and modern career prospects pushes rural youth toward urban migration or informal employment, leaving agriculture in the hands of an aging workforce.

This disengagement has far-reaching socio-economic consequences. With fewer young people entering farming, rural communities lose both their labor force and their potential innovators. Productivity stagnates, rural poverty deepens, and the risk of food insecurity grows. At the same time, the disconnect between rural youth and farming erodes social stability, as migration to overcrowded cities leads to unemployment, housing shortages, and rising inequality.

Addressing this challenge requires reimagining agriculture as a modern, technology-driven, and entrepreneurial field. Policies that expand access to credit, land, and training can empower young farmers. Investments in agri-tech, climate-smart practices, and digital tools can reshape agriculture into a sector of innovation and opportunity. Strengthening rural education and vocational training programs will equip youth with the skills needed to run agribusinesses and tap into global value chains. Ultimately, transforming agriculture into a profitable and attractive profession is not only vital for Pakistan's food security but also for unlocking the economic potential of its largest demographic resource—the youth.

Youth Employment in Agriculture

Existing research consistently shows that both structural and perceptual barriers restrict youth participation in agriculture, especially in countries like Pakistan where the sector is central to livelihoods and food security. Hussain (2023) emphasizes that rural-to-urban migration is accelerating among young people, who increasingly view farming as a "low-status, high-toil" occupation with poor economic returns. This perception not only erodes the sector's image but also pushes youth to seek alternatives in urban industries or abroad. Supporting this view, a World Bank (2023) study found that more than 65% of rural youth prefer careers in manufacturing, services, or overseas employment, citing agriculture's lack of income stability and decent working conditions.

Structural constraints compound these negative perceptions. Analyses by the Pakistan Institute of Development Economics (PIDE, 2023) and IFPRI (2022) highlight land fragmentation, weak access to credit, and climate-related risks as systemic barriers that undermine profitability and resilience. These issues prevent agriculture from being seen as a modern or sustainable livelihood option, reinforcing the cycle of disinterest among rural youth.

The economic realities paint an even more troubling picture. Dawn's Economic Review (2024) and the State Bank of Pakistan (2023) report that agricultural wages are 35–40% lower than in manufacturing and services, creating a strong economic disincentive. Skills are also a major gap: only 18% of rural youth have access to training in modern practices like digital agronomy or post-harvest management (PSLM, 2022–23). Market inefficiencies further depress incomes. According to UNDP (2023), smallholder farmers lose 20–30% of potential earnings due to supply chain bottlenecks, limited cold storage, and exploitation by intermediaries.

These factors converge to produce a steep decline in youth participation in farming, which carries far-reaching consequences. Low profitability and income drive rural poverty and indebtedness, while gender inequality in land ownership restricts opportunities for young women. Skills gaps reduce innovation, and limited mechanization prevents youth from entering high-value markets. Land fragmentation diminishes efficiency, and climate change adds volatility, making farming less predictable and riskier. The result is mass migration to cities, overcrowding, and a growing disconnect between generations, with traditional knowledge and practices gradually eroding.

Literature makes it clear that youth disengagement from agriculture is not a matter of personal preference alone but the outcome of intertwined economic, social, and environmental constraints. Left unaddressed, this trend threatens food security, rural livelihoods, and national economic stability. Future policy responses must therefore tackle both perception and structural barriers,

transforming agriculture into a sector that is profitable, resilient, and attractive to the younger generation.

Future Policy Recommendations: A Multi-Pronged Strategy

Revitalizing youth participation in agriculture requires more than piecemeal reforms; it demands an integrated, forward-looking strategy that reshapes how the sector is perceived and practiced. At the heart of this transformation is technology. A "Youth in Agri-Tech" initiative could make modern tools like precision planters, drones, and hydroponic systems accessible through subsidies and financing support. Digital platforms, developed in partnership with telecom and tech firms, would provide real-time market information, weather updates, and virtual extension services, bridging the gap between farmers and knowledge systems. Such interventions not only increase productivity but also make agriculture more appealing to digitally savvy youth.

Land reforms are equally essential. Cooperative farming and land pooling can overcome the challenge of fragmented holdings, enabling young farmers to operate on a scale and compete in markets. Legal frameworks for land leasing would allow youth without ownership rights to access farmland, breaking one of the biggest barriers to entry. Alongside land access, mainstreaming climate-resilient agriculture is critical. Training programs in climate-smart practices like drip irrigation, soil health management, and drought-resistant crops should become central to youth-focused agricultural initiatives. Green youth grants could further empower startups that innovate around climate adaptation, ensuring agriculture's long-term viability.

Education and skills development must evolve to align with modern agricultural needs. Curricula in vocational and higher education should integrate agribusiness management, digital literacy, and advanced farming practices. Structured apprenticeships with national and global agribusiness corporations would expose youth to practical, market-relevant skills. Young women also require deliberate empowerment through secure access to land, credit, and extension services. Highlighting successful female role models in agri-tech and food processing can help shift cultural norms and encourage broader participation.

Equally important are market reforms. Investments in rural infrastructure such as cold storage, packing houses, and collection centers would reduce post-harvest losses and improve profitability. Direct linkages between youth-led cooperatives and supermarkets, processors, and exporters could ensure better price realization, cutting out exploitative middlemen.

Finally, the future of agriculture lies in agripreneurship. By rebranding farming as a form of entrepreneurship, young people can be encouraged to explore high-value ventures. This includes developing e-agri platforms for digital marketplaces, vertical and urban farming models tailored for cities, and agri-fintech solutions that provide microcredit, digital payments, and crop insurance. These innovations not only promise profitability but also resonate with the entrepreneurial aspirations of the younger generation, turning agriculture into a viable and attractive career path.

Conclusion

The future of Pakistan's agriculture depends on its ability to re-engage its youth. Without their energy, innovation, and entrepreneurial drive, the sector risks falling further behind in productivity, sustainability, and global competitiveness. What emerges from the evidence is clear: disengagement is not the result of indifference but of systemic barriers that make farming appear unprofitable, insecure, and outdated. Tackling these barriers requires a deliberate, multi-pronged approach that addresses access to land, finance, technology, and markets while reshaping the perception of farming itself.

Youth must see agriculture not as a last resort but as a pathway to prosperity, innovation, and leadership. By aligning policies with the aspirations of a digitally connected and climate-conscious generation, Pakistan can reposition farming as agripreneurship, where technology, sustainability, and business opportunities intersect. Empowering young women, bridging skills gaps, and investing in rural infrastructure will further ensure that this transformation is broad-based and inclusive.

If policymakers act decisively, agriculture can evolve into a vibrant sector that secures livelihoods, ensures food security, and stabilizes rural communities. The choice is stark: continue with business as usual and risk deeper crises or embrace youth as partners in cultivating the future of Pakistan's economy and society.

References: FAO; Hussain; IFPRI; PBS; Government of Pakistan; SBP; UNDP; World Bank; PIDE; PSLM

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Youth in Agriculture: Startups and Rural Innovation in Pakistan

Discover how Pakistan's youth are transforming agriculture with startups, digital tools, and rural entrepreneurship to boost food security and growth.

Sobia Arjumand Qadri

9/25/2025

Agriculture remains the cornerstone of Pakistan's economy, contributing approximately 22.9% to the national GDP and employing 37.4% of the labor force (Pakistan Economic Survey, 2023–24). Beyond its economic importance, agriculture sustains nearly two-thirds of the population directly or indirectly, providing food, raw materials for industry, and export revenues. Yet, despite this central role, the sector continues to grapple with multiple challenges. Climate change has intensified the frequency of droughts, floods, and unpredictable rainfall, threatening crop yields and rural livelihoods. Meanwhile, post-harvest losses, estimated at 15–20% for major crops, further reduce farm incomes and limit the country's ability to meet rising domestic demand.

Against this backdrop of structural weaknesses, Pakistan's youth are emerging as agents of transformation. With over 60% of the population under 30, this demographic dividend is infusing the sector with new energy, skills, and ideas. Young entrepreneurs are increasingly turning to agribusiness, introducing modern farming techniques, digital solutions, and value-added enterprises that move agriculture beyond subsistence farming. From hydroponics and vertical farming in urban areas to precision agriculture powered by drones, sensors, and mobile applications in rural communities, youth-led innovation is redefining how agriculture is practiced and perceived.

Moreover, many youth-led startups are addressing gaps in supply chains and markets. Initiatives that link farmers directly with consumers through e-commerce platforms are helping producers secure better prices while ensuring consumers access fresh and affordable food. Similarly, ventures in food processing, cold storage, and logistics are reducing post-harvest losses and enhancing food safety standards.

This transformation holds immense promise not only for improving food security but also for creating sustainable employment opportunities in rural areas. If supported by enabling policies, access to finance, and strong mentorship, Pakistan's youth can steer agriculture toward becoming a resilient, technology-driven, and inclusive growth engine for the national economy.

Digital Tools for a New Era

Youth-led technological innovation is redefining the way agriculture operates in Pakistan, offering solutions to long-standing inefficiencies and bridging gaps in productivity, market access, and resource management. One of the most visible transformations is the rise of digital marketplaces. Mobile applications such as *Tazah* and *TractorSher* are empowering farmers by directly linking them with buyers, input suppliers, and service providers. By minimizing the role of middlemen, these platforms ensure fairer prices for producers while giving consumers more affordable and transparent access to fresh produce.

Equally transformative is the adoption of precision agriculture, where technologies like IoT-based soil sensors, satellite imaging, and drones are being used to optimize crop management. These innovations help monitor soil moisture, nutrient levels, and pest infestations in real time, enabling farmers to apply water, fertilizer, and pesticides with greater efficiency. In a country where nearly 90% of freshwater resources are consumed by agriculture (UN Water, 2023), such targeted use is not only cost-effective but also critical for conserving scarce water resources and adapting to climate change.

Supportive ecosystems are also emerging through incubation and mentorship programs. Agri-tech incubators, backed by organizations such as the World Bank and Pakistan's National Incubation Centers (NIC), are providing young entrepreneurs with opportunities to prototype, test, and scale their ideas. These initiatives offer technical guidance, seed funding, and networking opportunities that help early-stage startups overcome barriers and bring practical solutions to market.

Together, these digital tools are not only modernizing agricultural practices but also attracting a new generation of talent into the sector. By integrating technology into the agricultural value chain, youth are driving a shift from traditional farming toward a knowledge-based, data-driven agribusiness model that can deliver resilience, efficiency, and inclusive growth.

Diversifying Rural Entrepreneurship: Beyond Traditional Crops

Rural entrepreneurship in Pakistan is undergoing a significant transformation, spearheaded by young innovators who are reimagining farming beyond the cultivation of conventional staples like wheat and rice. With changing consumer preferences, rising urban demand, and the pressing need for sustainable livelihoods, youth are pioneering ventures in high-value agribusiness sectors that promise both profitability and resilience.

One key area of growth is organic farming. Young graduates are leveraging scientific knowledge and digital marketing tools to establish farms that cater to the expanding demand for chemical-free produce in urban centers. Similarly, floriculture and horticulture are emerging as lucrative enterprises. Flowers, ornamental plants, and exotic fruits not only serve premium markets but also generate consistent income streams throughout the year. Aquaculture is another frontier, with youth-led startups cultivating fish and shrimp in inland ponds, providing protein-rich food options while tapping into profitable local and export markets. Greenhouse farming has also gained momentum, enabling

year-round cultivation of high-value vegetables such as bell peppers, cucumbers, and cherry tomatoes, which fetch premium prices in cities.

Equally important is the integration of climate-smart agricultural models into these ventures. Young entrepreneurs are adopting drought-tolerant seeds, precision irrigation systems such as drip and sprinkler technologies, and renewable energy solutions like solar-powered pumps. These practices not only conserve scarce water resources but also reduce production costs and environmental impact. Moreover, such approaches create employment opportunities within rural communities by engaging youth and women in value chain activities, from input supply to processing and marketing. The diversification of rural entrepreneurship is therefore much more than an economic shift, it is a social transformation. By embracing innovation and sustainability, Pakistan's youth are broadening the scope of agriculture into vibrant agribusinesses that meet modern demands, enhance rural incomes, and build resilience against climate challenges.

The Startup Revolution: Reshaping Value Chains

The rise of agri-tech startups in Pakistan marks a turning point in how agricultural value chains are organized and managed. By leveraging digital tools and innovative business models, these ventures are addressing long-standing bottlenecks in financing, market access, and logistics, thereby reshaping agriculture into a more connected, efficient, and profitable sector.

One of the most significant areas of innovation lies in fintech solutions. Historically, smallholder farmers have struggled to access timely and affordable credit due to rigid collateral requirements and bureaucratic hurdles in formal banking. Startups are now stepping in to bridge this gap by offering microloans through mobile platforms, often supported by data-driven credit scoring models. These digital systems not only provide much-needed capital but also enable farmers to purchase high-quality seeds, fertilizers, and machinery at the right time. In addition, mobile wallets and digital payment systems are simplifying transactions, reducing dependency on informal moneylenders, and creating a more transparent financial ecosystem for rural communities.

Equally transformative is the role of e-commerce and logistics platforms. Direct-to-consumer models are gaining traction, allowing farmers to bypass traditional middlemen and sell directly to urban markets. This reduces costs, improves farm-gate prices, and strengthens consumer trust by ensuring traceability from farm to table. Innovative logistics networks, often supported by startups, are introducing cold-chain solutions and efficient transport services that minimize post-harvest losses, a challenge that has historically eroded farmer incomes by up to 20–30%.

These innovations have not gone unnoticed by investors. According to MAGNiTT (2023), agri-tech and food-related startups in Pakistan are increasingly attracting venture capital funding, reflecting agriculture's transition from a low-margin subsistence activity to a high-growth sector. Together, fintech, e-commerce, and logistics-driven startups are not just solving local inefficiencies but positioning agriculture as a modern, technology-driven industry.

Persistent Challenges and Barriers to Scale

While youth-led innovations and agri-tech startups are transforming Pakistan's agricultural landscape, the path to scalability is still obstructed by persistent challenges. One of the most pressing issues is financing gaps. Traditional banks and financial institutions remain risk-averse, particularly toward youth-led enterprises that often lack collateral or an established credit history. As a result, many young entrepreneurs rely on personal savings or informal borrowing, which restricts their ability to expand operations or adopt advanced technologies. Without tailored financial instruments, the full potential of these ventures remains untapped.

Gender inequality compounds the problem. Women entrepreneurs in agriculture play an indispensable role, especially in livestock management, food processing, and value-added enterprises, yet they face systemic hurdles. Socio-cultural barriers often limit their mobility, access to markets, and participation in training programs. According to the Asian Development Bank (2022), women-led agribusinesses in South Asia receive less than 5% of formal agricultural financing. This marginalization not only undermines gender equity but also curtails overall sectoral growth.

Adding to these constraints are infrastructural deficits. Rural areas continue to suffer from unreliable electricity supply, patchy internet connectivity, and inadequate transportation networks. These limitations hinder the effectiveness of digital tools and prevent entrepreneurs from accessing wider markets. Weak agricultural extension services further exacerbate the situation, leaving many farmers without the technical knowledge required to adopt innovations.

The Way Forward lies in building an enabling ecosystem that supports youth and women entrepreneurs. This includes integrating agri-entrepreneurship and digital literacy into education, expanding inclusive financial products like venture debt and yield-based insurance, and fostering public–private partnerships to strengthen rural infrastructure. Scaling incubation and mentorship models will also provide young innovators with the networks and resources they need. Overcoming these barriers is critical for transforming agriculture into a resilient, inclusive, and growth-oriented sector in Pakistan.

Conclusion

Pakistan's agriculture is at a crossroads, and its youth hold the key to charting a new direction. With fresh energy, technological expertise, and entrepreneurial drive, young innovators are redefining farming as a modern, opportunity-rich sector rather than a subsistence activity. From digital platforms and precision farming tools to climate-smart practices and high-value agribusiness ventures, youth-led initiatives are transforming the agricultural landscape into one that is more resilient, inclusive, and competitive.

Yet, this transformation cannot be sustained without systemic support. Financing barriers, gender inequities, and weak rural infrastructure continue to hinder the scaling of youth-led enterprises. Addressing these challenges requires coordinated policy interventions that ensure timely access to finance, invest in infrastructure, and mainstream agri-entrepreneurship within educational and training systems. Equally important is empowering women and marginalized groups, whose contributions remain critical but undervalued.

The future of agriculture in Pakistan lies not only in securing food for a growing population but also in creating dignified livelihoods, fostering innovation, and building resilience against climate risks. With the right ecosystem, Pakistan's youth can transform agriculture into a thriving, technology-driven growth engine that secures both rural prosperity and national food security.

References: ADB; Entrepreneur Middle East; FAO; IFPRI; MAGNiTT; GOP; UN Water; World Bank

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Agriculture's Role in Climate Change and the Path to Resilience

Agriculture is both a driver and victim of climate change. Discover climate-smart solutions to cut emissions, boost resilience, and secure food systems.

Shabnum Soomro

9/30/2025

For millennia, agriculture has served as the foundation of human civilization, shaping cultures, economies, and societies. It provided the stability needed for population growth, urban development, and the advancement of trade and technology. Yet today, agriculture finds itself at a critical turning point. On one hand, it is deeply vulnerable to the intensifying effects of climate change, from erratic rainfall and droughts to soil degradation and shifting pest patterns. On the other, agriculture itself contributes significantly to the problem, accounting for nearly one-third of global greenhouse gas (GHG) emissions through livestock, fertilizer use, and land-use change (FAO, 2021). This dual role being both a victim of and contributor to climate change makes the sector uniquely positioned in the global climate discourse.

At the same time, agriculture holds unparalleled potential as part of the climate solution. Practices such as improved soil management, agroforestry, precision irrigation, and methane reduction in livestock not only lower emissions but also build resilience against climate shocks. If reimagined through innovation, policy support, and farmer empowerment, agriculture can transition from being a driver of environmental stress to becoming a cornerstone of climate stability and global food security. The urgency is clear: transforming agriculture is not optional, which is essential for a sustainable future.

Agriculture's Dual Role in the Climate Crisis

The relationship between agriculture and climate change is characterized by a self-reinforcing cycle, where the sector both drives and suffers from environmental degradation. According to the Intergovernmental Panel on Climate Change (IPCC), Agriculture, Forestry, and Other Land Use (AFOLU) contributes roughly 22% of global greenhouse gas (GHG) emissions. When the broader food system is factored in including processing, transportation, and waste, this figure climbs to nearly one-third of total emissions (IPCC, 2022).

Within agriculture, several sources stand out as major contributors. Livestock production is particularly significant, responsible for around 14.5% of global emissions, largely through methane released during enteric fermentation in ruminants and from manure management (FAO, 2023). Synthetic fertilizers add another critical dimension: nitrogen-based applications release nitrous oxide (N_2O), a gas nearly 300 times more potent than carbon dioxide over a century, making it one of the most damaging agricultural pollutants (IPCC, 2021). Deforestation further compounds the crisis, as millions of hectares of tropical forests are cleared annually for cropland and grazing. In 2022 alone, the world lost 4.74 million hectares of primary tropical forest, erasing vital carbon sinks and biodiversity hotspots (World Resources Institute, 2023).

Yet agriculture is not only a contributor to climate change; it is also deeply vulnerable to its consequences. Rising global temperatures, shifting precipitation patterns, and an increase in extreme weather events are already undermining yields and destabilizing food systems. The Food and Agriculture Organization (FAO) projects that global agricultural productivity could decline by up to 17% by 2050 due to climate-related stresses, with disproportionate impacts on smallholder farmers in the Global South who often lack adaptive capacity (FAO, 2023).

Climate-Smart Agriculture: A Strategic Framework

In response to the escalating climate crisis, Climate-Smart Agriculture (CSA) has emerged as a comprehensive framework that seeks to simultaneously achieve three interconnected objectives: sustainably increase agricultural productivity and farmer incomes; enhance resilience and adaptive capacity to climate change; and reduce or remove greenhouse gas (GHG) emissions. By advancing these goals in tandem, CSA envisions transforming agriculture from being a major contributor to global emissions into a key sector for carbon sequestration and sustainable development.

Central to CSA are practices that balance productivity with ecological stewardship. Regenerative agriculture, for instance, recognizes soils as a critical carbon sink. Yet, with over 33% of global soils already degraded (FAO, 2020), urgent action is required. Techniques such as no-till farming, cover cropping, and diverse crop rotations restore soil organic matter, improve water retention, and enhance biodiversity. A landmark study published in *Nature* estimates that widespread adoption of regenerative practices could sequester up to 5.5 gigatons of CO_2 equivalent annually (Bossio et al., 2020).

Agroforestry, another pillar of CSA, integrates trees into farmlands to capture carbon, enrich biodiversity, and stabilize soils. Global studies indicate sequestration potential ranging between 1.5 and 3.5 gigatons of CO_2 equivalent per year (World Agroforestry, 2021). Precision agriculture further complements these approaches by harnessing digital tools such as GPS-guided machinery and sensor-based irrigation to optimize resource use. This technology reduces fertilizer inputs by 15–20% and increases water-use efficiency by up to 30%, directly lowering

emissions and conserving scarce resources (World Bank, 2022).

Sustainable livestock management also presents promising opportunities. Feed additives like 3-nitrooxypropanol (3-NOP) can cut enteric methane emissions by more than 30% without compromising productivity (Journal of Dairy Science, 2021), while managed rotational grazing enhances pasture health and soil carbon storage. Similarly, crop diversification and genetic innovation reduce vulnerability to climate shocks. Drought-tolerant maize in sub-Saharan Africa, for example, has consistently produced 20–30% higher yields under water-stressed conditions (CIMMYT, 2022), demonstrating the power of adaptive innovation.

Transforming Food Systems Beyond the Farm

While agricultural production is a major driver of greenhouse gas emissions, the broader food system from post-harvest handling to consumption plays an equally critical role in shaping climate outcomes. Food waste alone illustrates the magnitude of this challenge. In 2022, approximately 1.05 billion tonnes of food were discarded worldwide, generating 8–10% of global emissions (UNEP, 2024). Addressing this inefficiency offers a dual dividend: reducing pressure on natural resources while simultaneously improving food availability. Alongside waste reduction, dietary choices are a powerful lever for change. The EAT-Lancet Commission (2019) estimates that widespread adoption of plant-rich diets could cut food system emissions by nearly 50% while lowering global mortality rates by up to 23%, underscoring the co-benefits of healthier, more sustainable consumption patterns.

Central to this transformation are smallholder farmers, who produce more than one-third of the world's food yet often remain excluded from finance, technology, and decision-making. Equipping them with climate-informed credit, insurance, and digital advisory tools can build resilience and drive innovation. Closing the persistent gender gap is equally vital. Women represent 36% of the agricultural labor force but face disproportionate barriers to land ownership, extension services, and financial resources (World Bank, 2023). Empowering them as equal agents of change multiplies the sector's adaptive capacity.

Systemic transformation also requires bold policy and financial realignment. Globally, governments spend $540 billion annually on agricultural subsidies, much of it supporting environmentally harmful practices (FAO, 2021). Redirecting these funds toward climate-smart agriculture would yield substantial benefits. At the same time, agriculture receives only a small share of climate finance despite its outsized emissions footprint and vulnerability. Scaling investment and fostering stronger international cooperation are imperative to align the food system with the Paris Agreement and the Sustainable Development Goals. Without such reforms, sustainability targets will remain out of reach.

Conclusion

Agriculture stands at the center of the climate crisis both as a source of greenhouse gas emissions and as one of the sectors most at risk from climate impacts. Yet, this dual role also gives it unique potential to become a solution. By adopting Climate-Smart Agriculture (CSA), the sector can transition from being a net emitter to a driver of resilience, carbon sequestration, and sustainable development. Practices such as regenerative soil management, agroforestry, precision agriculture, sustainable livestock systems, and crop diversification demonstrate that productivity, resilience, and climate mitigation can be pursued together.

Beyond the farm, transforming food systems is equally urgent. Tackling food waste, shifting toward sustainable diets, and empowering smallholder farmers particularly women are critical levers for change. Achieving these goals, however, requires systemic support: redirecting agricultural subsidies toward sustainable practices, scaling up climate finance, and strengthening global cooperation to align food systems with the Paris Agreement and the Sustainable Development Goals.

The pathway forward is clear. Agriculture must no longer be seen only as a victim or a culprit in the climate narrative, but as a central pillar of the solution. With innovation, policy commitment, and farmer empowerment, it can secure both planetary health and global food security in a warming world.

References: Bossio et al; CIMMYT; EAT-Lancet Commission; FAO; IPCC; Journal of Dairy Science; UNEP; World Agroforestry; World Bank; World Resources Institute

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

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Empowering Farmers: Agricultural Cooperatives for Growth

Discover how agricultural cooperatives drive sustainable rural development and inclusive economic growth. They empower smallholder farmers by pooling resources, providing access to finance, and promoting modern practices, while fostering social inclusion and enhancing gender equality.

Mehak Naseer

9/1/2025

Agriculture remains a cornerstone of the global economy, sustaining the livelihoods of over 2.5 billion people and providing employment for a substantial share of the population in developing nations (World Bank, 2023). Small-scale farmers, who are responsible for producing roughly one-third of the world's food, face persistent structural disadvantages that constrain productivity and economic potential. These include fragmented access to markets, limited bargaining power with buyers and suppliers, insufficient access to affordable credit, and restricted opportunities to adopt modern technologies (FAO, 2021). These limitations not only affect individual farmers but also slow broader rural development and perpetuate cycles of poverty, food insecurity, and economic vulnerability.

Agricultural cooperatives have emerged as an effective institutional mechanism to address these structural inequities. By pooling resources, facilitating collective decision-making, and offering shared services, cooperatives enable farmers to overcome challenges that would be difficult to tackle individually. They strengthen market access by aggregating production for bulk sales, reduce input costs through collective procurement, and provide avenues for knowledge transfer, including training in modern agronomic practices, digital tools, and climate-resilient farming techniques. Cooperatives also help members mitigate risk by establishing shared storage, insurance schemes, and cooperative credit systems, increasing resilience against crop failure, price shocks, or extreme weather events.

Beyond their direct benefits to members, agricultural cooperatives have a broader impact on economic development. They generate employment in rural areas, support small-scale agro-processing industries, improve food security by stabilizing supply chains, and foster social cohesion through participatory governance. While challenges remain, including governance, financial sustainability, and adapting to market dynamics, cooperatives have proven their potential as drivers of inclusive growth.

This essay explores the multifaceted role of agricultural cooperatives in modern economic development, examining their organizational structures, tangible benefits, operational challenges, and measurable contributions to both local communities and national economies. By bridging the gap between small-scale farming and market-oriented development, cooperatives can play a pivotal role in achieving resilient and equitable agricultural growth.

Agricultural Cooperatives: Catalysts for Sustainable Rural Development

An agricultural cooperative is a member-owned and democratically governed enterprise where farmers pool resources and coordinate activities to enhance efficiency and market power. Operating on the principle of "one member, one vote," cooperatives are structured to serve the collective interests of their members rather than maximize profit for external shareholders. These institutions function across the entire agricultural value chain, addressing key constraints faced by smallholders. The primary types include marketing cooperatives, which enable collective selling of produce; supply cooperatives, which facilitate bulk purchasing of inputs such as seeds, fertilizer, and livestock feed; credit cooperatives, which provide loans, savings, and insurance; and service cooperatives, which offer shared machinery, storage, transport, and technical services.

The economic contributions of agricultural cooperatives are extensive. They enhance agricultural productivity and sustainability by addressing inefficiencies of scale. Through bulk purchasing, cooperatives secure high-quality inputs at lower costs, while also serving as critical channels for disseminating knowledge, technology, and climate-smart practices. FAO research underscores that farmer-led organizations play a pivotal role in implementing resilient agricultural methods, leading to higher yields, lower input costs, and improved resource management (FAO, 2022).

Access to finance remains a major constraint for smallholders. The International Finance Corporation estimates a $1.7 trillion global financing gap for small and medium agribusinesses (IFC, 2021). Agricultural credit cooperatives bridge this gap, providing affordable loans for inputs and equipment while offering crop insurance products that mitigate risks. Evidence from Kenya indicates that membership in credit cooperatives increases adoption of improved farming technologies by up to 30% (African Development Bank, 2022).

Market access is another critical area where cooperatives have transformative impact. Individual farmers often face weak bargaining power and exploitation by intermediaries. By aggregating supply, marketing cooperatives secure better prices, access larger markets, and invest in value-added processing. India's Amul dairy cooperative, connecting over 3.6 million milk producers with an annual turnover exceeding $7 billion, exemplifies this effect, ensuring fair and stable remuneration for its members

(GCMMF, 2023). Investments in shared storage and cold chains further reduce post-harvest losses, which can exceed 30% in developing countries (World Bank, 2021).

Beyond economic gains, cooperatives generate employment and spur rural development. They create direct jobs in management, logistics, and processing, and indirectly stimulate local economies. The ILO estimates that cooperatives employ roughly 10% of the global workforce (ILO, 2023). They also promote social inclusion and gender equality, offering women, youth, and marginalized farmers platforms to access resources, build skills, and assume leadership roles. UN Women reports that empowering women through cooperatives can increase farm yields by 20–30%, improving household income and nutrition (UN Women, 2022). Rwanda's coffee cooperatives provide a notable example of women-centered empowerment strategies that enhance socioeconomic outcomes.

Finally, agricultural cooperatives contribute significantly to global food security. By stabilizing supply chains and improving efficiency in production and distribution, they ensure reliable access to food. During crises like the COVID-19 pandemic, cooperatives played a critical role in maintaining food supply when traditional markets were disrupted, demonstrating their resilience and essential function in supporting national and global food systems (IFAD, 2021).

In sum, agricultural cooperatives are far more than collective organizations; they are engines of sustainable rural development. They enhance productivity, provide financial resilience, improve market access, foster social inclusion, create employment, and safeguard food security. By strengthening these institutions, nations can empower smallholder farmers, reduce rural poverty, and promote inclusive economic growth while building resilient agricultural systems capable of meeting the challenges of a changing world.

Challenges Facing Agricultural Cooperatives and Strategies for Strengthening Them

Agricultural cooperatives have demonstrated significant potential to enhance rural livelihoods, strengthen food systems, and promote inclusive economic growth. Yet, despite their proven benefits, these organizations face persistent and interconnected challenges that can limit their effectiveness. Weak governance remains a major constraint. Many cooperatives suffer from poor internal management structures, insufficient professional expertise, and limited member engagement. Without clear accountability mechanisms and active participation, decision-making can be slow, and resources are often underutilized or misallocated. This erodes trust among members and can undermine the cooperative's long-term viability.

Access to capital is another critical barrier. Nascent cooperatives often lack sufficient equity and collateral, making it difficult to secure loans or attract investment needed to scale operations. This limits their ability to invest in infrastructure, technology, and value-added processing that could enhance productivity and market competitiveness. Compounding these challenges is the digital divide. Many cooperatives struggle to integrate digital tools for financial management, market intelligence, supply chain traceability, and communication with members. In an increasingly technology-driven agricultural sector, this disadvantage can prevent cooperatives from fully participating in modern value chains and limit their resilience to market fluctuations.

Overcoming these hurdles requires a multi-pronged approach. Policy and legal frameworks must be strengthened to facilitate cooperative formation, protect member rights, and ensure a supportive regulatory environment. Capacity building is equally essential, with targeted training for leaders and members on governance, financial literacy, and digital skills to improve operational efficiency and strategic decision-making. Blended finance models, which combine development funding with private investment, can de-risk capital inflows and incentivize broader participation in the cooperative sector. By addressing governance, financing, and technological gaps simultaneously, agricultural cooperatives can realize their full potential as engines of rural development, economic inclusion, and resilient food systems.

Conclusion

Agricultural cooperatives have proven themselves to be vital instruments for promoting sustainable rural development and inclusive economic growth. By pooling resources, providing access to finance, facilitating market linkages, and enabling the adoption of modern agricultural practices, they empower smallholder farmers to overcome structural disadvantages that have historically limited productivity and income. Beyond direct economic benefits, cooperatives foster social inclusion, create employment opportunities, and enhance gender equality, offering platforms for women, youth, and marginalized groups to participate meaningfully in decision-making and resource management.

Moreover, cooperatives strengthen the resilience of food systems. Through collective storage, processing, and risk-sharing mechanisms, they reduce post-harvest losses, stabilize prices, and ensure consistent supply, even in the face of crises like extreme weather events or market disruptions. Their role in bridging gaps between small-scale producers and modern value chains demonstrates their capacity to transform agriculture from a subsistence activity into a driver of regional and national development.

Challenges remain, including governance weaknesses, limited access to capital, and a persistent digital divide. Addressing these requires coordinated interventions encompassing supportive policy frameworks, capacity-building initiatives, and innovative financing models that combine public, private, and development-sector resources. When

these hurdles are effectively managed, agricultural cooperatives can fulfill their full potential as engines of economic inclusion, food security, and sustainable growth. In essence, investing in cooperatives is not merely supporting individual farmers, it is investing in the resilience, equity, and prosperity of entire rural economies.

References: African Development Bank; FAO; GCMMF (Amul); IFC; IFAD; ILO; UN Women; World Bank; Birchall; ICA

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Gender Inequality in Agriculture: An Economic Challenge

Explore the pressing issue of gender inequality in agriculture and its impact on productivity and food security. Learn how empowering women in agriculture can enhance economic potential and rural development.

M. Abdullah Ramzan

9/3/2025

The agriculture sector is a critical driver of economic development, rural livelihoods, and global food security. Yet, gender inequality remains a persistent and costly barrier to its full potential. Women contribute substantially to agricultural labor, performing tasks ranging from planting and harvesting to post-harvest processing and marketing. Despite this central role, they frequently lack access to essential resources such as land, credit, modern inputs, extension services, and decision-making platforms. According to the FAO (2021), if women had the same access to productive resources as men, agricultural yields could increase by 20–30%, potentially reducing the number of undernourished people worldwide by 100–150 million.

This inequality is not merely a social or moral issue; it has direct economic consequences. Lower productivity among women farmers reduces overall agricultural output, limits household incomes, and constrains broader rural economic development. It also weakens food security, as women often play a key role in managing nutrition and household food consumption. Furthermore, the gender gap contributes to inefficiencies in labor allocation, technology adoption, and investment returns, ultimately slowing national economic growth.

Addressing this disparity requires targeted, evidence-based interventions. Policies must ensure women's access to land rights, affordable credit, training, and agricultural extension services, while also promoting their leadership in cooperative and community-based organizations. Digital tools and mobile platforms can expand access to market information, financial services, and technical knowledge. Recognizing and empowering women in agriculture is not only a matter of equity but a strategic economic imperative. By closing the gender gap, nations can enhance agricultural productivity, strengthen food security, and accelerate inclusive economic growth, ensuring that the sector benefits all stakeholders equitably.

Understanding Gender Inequality in Agriculture

Globally, agricultural systems remain shaped by entrenched gender norms that assign distinct roles and rights to men and women. Men often control productive assets such as land, capital, and decision-making authority, while women provide a substantial portion of agricultural labor, frequently unpaid or undercompensated. The Food and Agriculture Organization (FAO) estimates that women account for over 37% of the global agricultural labor force, a figure rising to nearly 50% in parts of Sub-Saharan Africa and Asia. Despite this central role, women own less than 15% of agricultural land worldwide (FAO, 2023). These disparities extend to access to essential resources such as credit, improved seeds, fertilizers, and extension services, perpetuating a structural gender gap in both productivity and economic empowerment.

The economic cost of this inequality is substantial. If women had equivalent access to productive resources as men, farm yields could increase by 20–30%, potentially raising total agricultural output in developing countries by 2.5–4% (FAO, 2023). Such gains could reduce global hunger by 12–17%, impacting approximately 100–150 million people. Importantly, the yield gap is not a reflection of capability but of resource access. Evidence shows that when men- and women-managed farms of similar size are provided with the same inputs and support, productivity differences largely disappear (World Bank, 2023).

The consequences of this inefficiency extend beyond farm output. Lower productivity among women farmers translates into reduced household incomes, weaker food and nutrition security, and slower national economic growth. Moreover, women typically reinvest up to 90% of their earnings in their families' health, education, and nutrition, compared to 30–40% for men (UN Women, 2022). Limiting their productivity therefore suppresses a powerful multiplier effect that strengthens rural communities and fosters human capital development. Closing the gender gap in agriculture is not merely a matter of fairness, it is an economic imperative that can drive higher productivity, improved food security, and inclusive growth across nations.

Barriers to Women's Participation in Agriculture and Pathways for Empowerment

Women in agriculture confront a complex web of structural, social, and economic barriers that constrain their productivity, income, and decision-making power. One of the most pervasive obstacles is limited land ownership. In many countries, legal frameworks and cultural norms prevent women from owning, inheriting, or controlling land, the most critical agricultural asset. Without land title, women face further restrictions in accessing credit, as banks and financial institutions typically require collateral for loans. This lack of capital compounds their difficulties in acquiring quality seeds, fertilizers, and mechanized equipment, reducing farm efficiency and yield potential.

Access to knowledge and extension services presents another critical barrier. Agricultural advisory systems are often designed with male farmers in mind, leaving women without training on

modern technologies, climate-smart practices, or sustainable resource management. Time poverty exacerbates the challenge: women frequently juggle farm labor alongside unpaid domestic responsibilities such as cooking, cleaning, and childcare, limiting the hours they can dedicate to productive work. Market access is similarly constrained, as mobility restrictions and cultural norms prevent women from engaging with high-value markets, negotiating fair prices, and integrating fully into supply chains.

Despite these challenges, targeted interventions show that progress is possible. In Ethiopia, joint land titles issued under the national land certification program increased land productivity on women-managed plots by 22% (World Bank, 2021). India's Self-Help Groups have empowered millions of women by providing microcredit, collective bargaining platforms, and entrepreneurial training, significantly boosting agricultural incomes (IFPRI, 2022). Rwanda's policies promoting women's land rights and political participation have also contributed to more inclusive agricultural growth and enhanced community well-being.

Achieving gender equality in agriculture requires comprehensive policy and institutional reforms. Legal protections must guarantee women equal rights to land and inheritance. Financial services need to be tailored for women, offering collateral-free loans and leveraging mobile banking for accessibility. Extension services should prioritize female agents and participatory training methods suited to women's schedules and constraints. Investments in labor-saving technologies and rural infrastructure, including mechanized equipment, clean energy, and childcare facilities, can reduce the dual burden of farm and domestic work. Strengthening women's roles in cooperatives and farmer organizations amplifies their bargaining power and leadership, while sex-disaggregated data ensures informed policy design and monitoring. By addressing these barriers holistically, countries can unlock women's full potential in agriculture, fostering higher productivity, improved food security, and more inclusive rural development.

Conclusion

Gender inequality in agriculture is not simply a social issue, it is a pressing economic challenge with far-reaching implications for productivity, food security, and rural development. Women constitute a substantial portion of the global agricultural labor force, yet they are systematically denied access to essential resources, including land, credit, modern inputs, extension services, and market opportunities. This structural disadvantage constrains their productivity, reduces household incomes, and limits the broader economic potential of agricultural communities. Evidence shows that when women receive the same resources and support as men, yield gaps disappear, demonstrating that the problem lies in access rather than capability.

Addressing these disparities is both a moral and strategic imperative. Policies must secure women's land and inheritance rights, provide gender-responsive financial services, and ensure extension programs reach women effectively. Investments in labor-saving technologies and rural infrastructure can alleviate time burdens, while fostering leadership roles in cooperatives and farmer organizations strengthens women's bargaining power. Targeted interventions, such as Ethiopia's joint land titles and India's Self-Help Groups, illustrate that empowering women directly enhances productivity, income, and community well-being.

Closing the gender gap in agriculture would not only increase farm yields and national output but also generate a powerful multiplier effect, as women reinvest earnings into nutrition, health, and education. By tackling the barriers women face, nations can unlock significant economic gains, strengthen food security, and achieve inclusive and sustainable rural development. Empowering women farmers is therefore a central pathway to equitable growth and resilient agricultural systems worldwide.

References: FAO; World Bank; UN Women; IFPRI; IFAD; UNDP; AfDB; Meinzen-Dick et al.

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Pakistan's Livestock Economy: Unlocking Potential

Explore how Pakistan's livestock sector can enhance food security and rural prosperity. Addressing challenges like diseases, feed shortages, and market weaknesses is crucial for maximizing productivity and building a competitive livestock economy.

Muhammad Roman

9/11/2025

The livestock sector is the backbone of Pakistan's agrarian economy, serving as a critical engine for rural livelihoods, national food security, and foreign exchange earnings. It contributes 60.5 percent to agricultural value-added and 11.6 percent to national GDP, underscoring its systemic importance (Pakistan Economic Survey of Pakistan, 2023–24). Beyond its contribution to macroeconomic indicators, the sector is the primary source of income and employment for nearly 8 million rural families, offering sustenance to some of the country's most vulnerable communities (PBS, 2023). Livestock provides not just food and raw materials, but also acts as a financial safety net, with animals functioning as a form of living savings and insurance for rural households.

Pakistan maintains a vast livestock population exceeding 217 million heads of cattle, buffalo, sheep, goats, and camels, complemented by a dynamic poultry industry. This scale positions the country among the largest global producers of milk and meat (FAO, 2023). Yet, the economic and social dividends of this immense resource base remain far below potential. Productivity levels are constrained by poor genetics, inadequate veterinary services, high disease prevalence, feed shortages, and fragmented markets. The absence of efficient value chains and limited cold storage facilities further restricts farmers from accessing higher-value markets.

The sector also faces mounting pressure from climate change, water scarcity, and environmental degradation, which threaten its long-term sustainability. Meanwhile, low investment in research, technology adoption, and farmer training perpetuates inefficiencies.

This article provides a comprehensive analysis of the status of the livestock sector, its pressing challenges, and the policy solutions required to unlock growth. By addressing structural bottlenecks, strengthening value chains, and promoting climate-smart livestock practices, Pakistan can transform its livestock industry into a driver of sustainable growth, food security, and rural prosperity.

Current Status and Production Metrics

Pakistan's livestock sector reflects a paradox of abundance and inefficiency. On the one hand, it produces immense volumes of milk, meat, and poultry products that are central to national food security. On the other, its per-animal productivity lags significantly behind global benchmarks, limiting both farmer incomes and the country's export competitiveness.

Milk production stands as the most prominent feature of the sector. With an annual output of 65.7 billion liters, Pakistan ranks as the fourth-largest milk producer in the world. Yet this headline achievement masks a structural weakness: average milk yield per animal is roughly 1,500 liters per lactation, far below the global average of more than 2,200 liters (USDA, 2023; PARC, 2022). The yield gap reflects poor genetics, limited access to quality feed, and inadequate veterinary services.

Meat production tells a similar story. Annual output is estimated at 5.3 million tons, largely supplied by cattle and buffaloes. However, it is poultry that has emerged as the fastest-growing contributor, now accounting for more than 38 percent of total meat production (PSLM, 2021–22). Alongside this, egg production has risen to about 20.5 billion units annually, while hides and skins from livestock provide essential raw materials for Pakistan's leather industry, a key export sector (PEPA, 2023).

Despite these achievements, the industry is heavily fragmented. Most farmers operate at a subsistence level, owning fewer than five animals. This smallholder-dominated structure constrains economies of scale and slows the adoption of modern technologies such as artificial insemination, improved feeding systems, or mechanized milking. Weak value chains and poor market integration further reduce incentives for productivity improvements. The result is a livestock sector that is large in volume but weak in efficiency, with significant untapped potential for modernization and growth.

Key Challenges and Their Impacts

The livestock sector's vast potential is undermined by a layered set of structural, biological, and institutional constraints that collectively suppress productivity and limit its contribution to food security and economic growth.

Animal health remains one of the most pressing issues. Endemic diseases such as Foot-and-Mouth Disease (FMD), Haemorrhagic Septicaemia (HS), and brucellosis drain the sector of billions annually, with estimates suggesting losses of up to PKR 300 billion. These losses arise not only from mortality but also from reduced fertility, lower milk yields, and restrictions on regional and international trade. The weakness of veterinary infrastructure magnifies the

problem: in rural areas, a single veterinarian may serve more than ten thousand animals, leaving disease surveillance, vaccination campaigns, and preventive care grossly inadequate.

Equally damaging is the sector's limited genetic base. Over ninety percent of animals are low-yielding, non-descript breeds, with artificial insemination services reaching less than one-fifth of the national herd. Without structured breeding programs or reliable performance recording systems, productivity improvements remain stagnant. Farmers are locked in a cycle of subsistence, unable to break into high-efficiency production.

Feed and fodder shortages intensify these limitations. The annual deficit of quality feed exceeds 30 percent, worsened by stagnant fodder cultivation, poor nutritional content, and the added pressures of climate change. Overgrazing depletes pastures, while land degradation reduces long-term carrying capacity. These factors translate directly into weaker animals, reduced reproductive performance, and lower yields, undermining the sector's stability.

On the market side, inefficiencies strip farmers of fair returns. With up to half of the consumer price lost to middlemen and 15–20 percent of milk wasted due to spoilage, producers have little incentive to expand or modernize. The absence of cold chains, processing facilities, and quality-based pricing means farmers remain stuck in informal markets, unable to capture value from surplus production.

Climate change adds a further layer of vulnerability. Heat stress lowers milk yields and animal fertility, while erratic rainfall and drought reduce fodder supplies. Floods wipe out entire herds, spread waterborne diseases, and displace rural communities. For a sector so tightly bound to weather and ecosystems, these risks are existential.

Financial exclusion compounds all these challenges. Smallholders lack access to credit and insurance, leaving them unable to invest in better genetics, nutrition, or technologies. Perceived risk keeps banks away, perpetuating underinvestment. This is worsened by a weak policy framework, with fragmented governance and underfunded R&D, receiving less than 0.2 percent of agricultural GDP, leaving the sector ill-prepared to modernize.

A Framework for Policy Recommendations

Transforming Pakistan's livestock sector demands more than piecemeal interventions; it requires a coordinated framework that addresses health, genetics, nutrition, markets, climate, finance, and governance in an integrated way. Animal health must be elevated to a national priority. A "One Health" initiative with mass vaccination campaigns against Foot-and-Mouth Disease and Haemorrhagic Septicaemia can drastically cut losses, while mobile diagnostic labs and trained para-vets would bring basic services closer to farmers. Affordable vaccines and a central disease database would strengthen disease control and surveillance.

Genetic improvement is another cornerstone. Establishing a National Genetic Evaluation Center to identify and propagate superior breeds, coupled with private-sector semen production and subsidies for artificial insemination, can break the cycle of low-yield herds. At the same time, the persistent feed and fodder deficit calls for promoting high-yield, drought-resistant crops like berseem and alfalfa, expanding community-led feed mills, and stabilizing fodder prices during lean periods.

Equally vital is market modernization. Village-level bulk milk coolers, refrigerated transport, and model slaughterhouses would reduce spoilage, improve quality, and open export markets. Empowering farmers through producer cooperatives can ensure fairer returns and strengthen bargaining power.

Climate resilience must also be woven into livestock development. Integrating livestock into national climate strategies, encouraging heat-tolerant breeds, and offering index-based livestock insurance would cushion farmers against droughts, floods, and rising temperatures. Access to finance is critical as well: tailored microcredit products, government-backed insurance schemes, and rural financial literacy programs can enable smallholders to invest in productivity-enhancing technologies.

Finally, institutional reforms are needed. Raising public investment in livestock research to at least one percent of agricultural GDP, creating a Livestock Transformation Council for federal–provincial coordination, and modernizing extension services with digital tools can provide the governance backbone for sustained sectoral growth.

Conclusion

Pakistan's livestock sector sits at a crossroads. It has the numbers, the demand, and the strategic importance to drive food security and rural prosperity, yet it continues to underperform due to systemic neglect and fragmented interventions. The evidence is clear: without tackling endemic diseases, genetic stagnation, feed shortages, and weak markets, productivity gains will remain marginal. But the sector's untapped potential is equally clear. With over 217 million livestock heads, a massive rural labor force, and a growing domestic and export demand, Pakistan has the raw ingredients to build a globally competitive livestock economy.

Real transformation will require deliberate investment and coordinated policy action. This means prioritizing animal health through mass vaccination and surveillance, making genetic improvement a structured national program, addressing the chronic feed deficit, and upgrading markets with cold chains and quality standards. Climate-smart practices and risk mitigation tools must be mainstreamed, while access to finance and institutional reform will determine whether smallholders, who form the backbone of the sector, can adopt modern technologies.

The path forward is demanding but achievable. By aligning policy, investment, and farmer empowerment, Pakistan can move from low-yield, fragmented production to a high-value, resilient livestock industry. Done right, this transformation can secure livelihoods, strengthen exports, and place livestock at the heart of sustainable national growth.

References: FAO; IUCN; Khan et al.; NFC; PBS; Government of Pakistan; PEPA; PVMA; Rehman et al.; SBP; USDA; PSLM

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Essential Veterinary Services for Global Food Safety

Veterinary services play a crucial role in animal health and food safety, ensuring the stability of the global food system. They protect livelihoods, enhance food safety, and mitigate zoonotic threats.

Muhammad Umair

9/15/2025

Agriculture is a cornerstone of global development, providing food security, employment, and income for billions of people, especially in rural areas where farming remains the primary source of livelihood. Within this system, the livestock sector holds a central position. It contributes more than 40 percent of global agricultural GDP and supports the survival and economic well-being of nearly 1.3 billion people (World Bank, 2023). Beyond food, livestock provides essential services, draft power, manure for soil fertility, and cultural value, making it far more than just a source of meat, milk, or fiber.

At the heart of livestock productivity lies animal health, and this is where veterinary services become indispensable. From vaccination campaigns to the diagnosis and treatment of disease, veterinarians ensure that herds remain healthy and productive. Healthy animals mean higher yields of milk, meat, and eggs, as well as better quality products that can meet both domestic nutritional needs and international trade standards. This link between veterinary care and economic stability is particularly important for low- and middle-income countries, where livestock often represents a family's most assets.

The role of veterinarians extends beyond farm gates. They are frontline defenders against zoonotic diseases, pathogens that can jump from animals to humans, which account for over 60 percent of known infectious diseases in people (WHO, 2022). Rabies, avian influenza, and brucellosis are stark reminders of the human costs when veterinary systems are weak. By safeguarding animal health, veterinarians protect public health, strengthen food safety, and build trust in food systems.

In an era marked by climate change, shifting disease patterns, and growing food demand, veterinary services are not a luxury but a necessity. They are a critical investment in resilient agriculture, sustainable livelihoods, and global health security (Giller et al., 2021).

Veterinary Services: Foundation of Animal Health, Food Safety, and Economic Growth

Veterinary services represent one of the most essential yet often underappreciated pillars of agriculture and public health. Broadly defined, they encompass all activities aimed at safeguarding animal health and welfare. This includes preventive measures such as vaccinations, deworming, and biosecurity protocols, as well as diagnostic services, clinical treatment, and herd health management. Their scope, however, extends far beyond clinical care. Veterinarians and paraprofessionals play an integral role in food safety inspection, antibiotic stewardship, and public health surveillance. They are the critical link between livestock health, consumer protection, and national economic resilience (FAO, 2023).

The delivery of veterinary services takes many forms depending on production systems. Commercial farms rely heavily on herd-level health management, precision nutrition, and data-driven disease prevention to maximize efficiency. Smallholder farms, which form the backbone of rural economies, often depend on individualized and mobile veterinary services that protect their few animals, often the most valuable household assets. Organic systems, meanwhile, emphasize natural interventions, preventive strategies, and welfare-centered practices required for certification. Each of these models illustrates the adaptability and wide-ranging importance of veterinary services across agricultural landscapes.

The value of veterinary care becomes clear when examining its impact on livestock health. Infectious diseases such as Foot-and-Mouth Disease or Avian Influenza can devastate herds, with mortality rates exceeding 20% and survivors experiencing productivity losses of up to 50%. These losses translate into a staggering $300 billion in annual damage worldwide (OIE, 2023). Systematic preventive measures are transformative. For example, brucellosis vaccination has reduced disease prevalence in cattle populations by more than 70% within five years (Jost et al., 2021). Beyond infectious threats, veterinary guidance on nutrition, housing, and welfare improves reproductive performance and reduces dependence on antimicrobials, helping slow the advance of antimicrobial resistance.

The economic case for veterinary services is equally compelling. Research indicates that every $1 invested in preventive care generates between $5 and $10 in avoided losses and improved productivity (FAO, 2023). Dairy herds that implement veterinary-guided mastitis control often record milk yield increases of 15–25%, while targeted deworming programs in ruminants can boost weight gain by up to 30% (Capper, 2021). These improvements directly enhance farm profitability and strengthen resilience to market volatility and environmental stress.

Veterinarians also safeguard food systems. From the farm through slaughterhouses and processing facilities, they ensure that meat, milk, and eggs meet health and safety standards. Their oversight minimizes risks from pathogens such as Salmonella and E. coli, regulates antibiotic use to prevent harmful residues, and enforces animal welfare practices that affect product quality. The World Health Organization estimates that foodborne diseases affect 600 million people annually, a burden that could be significantly reduced through strong veterinary oversight (WHO, 2022).

At the macroeconomic level, veterinary services are strategic assets for national economies. A single outbreak of Highly Pathogenic Avian Influenza can result in mass culling, trade embargoes, and losses running into billions of dollars. Conversely, countries with OIE-recognized veterinary infrastructure maintain stable export markets and consumer confidence. In Pakistan, livestock contributes approximately PKR 5.5 trillion (around $20 billion) annually, with continued growth contingent on effective veterinary systems and adherence to international sanitary standards (Economic Survey of Pakistan, 2023–24).

Ultimately, veterinary services are not just about treating animals. They are a foundation for agricultural productivity, food safety, and economic prosperity. By protecting animal health, veterinarians protect livelihoods, public health, and national economies, making investment in this sector a prerequisite for sustainable development.

Challenges and Future Directions for Veterinary Services in Sustainable Agriculture

Veterinary services stand at the intersection of animal health, food security, and human well-being, yet their effectiveness is often undermined by significant challenges. Accessibility remains the foremost barrier, particularly in developing regions where the shortage of veterinary professionals is acute. The World Organisation for Animal Health (OIE, 2023) estimates a global deficit of more than 100,000 veterinarians, with the sharpest gaps concentrated in rural Africa and Asia. These areas, where livestock are central to household survival, are often left underserved, leaving farmers to depend on informal providers with limited expertise. Even when services are available, affordability becomes another obstacle. For many smallholder farmers, the cost of veterinary care is prohibitive, leading to untreated illnesses, reduced productivity, and in some cases, herd losses that push families deeper into poverty. Infrastructure gaps exacerbate the problem: inadequate diagnostic laboratories, weak surveillance networks, and insufficient vaccine storage facilities compromise disease prevention and control efforts. At the same time, climate change is reshaping disease landscapes, intensifying heat stress in animals, and expanding the spread of vector-borne diseases, further stretching already fragile veterinary systems (IPCC, 2022).

Despite these constraints, veterinary services remain indispensable for building sustainable agriculture. Healthy animals not only perform better but also consume feed more efficiently, lowering methane and nitrogen emissions per unit of production. Veterinarians also guide practices such as manure management, pasture rotation, and integrated pest management, all of which close nutrient cycles and reduce environmental pressure (Garnett et al., 2023). In this way, veterinary care supports not just farm profitability but also food safety, human health, and the resilience of rural communities.

Looking ahead, the future of veterinary services will be shaped by technology and integrated approaches. Telemedicine, AI-based diagnostics, and wearable monitoring devices are making remote animal care increasingly possible, bridging gaps in access. Precision veterinary medicine, supported by data analytics, will enable more tailored interventions, predicting disease risks before they escalate. The adoption of the "One Health" framework will deepen collaboration between veterinarians, medical professionals, and environmental experts to address global threats such as antimicrobial resistance and pandemic preparedness. Finally, with climate change reshaping agriculture, veterinary services will play a central role in developing climate-smart practices and heat-tolerant breeds to safeguard productivity (Rockström et al., 2023). Together, these innovations position veterinary services not only as defenders of animal health but as key architects of a sustainable agricultural future.

Conclusion

Veterinary services are far more than an auxiliary component of agriculture; they are central to the stability and growth of the global food system. By safeguarding animal health, they protect livelihoods, strengthen food safety, and shield communities from zoonotic threats. Their economic value is equally undeniable, as preventive veterinary care consistently delivers high returns by reducing losses, improving yields, and securing international trade opportunities. Yet, the reality is that these services remain out of reach for many of the smallholder farmers who need them most. Shortages of trained professionals, weak infrastructure, and the high costs of care leave critical gaps, particularly in regions where livestock serve as the backbone of household survival.

At the same time, the future offers immense promise. Advances in telemedicine, AI-driven diagnostics, and precision veterinary practices are beginning to transform the sector, while the One Health approach highlights the interconnectedness of animal, human, and environmental well-being. Climate change will test the resilience of both livestock and veterinary systems, but it will also accelerate innovation in sustainable animal management. In this light, investing in veterinary services is not optional, it is a prerequisite for sustainable agriculture, resilient rural economies, and global health security. Their strengthening will shape not just the future of farming but the health and prosperity of societies worldwide.

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References: Capper; FAO; Garnett et al; Giller et al; IPCC; Jost et al; OIE; Government of Pakistan; Rockström et al; World Bank; WHO

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Population Growth and Economic Development in Pakistan

Explore how Pakistan's population growth and youth bulge can drive economic development. Learn from East Asia's success in transforming demographic challenges into opportunities for innovation, productivity, and investment.

Manahal Saleem

9/17/2025

Population growth is a fundamental force shaping the trajectory of global economic development. Historically, growth rates remained negligible, averaging just 0.002% per year, until the agricultural and industrial revolutions unleashed unprecedented demographic change. The global population, which took thousands of years to reach 1 billion around 1800, skyrocketed to more than 8 billion by 2022 (UN DESA, 2022). This expansion reflects advances in food production, medicine, and technology, but it also amplifies economic, social, and environmental pressures.

Pakistan illustrates both the promise and the peril of rapid population growth. Ranked as the world's fifth-most populous nation, its population stood at 241.5 million in 2023, growing at 1.98% annually, one of the highest rates in Asia (Pakistan Bureau of Statistics, 2023; World Bank, 2023). On one hand, such growth can be harnessed as a demographic dividend. A large working-age population, if well-educated and productively employed, can drive innovation, expand markets, and sustain long-term economic growth. Successful examples from East Asia demonstrate how human capital investments transformed population booms into engines of prosperity.

On the other hand, unchecked population growth risks overwhelming resources. Pakistan already struggles with food security, water scarcity, inadequate healthcare, and limited job opportunities. Rapid urbanization places immense stress on housing, transport, and infrastructure, while environmental degradation accelerates under mounting consumption. Without effective governance and forward-looking policies, the demographic dividend may quickly turn into a demographic burden, exacerbating inequality and instability.

The central question, therefore, is not simply how many people a country has, but how well it can equip them to contribute productively. Education, health, skills training, and job creation remain decisive factors. This article analyzes the dual impact of population growth on economic development, drawing on contemporary data and global evidence to assess Pakistan's prospects.

Global and Pakistani Demographic Trends

Global demographic patterns reveal stark contrasts between regions. In advanced economies such as Japan, Italy, and Germany, population growth has slowed to near zero or turned negative, with aging societies straining pension systems, healthcare, and labor markets. By contrast, many of Sub-Saharan Africa and South Asia continue to experience rapid expansion, with fertility rates well above replacement levels. These diverging trajectories highlight the uneven pace of demographic transitions worldwide and their implications for economic development.

Pakistan sits firmly within the high-growth category. Its population, already the fifth largest in the world, is projected to reach 300 million by 2048 (UN DESA, 2022). More striking is the age composition: over 64% of Pakistanis are under 30, producing a pronounced youth bulge (Pakistan National Human Development Report, 2022). This demographic structure has profound economic implications. A large, youthful workforce can become a catalyst for innovation, productivity, and long-term growth, if sufficient opportunities exist. However, failure to harness these potential risks fuel unemployment, social unrest, and resource strain.

Urbanization adds another layer of complexity. Pakistan's cities are expanding rapidly, with urban growth rates of 2.7% outpacing the rural rate of 2.23% (World Bank, 2023). This migration fuels the rise of sprawling megacities such as Karachi and Lahore, creating both hubs of economic dynamism and centers of acute stress on housing, transport, water, and sanitation systems. Urban governance, infrastructure investment, and job creation must keep pace with this surge to avoid deepening inequality and instability.

Together, these demographic trends position Pakistan at a crossroads. The combination of rapid population growth, a youthful age structure, and accelerated urbanization offers immense opportunity, but also unprecedented challenge. The country's future trajectory depends on how effectively it manages this transition.

The Positive and Negative Impacts of Population Growth

When managed strategically, population growth can become a vital asset for economic progress. A larger, younger population increases the size of the labor force, raising the potential for higher output and productivity. This demographic dividend has been a decisive factor in East Asia's remarkable growth story, where a swelling workforce helped fuel decades of industrial expansion and prosperity (Bloom, Canning, & Sevilla, 2003). For Pakistan, a similar opportunity exists: if the growing working-age population can be productively absorbed, it could significantly raise national income and economic resilience.

Population growth also expands consumer markets. A larger domestic

base stimulates demand for goods and services, encouraging businesses to invest, scale production, and innovate. For global corporations seeking new markets, Pakistan's size and youthful demographic structure make it one of the most attractive emerging economies. This creates potential for foreign direct investment, deeper integration into global value chains, and economies of scale that reduce production costs.

Equally important is the reservoir of human capital and innovation that a youthful population represents. With adequate investment in education, healthcare, and skills development, this youth bulge can drive entrepreneurship, technological adoption, and productivity growth. The IMF (2021) found that even a one-year increase in average educational attainment can raise GDP growth by 0.3–0.5 percentage points, illustrating the payoff of human capital investment. Urbanization further reinforces these dynamics by generating agglomeration economies, specialized labor, knowledge spillovers, and lower costs for firms, strengthening overall productivity and competitiveness.

Yet, the same demographic trends can also become liabilities if institutions, investments, and policies fail to keep pace. Rapid growth often dilutes capital, as limited resources are stretched thin across a larger population, reducing productivity. High youth dependency ratios suppress household savings, constraining funds available for investment and slowing capital accumulation (World Bank, 2022).

Governments also face enormous pressure to provide public services. Pakistan, for instance, must create more than 1.5 million jobs each year just to absorb new entrants into the labor force, a target it consistently misses (ILO, 2023). The result is widespread underemployment, affecting nearly one-third of the workforce (PBS, 2023). Alongside economic stress, environmental pressures intensify. Pakistan's water availability has dropped from 5,600 cubic meters per capita in 1947 to below 1,000 cubic meters today, pushing the country toward absolute scarcity (PCRWR, 2023). This endangers agriculture and food security.

If unchecked, these pressures reinforce poverty and inequality, trapping families in cycles of deprivation. Ultimately, whether population growth is an asset or a liability depends on governance. With the right investments and reforms, it can unlock prosperity; without them, it risks destabilizing both economy and society.

The Pivotal Role of Policy in Shaping Demographic Outcomes

The ultimate impact of population growth is not predetermined; it is shaped by the quality of governance, institutions, and policy interventions (Acemoglu & Robinson, 2012). With sound strategies, a growing population can become a driver of economic dynamism rather than a source of strain.

Investing in human capital is the cornerstone of effective demographic policy. Quality education, particularly at secondary, tertiary, and vocational levels, equips youth with the skills needed in a modern, knowledge-driven economy. Complementary investments in healthcare, including universal access to reproductive health services and family planning, are essential. The UNFPA (2023) reports that 23% of married women in Pakistan have an unmet need for family planning, highlighting the scope for intervention. Empowering women through education and economic opportunities not only lowers fertility rates but also improves child health outcomes and boosts household productivity.

Economic and labor market reforms are equally critical. A job-led growth strategy that emphasizes labor-intensive manufacturing and services can absorb the expanding workforce, mitigate underemployment and enhance living standards. Formalizing the economy further strengthens productivity, expands tax revenue, and provides workers with social protection, creating a more resilient labor market.

Sustainable resource management must accompany demographic policies. Water security, through integrated resource management, increased storage capacity, and efficient irrigation, is an existential priority for Pakistan. Urban planning is also essential; developing smart, sustainable cities with adequate housing, public transport, and waste management systems helps manage rapid urbanization and maintain quality of life.

Finally, leveraging international cooperation enhances policy effectiveness. Organizations such as the World Bank, IMF, and UNFPA provide funding, technical expertise, and research support. Aligning national strategies with the Sustainable Development Goals ensures a holistic approach, integrating economic, social, and environmental dimensions.

In sum, population growth is neither inherently advantageous nor harmful. Its effect depends on proactive, evidence-based policies that prioritize human capital, labor market readiness, resource sustainability, and global collaboration. With strategic governance, Pakistan can harness its demographic potential to drive inclusive and long-term economic development.

Conclusion

Population growth represents a dual-edged force for economic development, with the potential to either accelerate prosperity or exacerbate existing challenges. Pakistan's rapidly expanding population, coupled with a pronounced youth bulge and accelerating urbanization, embodies this tension. On one hand, a large, young workforce can serve as a demographic dividend, stimulating productivity, expanding domestic markets, fostering innovation, and attracting investment. Lessons from East Asia illustrate how targeted investments in human capital and effective labor market policies can transform population growth into sustained economic gains.

On the other hand, rapid demographic expansion can strain resources, overwhelm public services, and deepen

environmental pressures. Pakistan faces acute challenges in job creation, healthcare, education, water availability, and urban infrastructure. Without timely and strategic interventions, these pressures risk creating underemployment, poverty traps, and social instability, turning a potential advantage into a liability.

The decisive factor lies in policy. Investing in quality education, healthcare, and family planning; implementing labor-intensive, job-led growth strategies; managing natural resources sustainably; and planning resilient urban infrastructure are essential. Equally important is leveraging international cooperation and aligning strategies with global development frameworks such as the Sustainable Development Goals.

Ultimately, population growth is neither inherently beneficial nor harmful. Its impact depends on governance, institutional capacity, and forward-looking policy. By harnessing human capital, creating inclusive opportunities, and managing resources prudently, Pakistan can convert its demographic dynamics into a cornerstone for long-term, equitable, and sustainable economic development.

References: Acemoglu & Robinson; Bloom et al; ILO; IMF; PBS; PCRWR; UN DESA; UNFPA; World Bank

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Wheat Production in Baluchistan: Challenges, Trends, and Policy Implications

Transforming Balochistan's wheat sector is not only crucial for local livelihoods but also essential for Pakistan's broader food security agenda. Sustainable reforms today can secure resilience against tomorrow's climate and market shocks.

Imam uddin

9/24/2025

Wheat holds a central role in Pakistan's economy and food security, accounting for a substantial portion of the agricultural GDP and contributing over 35% of the population's daily caloric intake (FAO, 2023). In Balochistan, wheat is not only the staple food for households but also a critical source of livelihood for the rural population, where agriculture remains the backbone of local economies. Despite being the largest province by area, Balochistan contributes less than 7% to the country's overall wheat production (PBS, 2023). The growing imbalance between consumption and production has become a major concern, aggravated by rapid population growth, climate change-induced water scarcity, and systemic inefficiencies in the province's agricultural system (Haq et al., 2022).

Existing research highlights that wheat yields in Balochistan lag significantly behind those in Punjab and Sindh. The reasons are multifaceted and deeply structural. Haq et al. (2022) report that groundwater depletion is more severe in Balochistan than in other provinces, with declining water tables posing the single greatest threat to sustainable agriculture. Compounding this, Ali et al. (2021) observed that adoption rates of improved, high-yield, drought-tolerant wheat varieties remain below 20% in Balochistan far lower than in more agriculturally advanced provinces. This limited uptake reflects not only weak extension services but also farmers' restricted access to certified seeds and modern inputs.

Climate change further magnifies these challenges. According to the World Bank (2023), Balochistan ranks among the most vulnerable regions in Pakistan to climate-induced risks, including rising average temperatures, erratic rainfall, and prolonged droughts. Such climatic stressors particularly endanger rain-fed (barani) wheat systems, which constitute a considerable share of cultivation in the province.

Policy frameworks like the National Food Security Policy (GoP, 2022) have sought to address these structural issues but with limited success in Balochistan. Weak institutional capacity, logistical constraints, and insufficient farmer engagement have hindered meaningful outcomes. Consequently, experts increasingly argue for a province-specific, tailored strategy that strengthens water management, expands access to climate-resilient seeds, and invests in farmer-centered extension services. Unlocking Balochistan's wheat potential is essential not only for the province's rural livelihoods but also for Pakistan's broader food security agenda.

Current Production Trends and the Consumption-Production Gap

According to the Pakistan Bureau of Statistics (2023), Balochistan's wheat production for the 2022–23 crop year stood at approximately 1.52 million tonnes, cultivated over an area of 723,000 hectares. While this appears substantial in absolute terms, it represents only about 6.5% of Pakistan's total wheat output of 23.4 million tonnes. More concerning is the persistently low productivity in the province. Average yields in Balochistan remain stagnant at around 2.1 tonnes per hectare, well below Punjab's average of 3.1 tonnes and the national benchmark of 2.8 tonnes per hectare. This yield gap highlights structural inefficiencies in input use, irrigation practices, and the adoption of improved crop varieties. It also reflects the province's vulnerability to climate-related shocks, as a significant share of wheat is produced in rain-fed systems with low resilience to erratic rainfall patterns.

This stagnation in yield coincides with a steadily rising demand. The Government of Balochistan (2023) estimates the provincial population at 14.89 million. Given an annual per capita consumption requirement of 125 kg, total demand amounts to roughly 1.86 million tonnes. With current production at 1.52 million tonnes, the province faces an annual deficit of more than 340,000 tonnes. This shortfall is routinely bridged by imports from Punjab and Sindh, which not only place a burden on provincial finances but also contribute to higher consumer prices due to transportation and distribution costs.

Per capita availability from local production stands at only 102 kg/year well below the requirement of 125 kg. This gap illustrates a growing food insecurity challenge, particularly for rural and low-income households that already allocate a large share of their income to food. Unless productivity improves and the yield gap narrows, Balochistan's dependence on external supplies will deepen, threatening both household nutrition and provincial economic stability.

Key Challenges Intensifying

Wheat production in Balochistan is under immense pressure due to a convergence of natural, technical, and socio-economic challenges that continue to intensify with each passing year. The most critical among these is water scarcity. Over 60% of the province's water sources are already over-exploited, with groundwater extraction far outpacing natural recharge rates. The Quetta Valley aquifer, once considered a lifeline for agriculture and urban needs, is now depleting at an alarming rate of 3–5 meters annually (WaterAid, 2022). This unsustainable extraction not only limits wheat cultivation but also threatens the long-term viability of agriculture in the region.

Climate change compounds this crisis. Balochistan has experienced recurrent droughts interspersed with destructive flash floods, both of which destabilize traditional cropping cycles. Rising

temperatures are shortening the wheat growing season and increasing evapotranspiration rates, reducing soil moisture availability at critical crop stages. These climatic shifts make wheat production more uncertain and risk-prone than in other provinces, forcing farmers into repeated cycles of loss.

At the farm level, input inefficiency further weakens productivity. Less than 25% of farmers use certified seeds, while the majority rely on traditional or recycled seed stock with lower yield potential. Fertilizer application is often imbalanced or insufficient, driven by both high input costs and inadequate farmer knowledge (IUCN, 2021). Such inefficiencies significantly widen the yield gap between Balochistan and the rest of the country.

Finally, socio-economic constraints act as a persistent drag on progress. Smallholder farmers struggle with limited access to affordable credit, making timely investment in input difficult. Landholdings are highly fragmented, reducing economies of scale and mechanization potential. Poor rural infrastructure, including inadequate storage facilities and weak road networks, further isolates farmers from competitive markets. These interlinked challenges collectively erode productivity and entrench food insecurity in the province.

Policy Implications and Recommendations

Addressing the constraints to wheat production in Balochistan requires a carefully designed, multi-dimensional strategy that not only targets immediate productivity concerns but also builds long-term resilience. A key priority is the promotion of climate-resilient water management. Policies must move beyond traditional supply-side measures and instead emphasize efficient use. Large-scale promotion of drip and sprinkler irrigation, backed by significant subsidies, can substantially reduce water wastage. At the same time, small-scale delay action dams should be constructed to recharge groundwater aquifers, while strict regulations on tube wells and groundwater extraction must be enforced to ensure sustainability.

Equally critical is the acceleration of improved seed dissemination. Heat- and drought-tolerant wheat varieties tailored for Balochistan's diverse agro-ecologies need to be developed, multiplied, and distributed effectively. Strengthening seed systems at the local level will ensure availability and affordability, bridging the adoption gap.

Digital innovation should complement conventional extension. Mobile platforms can deliver timely weather updates, pest alerts, and market prices directly to farmers' phones, while revitalized public extension networks can provide on-the-ground demonstrations of modern practices such as conservation tillage and balanced fertilizer use.

To improve profitability, investment in post-harvest infrastructure is vital. Modern silos and storage units in wheat-growing districts can reduce post-harvest losses, currently estimated at 15–20%. Enhanced rural road connectivity will also link farmers directly with markets, reducing dependence on exploitative intermediaries.

Finally, a Provincial Climate-Smart Agriculture Fund should be established. This dedicated mechanism could support crop insurance schemes, subsidize laser land leveling, and promote renewable technologies like solar-powered irrigation. Together, these measures can transform Balochistan's wheat sector into a more sustainable and resilient contributor to national food security.

Conclusion

Wheat production in Balochistan lies at the intersection of food security, rural livelihoods, and climate resilience. Despite its vast land area and agricultural potential, the province continues to lag in both productivity and self-sufficiency, contributing less than 7% to Pakistan's national wheat output. The widening consumption–production gap, currently exceeding 340,000 tonnes annually, reflects not only natural resource constraints but also systemic weaknesses in policy implementation, infrastructure, and farm-level practices.

The evidence is clear: water scarcity, climate change, and socio-economic barriers are intensifying the crisis. With aquifers depleting at alarming rates, recurrent droughts and floods destabilizing cropping cycles, and less than a quarter of farmers using certified seeds, the yield gap remains stubbornly wide. These challenges are further compounded by weak rural infrastructure and limited access to affordable finance, leaving smallholders particularly vulnerable.

Moving forward, a province-specific, integrated strategy is imperative. Promoting climate-smart irrigation, disseminating drought-tolerant varieties, revitalizing extension services, and investing in post-harvest facilities must form the backbone of reform. Equally important is establishing innovative financing and risk-sharing mechanisms, such as crop insurance and renewable-powered irrigation. Only through such targeted interventions can Balochistan's wheat sector be transformed into a resilient contributor to both provincial stability and Pakistan's broader food security goals.

References: Ali et. Al; FAO; Government of Balochistan; Government of Pakistan; IUCN; PBS; Haq et. Al; WaterAid; World Bank

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Is Politics Driving Turkish Agriculture to a Dead End?

Discover how political short-termism and weak reforms are pushing Turkish agriculture toward crisis. This article explores policy failures, farmer struggles, and the urgent need for a depoliticized, farmer-centric strategy to secure food security and rural development.

RURAL COMMUNITY

Mithat Direk

9/26/2025

When the government announces new agricultural packages, the cycle is painfully predictable: a brief wave of headlines, political fanfare, and short-lived optimism, only to give way once again to the entrenched problems that continue to paralyze the sector. The recent support packages, while offering short-term relief in the form of subsidies or loan rescheduling, fail to address the root causes of the crisis. What is missing is not intent but a comprehensive, depoliticized reform framework capable of reshaping agriculture into a sustainable and resilient driver of the economy. The question that lingers is why such overdue structural reforms remain perpetually delayed.

At the heart of this dilemma is a deep disconnect between policymakers and practitioners. Many of those designing agricultural strategies have never set foot in a field or experienced the uncertainty of rainfall, pest outbreaks, or fluctuating international markets. Agriculture does not follow a linear formula; the same inputs can produce dramatically different outcomes depending on seasonal conditions, global demand, or sudden disease outbreaks. A truly effective agricultural policy must therefore emerge from collaboration with those who hold firsthand knowledge of the soil, rather than being drafted in distant offices.

Calls for farmer mobilization are frequent, but the underlying constraints are rarely acknowledged. Farmer unions, in their current form, are often limited in capacity and at times function as intermediaries rather than authentic representatives of grassroots concerns. Many are led by individuals with little connection to farming realities, weakening their ability to propose transformative reforms.

The Ministry of Agriculture and Forestry, though vast and resourceful, often struggles to move beyond administrative duties into genuine strategic foresight. What is urgently required is a consistent, cross-party, long-term agricultural strategy that insulates the sector from short-term political cycles and builds trust with farmers who form its backbone.

From Scarcity to Misdirected Abundance: A Lost Opportunity?

Is Anatolia truly unable to feed its people? The reality is quite the opposite. Türkiye remains among the few nations in the world with the natural capacity to achieve food self-sufficiency. Its diverse climates, fertile soils, and rich agricultural traditions provide a strong foundation. Those who lived through the shortages of the late 1970s and early 1980s when sugar, oil, and meat were rationed, remember the vulnerability of that era. The subsequent transition from a state-controlled economy to one more open to privatization and global integration undeniably increased agricultural productivity and stabilized food supplies. Today, Türkiye even manages surpluses in certain commodities, such as sugar, which are regulated through quota systems (TÜİK, 2023).

Yet this abundance hides an uncomfortable paradox. While the country achieved higher output, it failed to channel this productivity into building lasting strategic advantages. Rather than focusing on a select group of native crops with global potential, policy choices often promoted scattered diversification, leaving no single area with strong technological or branding dominance. Developed nations, by contrast, have jealously guarded and expanded their competitive edge in crops like soybeans, wheat, and corn backed by research, innovation, and global marketing power.

The case of hazelnuts illustrates this lost opportunity vividly. Türkiye produces around 65% of the world's hazelnuts (FAO, 2022), yet much of the technological innovation, high-value processing, and brand recognition are concentrated outside its borders (World Bank, 2021). Instead of becoming a global leader in hazelnut-based value chains, Türkiye remains largely a supplier of raw material. This reflects a deeper policy flaw: a tendency to prioritize short-term, politically visible gains over long-term strategies rooted in research, innovation, and knowledge-driven planning. Without a shift toward this vision, abundance risks turning into another missed opportunity.

A Reality Check on Recent Policy Pledges

A closer examination of recent government pledges in agriculture reveals a concerning gap between rhetoric and practical implementation. Take, for example, the promise to cultivate fallow lands. While the idea of bringing unused plots into production sounds appealing, the state's own record with large-scale farming initiatives such as those under TİGEM casts doubt on the feasibility of managing fragmented and scattered lands through centralized intervention. A more sustainable pathway would be to empower private farmers and cooperatives with incentives to consolidate land, adopt modern techniques, and improve productivity, rather than repeating past state-led inefficiencies.

Similarly, the pledge to protect pastures through stricter penalties for misuse addresses only part of the problem. By the time penalties are applied, much of this land has already been compromised by urban sprawl, unregulated construction, or mismanagement. The emphasis should shift from reactive enforcement to proactive preservation and reclamation of these vital resources. Pastures not only support livestock but also sustain ecological balance, and their continued loss will have long-term repercussions for rural livelihoods and biodiversity.

Equally concerning are the promises to expand production of strategic crops. While politically attractive, these pledges overlook the fact that producers of Türkiye's traditional export strengths, hazelnuts, apricots, figs, and cherries, are already under strain. Rising input costs, volatile markets, and inadequate state support have left many farmers disillusioned. Instead of celebrating export volumes alone, policymakers must address the realities on the ground: farmer protests, squeezed profit margins, and declining competitiveness (TMMOB, 2023).

In short, without honest acknowledgment of structural weaknesses and a focus on empowering farmers rather than making symbolic pledges, these policies risk remaining slogans rather than solutions.

From Political Stopgaps to Farmer-Centric Logic

The central question for Türkiye's agricultural sector is whether productivity can genuinely rise in a system that remains heavily politicized and detached from farmers' realities. Even if yields increase through new technologies or expanded cultivation, the outcome will remain hollow unless farmers themselves are ensured a dignified livelihood through fair and predictable prices. Agriculture cannot thrive on temporary packages or politically motivated announcements; it requires a structural transformation rooted in farmer satisfaction.

The path forward begins with a shift from ad-hoc subsidies to direct, consistent, and depoliticized support. A considerable share of the ministry's vast budget should be allocated to predictable income support, delivered transparently and equitably. Such measures empower farmers to plan, manage risks, and adopt modern practices, unlike one-off subsidy packages that often arrive too late or miss their target altogether.

Equally important is restructuring production toward market-oriented, cluster-based systems. The greatest frustration for any farmer is not producing food but selling it profitably. By creating specialized production zones and integrating them into value chains, farmers can secure pre-determined marketing channels, reducing both pre- and post-harvest uncertainty. This model, widely adopted in developed economies, offers stability, competitiveness, and fairer income distribution.

Finally, institutional restructuring is indispensable. The Ministry of Agriculture and Forestry should transform from a direct operator, often burdened by inefficiencies, into a facilitator and regulator. Allowing a competitive private sector to deliver support services, while the ministry ensures transparency and accountability, would foster efficiency and innovation.

In essence, a farmer-centric, depoliticized strategy is not only possible but necessary. True progress lies not in political stopgaps but in building an agricultural system where farmers are empowered as equal stakeholders in national food security and rural development.

Conclusion

Turkish agriculture stands at a crossroads where political rhetoric, and short-term packages can no longer disguise the sector's structural weaknesses. Despite its natural abundance, rich agro-ecological diversity, and historical resilience, the sector has been weighed down by policy inconsistency, bureaucratic inefficiency, and a persistent disconnect between decision-makers and farmers. The paradox is stark: a country that leads the world in crops like hazelnuts still fails to capture value through innovation, branding, and high-end processing. Similarly, pledges to expand cultivation or protect pastures remain hollow when not matched by credible, proactive, and farmer-centered implementation.

The way forward demands a decisive break from politically motivated stopgaps toward a depoliticized, long-term national agricultural strategy. Farmers must be placed at the heart of this transformation, with predictable income support, stronger value chains, and institutions that serve as facilitators rather than controllers. Investments in research, climate-smart practices, and rural infrastructure can turn Türkiye's potential into sustainable competitive advantage. Above all, farmer dignity and satisfaction must become the cornerstone of agricultural reform. Only then can the sector shift from stagnation to resilience, from missed opportunities to lasting prosperity, and reclaim its role as a true engine of national food security and rural development.

References: FAO; TÜİK; TMMOB; World Bank

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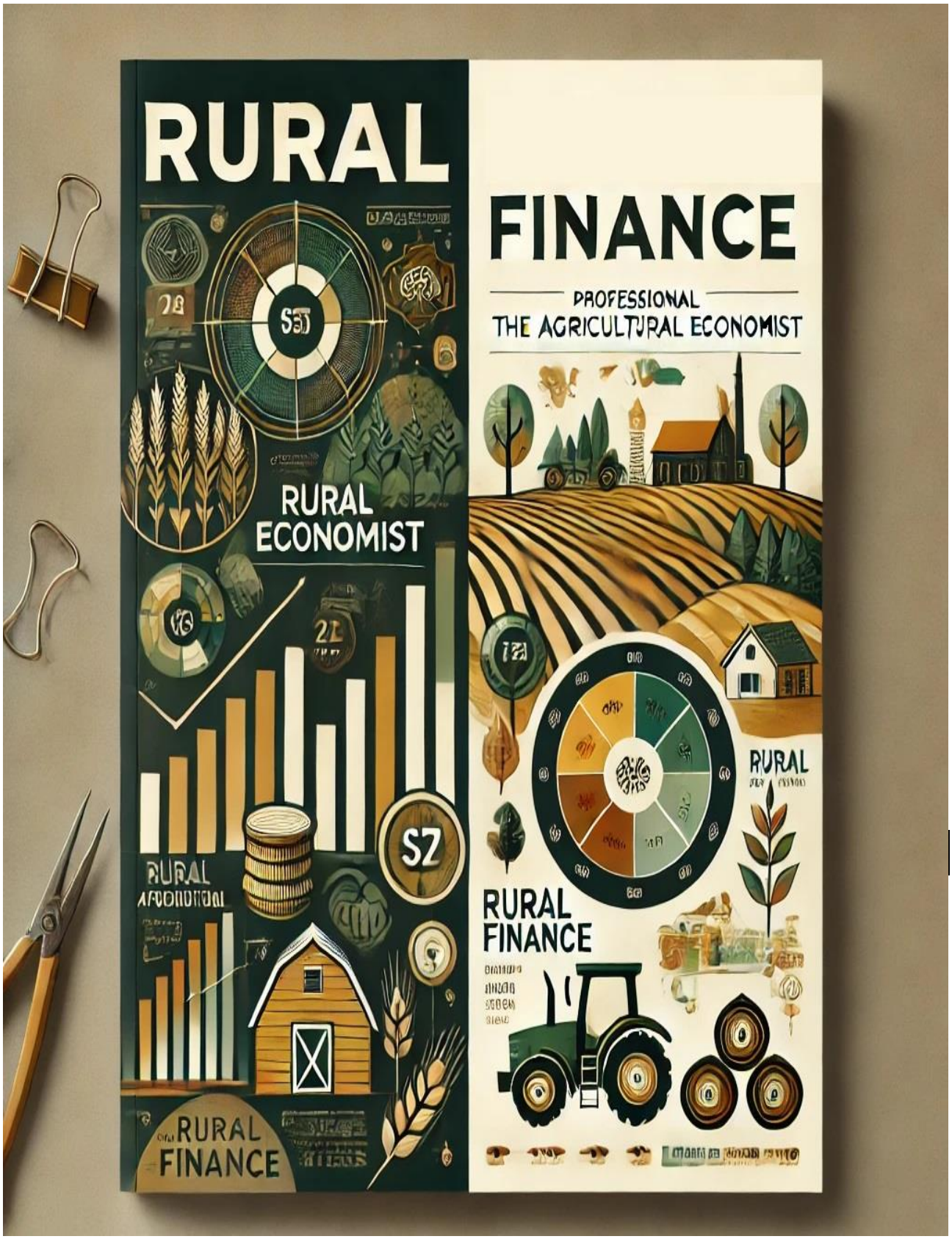

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Agricultural Export Subsidies: Pros and Cons

Explore how agricultural export subsidies impact global competitiveness and rural economies. Learn about Pakistan's experience with these policies, highlighting their benefits and risks, including trade issues and environmental concerns.

Muhammad Bilal

9/1/2025

Agriculture remains a cornerstone of global economic systems, particularly in developing nations where it is critical for rural livelihoods, food security, and economic stability. To enhance competitiveness in the increasingly integrated global market, governments frequently deploy policy instruments like subsidies. Agricultural export subsidies, financial supports designed to lower the cost of producing goods for export, are among the most potent and contentious of these tools.

While designed to make domestic products more attractive overseas, thereby boosting export volumes and improving trade balances, these subsidies are a double-edged sword. They can empower domestic farmers and stabilize rural economies but also risk distorting international trade, provoking disputes, straining national budgets, and encouraging environmentally unsustainable overproduction. In an era defined by World Trade Organization (WTO) disciplines and growing advocacy for fair trade, the economic implications of these subsidies demand rigorous, evidence-based analysis.

This paper examines the mechanisms of agricultural export subsidies, analyzes their multifaceted economic impacts, presents relevant case studies with a focus on Pakistan, and discusses the evolving global regulatory framework. It concludes with policy recommendations for designing sustainable and equitable agricultural trade policies.

Agricultural Export Support: Global Trends and the Pakistani Context

Globally, direct export subsidies have largely declined following the World Trade Organization's 2015 Nairobi Package, in which members agreed to phase out such measures. Despite this, many countries continue to provide domestic support that indirectly enhances export competitiveness. These supports take diverse forms, from input subsidies to financial incentives, and aim to reduce production costs, improve market access, and stabilize farm incomes. While the rationale behind such policies is often to protect domestic producers and secure foreign exchange, they must be carefully calibrated to avoid trade distortions and fiscal strain.

In Pakistan, agriculture remains a cornerstone of the economy, contributing 22.9% to GDP and employing 37.4% of the labor force (Economic Survey of Pakistan, 2023-24). The government has historically relied on a mix of support mechanisms to sustain production and promote exports. These include input subsidies on fertilizers and electricity, minimum support prices (MSPs) for staple crops, and targeted direct export incentives. Collectively, these measures aim to stabilize domestic markets, ensure farmer profitability, and maintain the competitiveness of Pakistani agricultural exports in global markets.

Export support mechanisms now extend beyond direct subsidies. Direct payments and export incentives compensate for price differences between domestic production costs and international markets, as seen historically in sugar and wheat exports. Input subsidies reduce costs of key agricultural inputs, effectively lowering the overall production cost for exportable commodities. Transport and freight support helps overcome logistical barriers, particularly for distant or landlocked markets. Tax exemptions and rebates shield exporters from certain fiscal burdens, while concessional financing provides lower-cost capital for export-oriented production. Together, these mechanisms form a comprehensive system designed to sustain Pakistan's agricultural export performance while navigating global trade norms and domestic development objectives.

Economic Impacts of Agricultural Export Subsidies: Balancing Gains and Risks

Export subsidies and related support mechanisms in agriculture present a dual-edged sword, delivering immediate benefits while carrying significant long-term risks. On the positive side, these supports can enhance the competitiveness of domestic producers in global markets. By lowering export prices, developing countries can compete with highly efficient producers in regions such as the United States or European Union. This often translates into increased market share, higher foreign exchange earnings, and opportunities for farmers to expand production. Export incentives also stabilize domestic markets by providing an outlet for surplus produce, preventing price collapses that would otherwise undermine farmer incomes. Furthermore, increased export demand stimulates rural economies, generating employment not only in farming but also in transport, processing, and logistics, thereby amplifying the socioeconomic impact beyond the farm gate.

However, these gains come with substantial risks. International trade distortion is a primary concern, as subsidies artificially alter comparative advantage and distort global resource allocation. This can depress world prices, negatively affecting unsubsidized farmers in other developing countries. The WTO recognizes export subsidies as among the most trade-distorting forms of support.

Fiscal burden is another critical issue; subsidy programs are expensive and can strain national treasuries. In Pakistan, diversion of funds to costly subsidy schemes has often limited investments in infrastructure, research, and development. Domestic market distortions are also frequent: incentivizing exports can reduce local supply, driving up food prices and harming poor consumers, as seen in Pakistan's sugar market during 2022. Environmentally, subsidies tied to production volumes encourage monocropping, overuse of water and agrochemicals, and cultivation on marginal lands, producing long-term ecological damage.

Pakistan's experience highlights the trade-offs involved. Wheat and sugar export subsidies have often backfired, creating domestic shortages and inflation despite massive fiscal outlays. The sesame seed sector illustrates volatility: a surge in exports due to Chinese demand was followed by a 53% collapse within a year, demonstrating the instability of relying on temporary incentives rather than productivity improvements. Current IMF agreements push Pakistan toward fiscal transparency, phasing out hidden subsidies and moving support onto the federal budget, underscoring the need for sustainable, predictable, and well-targeted policies.

In sum, export subsidies can provide short-term economic relief and competitive advantage but require careful calibration. Without sound planning, they risk fiscal strain, domestic price shocks, environmental degradation, and trade disputes. Sustainable strategies should prioritize long-term productivity, quality improvements, and market diversification to balance economic benefits with structural stability.

The Way Forward: Building Sustainable and Resilient Agricultural Policies

For Pakistan and other countries navigating the complexities of agricultural export support, a strategic shift from short-term subsidies to sustainable development is essential. The priority is investing in productivity and infrastructure. Instead of blanket export subsidies, fiscal resources should fund agricultural research and development for climate-resilient seeds, expand efficient irrigation systems such as drip or sprinkler networks, and modernize storage and cold chain facilities to reduce post-harvest losses, which can reach up to 40% for perishable goods. These investments lower production costs permanently and strengthen the sector's competitiveness.

Diversification is another critical step. Policies should incentivize farmers to move beyond traditional, subsidy-reliant crops like wheat, sugar, and rice, encouraging cultivation of high-value, non-traditional products such as fruits, vegetables, and medicinal plants. These crops offer higher returns and align with Pakistan's comparative advantages in international markets.

Transparency and targeting are equally important. Support mechanisms must be budget-visible and directed toward smallholder farmers, who are most vulnerable to price shocks, rather than large agribusinesses that often capture disproportionate benefits. Strengthening domestic market efficiency is also key. Improved market information systems and supply chain logistics ensure that domestic demand and supply are balanced before promoting exports, securing food security and price stability at home.

Finally, alignment with global trade rules is essential. Policies must comply with WTO guidelines and best international practices to avoid trade disputes and enhance the country's credibility as a reliable trading partner. By combining targeted investment, diversification, transparency, and regulatory compliance, Pakistan can transition from a subsidy-dependent model toward a resilient, competitive, and sustainable agricultural sector.

Conclusion

Agricultural export subsidies have long been a prominent policy tool for countries seeking to boost global competitiveness, stabilize rural economies, and generate foreign exchange. Pakistan's experience illustrates both the potential advantages and the significant risks associated with these mechanisms. On one hand, subsidies can provide immediate relief to farmers, increase market share, stimulate rural employment, and prevent domestic price collapses. On the other, they carry substantial trade, fiscal, and environmental risks. Overreliance on temporary incentives has contributed to domestic shortages, inflationary pressures, and unsustainable farming practices, as seen in the wheat, sugar, and sesame sectors.

The path forward requires fundamental reorientation from short-term, volume-based support to long-term, productivity-focused strategies. Investments in research, irrigation, post-harvest infrastructure, and climate-resilient technologies can permanently reduce production costs and strengthen competitiveness without the distortions caused by subsidies. Encouraging diversification into high-value, non-traditional crops further enhances resilience and aligns with global market opportunities. Transparency, targeted support for smallholders, and compliance with WTO norms are essential to ensure equitable and sustainable outcomes.

Ultimately, the goal should be to create an agricultural sector that is self-reliant, market-responsive, and environmentally sustainable. By prioritizing productivity, quality, and efficient market integration over temporary financial incentives, Pakistan can build a resilient export-oriented agricultural economy that benefits farmers, consumers, and the national economy alike, while minimizing the negative consequences historically associated with export subsidies.

References: Government of Pakistan; WTO; IMF; USDA; Dawn; The Express Tribune; FAO; World Bank; Pakistan Cold Chain Summit; Dorosh & Malik

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Dairy Cooperatives: Boosting Rural Economics

Discover how dairy cooperatives transform rural economies by delivering higher farmgate prices, improving access to technology, and fostering collaboration among farmers. Learn about their role in creating jobs, enhancing market security, and building social capital for long-term prosperity.

Muhammad Numan

9/16/2025

Dairy cooperatives represent a transformative model in the agricultural sector, particularly in countries where smallholder farmers dominate milk production. These cooperatives are designed to consolidate the interests of fragmented dairy farmers, allowing them to enhance their economic viability through collective strength. By pooling resources and organizing production, member-owned enterprises enable farmers to negotiate better prices for their milk, access modern processing technologies, and participate in structured training programs that improve quality and efficiency. This collective approach not only strengthens bargaining power against middlemen but also reduces transaction costs, ensuring that farmers capture a greater share of value along the supply chain.

The economic mechanics of dairy cooperatives extend beyond price improvements. Cooperatives often provide credit facilities, veterinary services, and access to improved feed and breeding technologies, which raise productivity and ensure higher returns. They also create stable markets, reducing the uncertainty and volatility that individual farmers face when selling perishable milk in informal channels. Importantly, cooperatives foster social capital and trust among members, encouraging long-term investments in both farm-level improvements and community development.

However, despite these advantages, dairy cooperatives face significant challenges. Poor governance, lack of transparency, and limited managerial skills often undermine their effectiveness. In many regions, inadequate infrastructure for chilling, storage, and transportation hinders their ability to maintain quality and expand market reach. Competition from private processors can also marginalize poorly managed cooperatives, highlighting the need for capacity building and strong institutional support.

Looking ahead, dairy cooperatives hold enormous potential for growth and sustainability if supported by favorable policies, technological innovation, and effective leadership. With the right interventions, they can become engines of rural development, bridging the gap between smallholder farmers and modern markets, while contributing significantly to food security, income generation, and poverty reduction.

Dairy Cooperatives as Engines of Rural Prosperity

The most immediate and visible economic benefit of dairy cooperatives is the substantial improvement in farmers' income. When small producers act collectively, they gain the ability to aggregate supply, lower transaction costs, and negotiate from a position of strength. This aggregation reduces the dominance of intermediaries who traditionally capture disproportionate margins in milk marketing. As a result, farmers retain a greater share of the consumer dollar. Studies validate this outcome: members of cooperatives consistently receive 10–15 percent higher prices for their milk compared to those selling individually to private processors (International Labor Organization, 2022). Beyond better prices, cooperatives often distribute dividends or patronage refunds linked to the volume supplied, creating an additional and predictable income stream. For rural households often living on narrow margins, these payments translate into greater financial resilience, the ability to invest in children's education, and improved household nutrition.

Beyond income, cooperatives act as a vital channel for technical and operational efficiency. They serve as platforms for disseminating advanced technologies such as artificial insemination, improved feed systems, and regular veterinary services. Access to such services is usually costly for smallholders, but cooperatives make them affordable and widely available. This support yields direct gains: research by FAO (2023) shows cooperative members achieve 20–30 percent higher milk yields compared to non-members, largely due to improved husbandry and feeding practices. Moreover, cooperatives uphold strict quality testing standards, including somatic cell count and bacterial checks, which ensure premium-grade milk. Higher quality not only fetches better prices but also builds trust with buyers in both domestic and export markets.

The benefits extend further through employment generation and broader rural development. Cooperative operations involve a wide array of activities from milk collection and chilling centers to processing plants producing cheese, yogurt, butter, and milk powder. Each stage creates jobs for technicians, transporters, quality controllers, and marketing professionals. Secondary and tertiary roles emerge in packaging, administration, and retail distribution, multiplying the economic impact. The International Cooperative Alliance (2023) highlights how these jobs stabilize local economies by circulating income within communities, supporting shopkeepers, service providers, and other micro-enterprises. This ecosystem approach positions dairy cooperatives not only as income boosters for farmers but as

anchors of sustainable rural development. Crucially, by providing opportunities within villages, they help reduce rural-to-urban migration, ensuring that growth is rooted where it is most needed.

Challenges and Future Pathways for Dairy Cooperatives

While dairy cooperatives offer clear economic and social benefits, they also operate in an environment filled with structural and competitive challenges. One of the most pressing is the intense rivalry from large, vertically integrated corporations. These private players often attract farmers with immediate cash payments and short-term incentives, undermining member loyalty and disrupting the steady milk supply that cooperatives rely upon. In contrast, cooperatives must balance fair returns with long-term stability, which sometimes makes them appear less attractive in the short run.

Capital constraints present another obstacle. Expanding processing plants, installing modern cooling systems, and adopting new technologies all require significant financial investment. Many cooperatives struggle to access affordable credit or external financing, leaving them unable to innovate or scale effectively (World Bank, 2022). This financial bottleneck restricts their ability to compete with better-funded corporate processors.

Governance and management also remain sensitive issues. Cooperatives are designed to function democratically, but without strong leadership and transparent systems, inefficiencies can emerge. Balancing grassroots participation with professional management is critical, and mismanagement or weak accountability can erode both member confidence and operational performance.

Looking ahead, policy support and innovation will be decisive in shaping the cooperative movement's trajectory. Governments can create enabling conditions through low-interest credit, grants for infrastructure like bulk milk coolers, and tax incentives that level the playing field. Training programs for cooperative leadership would strengthen governance and ensure accountability. Equally important is product diversification. By moving beyond raw milk sales into value-added products specialty cheeses, probiotic yogurts, fortified milk, or whey protein cooperatives can capture higher margins and insulate themselves from price volatility. Digital integration is another frontier, offering tools for transparent milk collection, herd management, and direct-to-consumer platforms that improve efficiency and market reach.

The story of Amul in India offers a powerful model. What began as a small farmers' revolt is today one of the world's largest dairy brands, connecting 3.6 million farmers to markets through a diversified product portfolio and strong brand identity (National Dairy Development Board, 2023). Amul's success proves that with supportive policy, innovation, and sound management, cooperatives can achieve global competitiveness while keeping farmers at the core.

Conclusion

Dairy cooperatives have proven to be more than just market intermediaries; they are strategic institutions that reshape the economics of rural communities. By organizing fragmented producers into cohesive groups, they deliver higher farmgate prices, improved access to technology, and more secure markets. Their impact extends far beyond individual farmers, stimulating local economies, creating jobs across the dairy value chain, and fostering resilience against price volatility. Importantly, cooperatives also generate social capital, building trust, encouraging collaboration, and reinforcing the idea that collective action can drive long-term prosperity.

Yet the challenges remain real. Limited access to capital, governance inefficiencies, and competition from powerful private corporations continue to test their viability. Without the ability to innovate, invest in infrastructure, and manage operations professionally, many cooperatives risk stagnation or decline. This makes supportive policy frameworks and strategic innovation critical. Governments, development agencies, and cooperative leaders must work in tandem to unlock credit, strengthen governance, and expand into value-added processing.

The lessons from Amul demonstrate that scale, efficiency, and farmer ownership can coexist. If backed by vision and effective policy, dairy cooperatives can anchor rural development, reduce poverty, and contribute decisively to national food security while keeping farmers at the heart of the system.

References: FAO; ICA; ILO; NDDB; World Bank

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Agricultural Credit Crisis in Pakistan

Delayed agricultural credit in Pakistan traps small farmers in debt, undermines productivity, and threatens food security. Explore causes and solutions.

Sarmad Veesar

9/23/2025

For Pakistan's farmers, the sowing season is nothing short of a race against time. The first drops of rain soften the soil, creating a narrow yet crucial window in which fields must be ploughed, seeds sown, and nutrients applied. Every passing day matters. If the cycle is delayed, yields fall, livelihoods shrink, and the nation's food security comes under strain. To keep this cycle running, farmers need one essential fuel i.e. capital. Timely access to credit allows them to buy quality seeds, fertilizers, pesticides, and fuel for machinery. Without it, the season of hope often turns into another round of despair.

Agricultural financing is therefore not just a supportive measure; it is a lifeline for growth and sustainability. Yet, in Pakistan, systemic bottlenecks ensure that funds rarely reach farmers when they are needed most. According to the State Bank of Pakistan (2023), the agricultural credit portfolio crossed Rs. 1.8 trillion in the fiscal year 2022–23, an impressive figure on paper. But beneath this achievement lies a sobering reality. Research shows that while institutional credit satisfies over 60% of the needs of large-scale farmers, smallholders, the true backbone of the rural economy, receive less than 15% of their financing requirements from formal sources (IFPRI, 2023).

This imbalance is more than a statistical gap; it reflects deep-rooted inequities within the financial system. Small farmers, lacking collateral or formal banking relationships, are systematically excluded. Left with no alternative, they are pushed toward informal moneylenders who exploit their vulnerability by charging exorbitant interest rates. The result is a vicious cycle of debt that erodes household income, undermines resilience, and traps farming families in poverty across generations. Unless reforms ensure timely, inclusive, and affordable credit flows, Pakistan's smallholder farmers will remain caught between the promise of the rains and the harsh reality of financial exclusion.

Bureaucracy and Systemic Failure

The persistent delays in agricultural loan disbursement are not mere administrative lapses but rather the outcome of entrenched systemic weaknesses that weigh most heavily on smallholder farmers. What should be a straightforward process of financial support often turns into a complex ordeal, where time lost translates directly into reduced yields and rising vulnerability.

At the forefront lies the problem of bureaucracy. Farmers, many of whom have limited literacy, are required to provide an array of documents such as land ownership records (*Fard*), tenancy agreements, and multiple forms of identity verification. These requirements are not only time-consuming but also intimidating, often forcing farmers to rely on middlemen who exploit their desperation. A 2024 study by Karachi University Business School revealed that the average processing time for an agricultural loan from a major commercial bank is 42 days, a stark mismatch with the crucial 10–15-day planting window after the first rains. For many farmers, this delay means the season is lost before financing arrives.

Financial institutions' risk aversion further compounds the problem. Smallholders, especially those cultivating less than 12.5 acres, are viewed as high-risk clients due to their limited collateral and exposure to climate variability. This results in prolonged verification processes and cautious lending. The data underscores this imbalance: in FY2022–23, only 22% of total agricultural lending reached small farmers, despite their dominance in Pakistan's cultivated land area (SBP, 2023). Larger landowners, with established relationships and tangible collateral, face fewer hurdles, widening the equity gap.

Additionally, infrastructural and digital divides reinforce exclusion. For many rural households, accessing a bank branch requires an entire day's travel. While initiatives such as the State Bank's Kisan Digital Hub and the Raast instant payment system hold promise, uptake remains limited. As of early 2024, digital transactions accounted for less than 20% of agricultural loan disbursements, constrained by unreliable internet and low digital literacy (SBP, 2024).

The Devastating Ripple Effects

The consequences of delayed agricultural credit disbursement extend far beyond individual farmers, setting off ripple effects that undermine livelihoods, food security, and the national economy. What begins as a financial bottleneck at the farm level quickly cascades into systemic challenges with long-term repercussions.

At the most immediate level, agricultural productivity suffers. When credit is not available on time, farmers are forced to postpone planting or reduce the land under cultivation. Many are compelled to compromise on input quality, purchasing cheaper seeds or applying insufficient fertilizer. According to a World Bank assessment (2023), delayed access to credit leads to a 15–30% decline in yields per acre for major crops such as wheat and cotton. Lower yields not only shrink household incomes but also reduce national food supply, creating volatility in staple crop markets.

Financially, the burden is crushing. Farmers unable to wait for institutional loans often resort to informal lenders, locally known as *arthis*. While these lenders provide quick access to cash, they do so at exploitative interest rates, frequently surpassing 30% per cropping

season (Pakistan Poverty Alleviation Fund, 2023). Servicing these loans consumes a significant share of farmers' earnings, leaving little for reinvestment in productivity or household welfare. Over time, this entrenches families in a cycle of debt dependency, eroding their resilience against future shocks.

At the macroeconomic level, the implications are equally alarming. With agricultural growth stagnating around 2–3%, consistently below the national target of 4–5%, the country has been unable to meet its domestic food requirements. As a result, Pakistan's food import bill surged past $9 billion in FY2023 (Ministry of National Food Security & Research, 2023). This rising reliance on imports not only widens the trade deficit but also heightens exposure to global price shocks. Simultaneously, declining rural incomes accelerate poverty, forcing vulnerable households into urban migration and further straining city infrastructure.

Solutions for a Timely Credit System

Overcoming the persistent delays in agricultural credit disbursement demands a comprehensive and forward-looking strategy that combines technological innovation, institutional reform, and farmer empowerment. Digitization must play a central role in this transformation. By adopting mobile-first platforms that integrate directly with national systems such as NADRA and the Land Record Management Information System (LRMIS), banks can verify farmer identities and landholdings instantly. Automated credit scoring models, designed to incorporate both traditional and alternative data sources, have the potential to minimize human intervention and reduce processing times from several weeks to just a few days, making credit available within the critical sowing window.

Equally important is the expansion of alternative delivery mechanisms. Rural communities often remain cut off from formal financial services due to limited physical access. Mobile banking vans, agent banking initiatives such as Asaan Finance, and collaborations with telecom operators or local retail shops can ensure that services reach villages directly. Loan disbursements through mobile wallets connected to platforms like Raast can further guarantee instant fund transfers, even to farmers without conventional bank accounts, bridging the digital divide.

Policy innovation must complement these operational reforms. The State Bank of Pakistan can create stronger incentives for timely lending by offering preferential refinancing schemes that reward banks for serving smallholders efficiently. Simultaneously, the introduction of products such as weather-indexed and parametric insurance can reduce banks' perceived risks, encouraging quicker loan approvals. Finally, sustained financial literacy campaigns will empower farmers to navigate the system more effectively, ensuring they understand both their rights and the available tools for securing timely, affordable credit.

Conclusion

The crisis of delayed agricultural credit in Pakistan is not merely a financial management issue, it is a structural challenge that directly undermines productivity, livelihoods, and national food security. While the government and financial institutions highlight large aggregate lending figures, these numbers obscure the lived reality of millions of smallholder farmers who continue to struggle with delayed or denied access to critical credit. The bureaucratic hurdles, infrastructural gaps, and risk-averse lending practices systematically disadvantage the very farmers who form the backbone of Pakistan's agricultural economy.

The ripple effects are far-reaching: reduced yields, entrenched cycles of indebtedness, rising food imports, and worsening poverty in rural areas. Left unaddressed, these failures will continue to erode Pakistan's agricultural resilience at a time when climate variability already poses severe threats.

However, solutions are within reach. By embracing digitization, expanding delivery channels, and fostering policy innovation, the agricultural credit system can be transformed into a timely, inclusive, and farmer-centric model. Such reforms will not only empower smallholders but also strengthen food security and stabilize the national economy. The rains may be beyond human control, but ensuring credit arrives on time is a choice, and one that Pakistan can no longer afford to ignore.

References: IFPRI; Karachi University Business School; Ministry of National Food Security & Research; PPAF; SBP; World Bank

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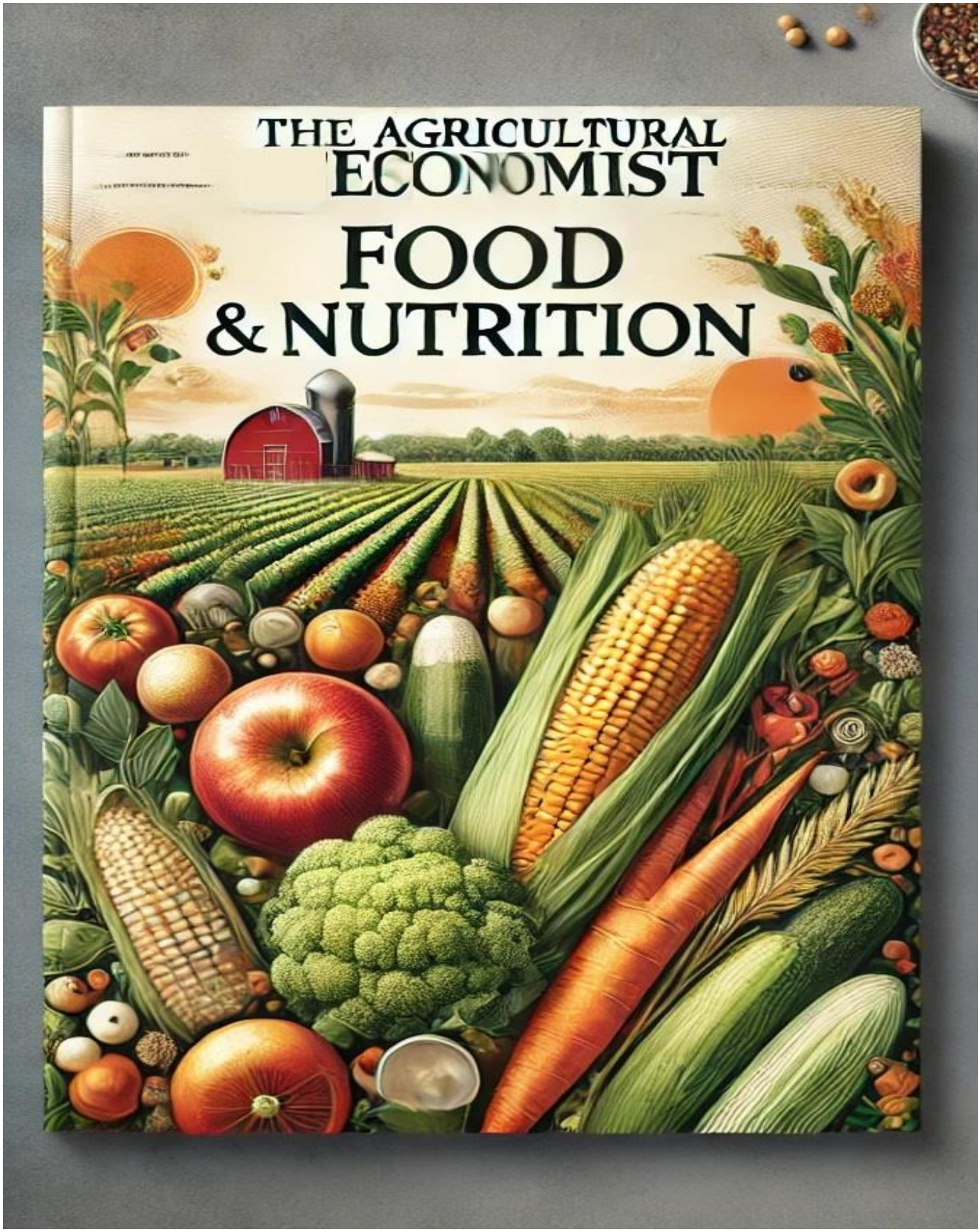

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Poultry Farming in Pakistan: Challenges & Opportunities

Explore the critical role of poultry farming in Pakistan's agriculture and food security. Understand the challenges faced by producers and the impact of profit distribution on rural livelihoods and consumer prices.

Muhammad Awais

9/10/2025

Poultry is a cornerstone of Pakistan's agricultural economy and an essential weapon in the fight against malnutrition. As the country's most affordable and accessible source of animal protein, poultry provides a critical dietary buffer in a context where 38 percent of children under five suffer from stunting caused by chronic malnutrition (NNS, 2018). Eggs and chicken meat supply not just protein but also vital micronutrients that directly influence growth, immunity, and cognitive development. In a nation struggling to meet its nutritional needs, the sector carries both economic and public health significance.

Despite its enormous potential, poultry farming in Pakistan faces persistent structural inefficiencies that prevent it from reaching full capacity. Small and medium producers, who form the backbone of the industry, often work under volatile conditions with thin margins. Rising feed costs, disease outbreaks, and limited access to affordable credit already strain their operations. However, the greatest obstacle is the inequitable distribution of profits across the supply chain. Middlemen and large traders capture a disproportionate share of earnings, leaving farmers with little incentive to expand or adopt improved production practices. This imbalance suppresses the sector's growth trajectory and keeps consumer prices higher than they should be.

The present study examines the economics of poultry production with a particular focus on how profitability is distributed among stakeholders. By testing the hypothesis that intermediaries extract excessive margins at the expense of producers, it highlights a critical barrier to both industry growth and nutritional security. Unlocking the sector's potential requires rethinking pricing mechanisms, strengthening producer cooperatives, and improving direct market access. A fairer system would not only enhance farm-level profitability but also reduce costs for consumers, positioning poultry as a sustainable driver of food security and rural livelihoods in Pakistan.

The Critical Role of Poultry in Pakistan's Food Security

Pakistan faces a widening protein gap that directly undermines national food security and public health. Average per capita protein consumption hovers around 67.3 grams per day, far below the recommended intake of over 90 grams (FAO, 2020). Poultry meat and eggs stand out as the most practical and affordable means of bridging this deficit. Today, the sector contributes more than 35 percent of the country's total meat production (PSLM, 2021-22), making it indispensable to nutritional improvement.

The poultry industry has undergone a remarkable transformation over the past few decades. Once limited to household backyards, it has grown into a highly organized and capital-intensive sector. Current estimates place total investment above PKR 1.5 trillion, with over 1.5 million people directly or indirectly employed (PEPA, 2023). Despite these impressive figures, the benefits of this growth remain unevenly distributed. Producers, the foundation of the industry, receive a disproportionately small share of profits compared to intermediaries, weakening incentives to expand production.

Profit distribution patterns reveal a stark imbalance. Commission agents, positioned as essential gatekeepers between farmers and markets, capture 47 percent of the total profit. Their dominance allows them to set prices that favor their own margins at the expense of producers. Retailers take an additional 28 percent, justified partly by operational costs but inflated by limited local competition. In contrast, producers, who face the highest production risks from disease outbreaks, feeding price volatility, and fluctuating demand, receive just 25 percent of total profits. This imbalance has deepened over time. Earlier research by Qazi (1989) suggested that intermediaries together controlled around 61 percent of profits. Today their share has grown, reflecting the increasing market power they wield against vulnerable producers.

Price volatility further compounds these challenges. Poultry prices in Pakistan are notoriously unstable, with the coefficient of variation for monthly broiler prices often exceeding 20 percent (State Bank of Pakistan, 2022). Seasonal patterns highlight the fragility of the system: prices typically peak during the hot months, when heat stress reduces bird survival and production levels, and again drop sharply in February, when post-marriage season demand subsides. For producers, such unpredictability makes planning production cycles and securing financing almost impossible. Many farmers are forced into a cycle of debt, relying on commission agents for quick cash sales, which further entrenches their dependence and erodes profitability.

The marketing system itself is riddled with constraints that perpetuate these inequities. Farmers regularly report on market manipulation, where a small number of commission agents collude to

fix prices. Unethical practices, such as underweighting, under-counting, and tampered scales, are widespread. Commission charges, often between 6 and 8 percent per transaction, are levied without oversight. Most damaging is the absence of direct access to markets. Without regulated mandis, cooperative marketing systems, or structured farm-to-retailer contracts, producers remain locked out of a fair share of consumer spending.

The evidence underscores a critical reality: poultry farming in Pakistan has the potential to play a transformative role in food security, but its promise is held back by structural inequities in the value chain. Unless reforms ensure that producers are empowered to capture a greater portion of value, the sector will continue to underperform in its mission to reduce malnutrition and strengthen rural livelihoods.

Policy Recommendations for a Fair and Efficient Poultry Value Chain

The poultry sector in Pakistan holds immense promise for reducing malnutrition and meeting national food security goals. However, its ability to fulfill this role is undermined not by low production capacity, but by an exploitative and inefficient marketing system. The central issue lies in the inequitable distribution of value across the supply chain, which systematically disadvantages producers and discourages them from expanding operations. Without structural reforms, the sector will remain trapped in a cycle where farmers bear the highest risks but reap the smallest rewards. To reverse this trajectory, a multi-pronged policy approach is essential.

First, the development of alternative market institutions is critical. Government and development partners should prioritize the creation of producer cooperatives, associations, and farmer-led marketing companies. These organizations would enable collective bargaining, bulk transportation, and direct contracting with supermarkets, hotels, restaurants, and institutional buyers. By reducing the reliance on commission agents, producers would gain both bargaining power and price stability. Evidence from successful cooperative models in South Asia shows that such institutions not only improve farmer incomes but also increase consumer trust in food quality and safety.

Second, regulatory oversight must be strengthened. At present, commission agents operate with near-total impunity, exploiting loopholes in market regulation. A system of regular monitoring of weights, measures, and commission charges should be implemented at district and provincial levels. Transparent reporting mechanisms, along with penalties for malpractice, would reduce exploitative practices such as underweighting and arbitrary deductions. Such oversight would restore confidence among producers and help normalize fair market behavior.

Third, access to finance and insurance is vital to reducing farmer vulnerability. Poultry farming is highly sensitive to shocks, ranging from disease outbreaks to sudden feed price hikes. Yet farmers often lack financial cushions and must sell at unfavorable terms to cover urgent expenses. Tailored credit products, working capital loans, and affordable insurance schemes could transform this dynamic. Public–private partnerships with banks and microfinance institutions could design instruments specifically for small and medium poultry producers, enabling them to manage risk without falling prey to intermediaries.

Fourth, there is an urgent need for investment in cold chain infrastructure. Pakistan's poultry supply chain is highly perishable, leaving farmers at the mercy of daily demand fluctuations. Public and private investment in cold storage, refrigerated transport, and processing facilities would allow farmers to store surplus, smooth supply over time, and negotiate better terms. Such infrastructure would also encourage value addition, through processed meat and egg products, which could expand both domestic and export markets.

Finally, consumer awareness and market integration should not be overlooked. Designated farmer markets in urban centers, along with digital platforms that link producers directly with consumers, can reduce supply chain layers. This would simultaneously improve producer margins and lower consumer prices. Additionally, awareness campaigns about the nutritional importance of poultry products could further stimulate demand, ensuring a steady and predictable market for producers.

In sum, the poultry sector does not require more birds in the barns, it requires a fairer system to move those birds to market. By reforming market institutions, enforcing regulations, improving access to finance, building cold chain capacity, and integrating producers more directly with consumers, Pakistan can create a more equitable and efficient poultry value chain. These measures will ensure sustainable profitability for farmers, affordability for consumers, and a stronger national response to the challenge of malnutrition.

Conclusion

Poultry farming in Pakistan sits at the crossroads of agriculture, nutrition, and rural livelihoods. It is not the lack of production capacity that limits the sector's contribution to food security, but the inequitable distribution of profits along the value chain. Producers, who shoulder the highest risks, continue to receive the smallest share, while intermediaries extract excessive margins. This imbalance not only weakens farmer incentives but also inflates consumer prices, undermining poultry's role as the most affordable source of protein.

The evidence makes clear that reforming the marketing and distribution system is as critical as improving productivity. Strengthening producer cooperatives, enforcing regulatory oversight, expanding financial and insurance access, investing in cold chain infrastructure, and enabling direct market integration are all essential steps. Together, these measures can shift the balance of power back toward

farmers, ensuring they are rewarded fairly for their efforts.

If Pakistan is to meet its nutrition targets and reduce the burden of child malnutrition, the poultry sector must be restructured into a fairer, more efficient system. A value chain that works for farmers and consumers alike can transform poultry into a sustainable engine of food security, rural prosperity, and national health.

References: FAO; NNS; PBS; PEPA; SBP; Qazi

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Pakistan’s Blue Economy: Unlocking Seaweed Potential

Discover how Pakistan’s untapped seaweed resources can boost food, health, and exports, driving growth in the blue economy and sustainability.

Azizullah Noondani

9/26/2025

When discussing Pakistan's economy, attention usually centers on textiles, agriculture, or remittances. Rarely does the conversation highlight the untapped potential of the blue economy, the sustainable use of ocean resources for economic growth and livelihoods. With a 1,050 km coastline along the Arabian Sea and an Exclusive Economic Zone covering nearly 290,000 square kilometers, Pakistan possesses a wealth of marine resources. Yet one of the most promising, seaweed, remains critically underexplored.

Often dismissed as slimy waste washed up on beaches, seaweed is in fact one of the most versatile and valuable bio-resources in the world. Globally, it underpins multi-billion-dollar industries, spanning food, pharmaceuticals, cosmetics, agriculture, and renewable energy. In East Asian countries such as China, Japan, and South Korea, seaweed cultivation has become a thriving sector, supporting coastal livelihoods while generating exports and cutting-edge innovations. For example, seaweed extracts are used in everything from sushi wraps and nutritional supplements to natural fertilizers and biodegradable packaging.

In Pakistan, however, seaweed resources remain largely unharvested, with little research, investment, or policy support directed toward their utilization. This represents a lost opportunity not only for economic diversification but also for sustainable development. Seaweed farming could provide coastal communities with alternative incomes, reduce pressure on overfished stocks, and contribute to climate resilience by absorbing carbon dioxide and improving marine biodiversity. Moreover, Pakistan’s strategic location gives it access to regional markets in the Middle East and South Asia, where demand for seaweed-based products is rising rapidly.

Recognizing seaweed as more than “beach waste” requires a national shift in perspective. With targeted investment, training, and policy incentives, Pakistan could transform its overlooked seaweed reserves into a vibrant sector of the blue economy, unlocking new jobs, boosting exports, and supporting environmental sustainability.

Seaweed and Its Global Significance

Seaweeds, also known as macroalgae, are broadly classified into three major categories: brown (Phaeophyceae), red (Rhodophyta), and green (Chlorophyta). Each variety has distinct biological properties and commercial applications, making them central to both ecological health and global industries. Ecologically, seaweed is indispensable to marine ecosystems. They provide shelter and breeding grounds for fish and other aquatic organisms, produce significant amounts of oxygen through photosynthesis, and play a crucial role in sequestering carbon dioxide from the atmosphere. Their capacity to capture carbon makes them increasingly recognized as a natural ally in climate change mitigation, alongside their contribution to sustaining biodiversity in coastal regions.

Economically, seaweed is no less important. The global seaweed market was valued at USD 17.59 billion in 2022 and is expected to grow at a robust compound annual growth rate (CAGR) of 10.7% between 2023 and 2030, potentially surpassing USD 30 billion by 2030 (Grand View Research, 2023). This rapid expansion reflects the rising global interest in sustainable, natural, and plant-based solutions. Demand spans multiple industries from food and pharmaceuticals to cosmetics, agriculture, and renewable energy. Seaweed extracts such as carrageenan, agar, and alginate are now widely used as gelling, stabilizing, and thickening agents in processed foods, while bioactive compounds derived from seaweed are gaining traction in nutraceuticals and skincare.

Asia-Pacific dominates seaweed production and consumption, with China, Indonesia, and South Korea at the forefront. For example, Indonesia produces over 9 million metric tons annually, sustaining the livelihoods of hundreds of thousands of coastal households (FAO, 2022). This success story demonstrates how seaweed cultivation can serve as a dual engine for economic development and environmental stewardship. With rising global demand, seaweed is no longer a niche commodity but a strategic resource shaping the future of food security, green industries, and climate resilience.

Pakistan’s Untapped Potential

Pakistan is far from lacking in marine resources. Its 1,050 km coastline along the Arabian Sea harbors a remarkable diversity of seaweeds, with researchers documenting more than 200 species (Amir et al., 2021). These include commercially valuable varieties such as *Gracilaria*, widely used for agar extraction; *Sargassum*, important in pharmaceuticals, biofertilizers, and alginates; and *Ulva*, known for its applications in food, feed, and cosmetics. Abundant growth is observed in coastal regions like Manora and Paradise Point near Karachi, as well as the rocky shores of Balochistan, particularly around Sonmiani Bay and Gwadar. This natural wealth positions

Pakistan to participate meaningfully in the expanding global seaweed economy.

Yet despite this potential, seaweed remains one of the country's most underutilized marine resources. The sector has received minimal policy attention, and commercial cultivation is virtually absent. According to the International Trade Centre (2023), Pakistan's exports of aquatic plants, primarily seaweed, stood at only about USD 2.1 million in 2022. While this reflects a modest rise compared to earlier years, it remains negligible when contrasted with regional competitors like Indonesia, which generates billions annually from seaweed exports. The stark difference lies not only in scale but also in value addition.

Most of Pakistan's limited exports are raw, unprocessed seaweed, shipped without significant transformation into high-value products. This approach leaves the country capturing only a sliver of the global value chain, while others profit from processing seaweed into carrageenan, alginates, biofertilizers, nutraceuticals, and even biofuels. By failing to move beyond raw exports, Pakistan misses out on creating jobs, boosting coastal incomes, and strengthening its foreign exchange earnings. With proper investment in aquaculture, processing facilities, and training, Pakistan could unlock the immense economic, nutritional, and environmental benefits of its coastal bounty, turning seaweed into a cornerstone of its blue economy.

The Multifaceted Uses of Seaweed

Seaweed's versatility makes it one of the most promising resources for Pakistan's future, with applications that cut across food security, health, agriculture, industry, and renewable energy. Its nutritional value is particularly striking. Rich in iodine, vitamins A, B, C, and E, as well as protein and essential minerals, seaweed offers a low-cost way to address widespread micronutrient deficiencies in Pakistan. Beyond health supplements, it can be creatively incorporated into traditional foods such as samosas, pakoras, or even baked goods, providing affordable pathways to improve community-level nutrition security.

In pharmaceuticals and cosmetics, seaweed holds equally transformative potential. Compounds extracted from local species possess anti-inflammatory, antioxidant, and anti-viral properties. Research by Shameel (2019) has already pointed to applications for skin care, including moisturizing, anti-aging, and UV-protection products. Developing such industries locally could open high-value export markets while also reducing dependence on imported cosmetic ingredients.

Agriculture, Pakistan's economic backbone, could also benefit immensely. Seaweed-based bio-stimulants are proven to enhance crop yields, improve soil fertility, and boost resilience to drought and salinity, an urgent need in a country facing water scarcity and climate stress. Using seaweed extracts as organic fertilizers can also reduce dependence on expensive chemical inputs, lowering production costs for farmers.

The industrial uses are equally significant. Seaweed provides agar, carrageenan, and alginates, which are essential gelling and stabilizing agents in global food and pharmaceutical industries. Pakistan currently imports these products, but with local production, it could become a supplier instead. Moreover, seaweed offers exciting prospects for renewable energy as a sustainable feedstock for biofuels. Unlike crops grown on arable land, seaweed does not compete with food production, making it a cleaner and more sustainable option for energy diversification.

Challenges Holding Pakistan Back

Despite its rich coastal biodiversity and natural potential, Pakistan has yet to harness seaweed as a driver of economic growth. Several interconnected barriers continue to impede progress. The most fundamental challenge is the absence of policy and strategic focus. Seaweed is almost invisible in national economic and agricultural agendas, and there is no regulatory framework or incentive structure to encourage systematic cultivation, processing, or export (WWF-Pakistan, 2021). This policy vacuum has left the sector fragmented and overlooked.

Research and Development (R&D) is another critical bottleneck. While institutions such as the University of Karachi and SUPARCO have conducted taxonomic surveys and ecological assessments, these efforts remain academic rather than commercial. There is little focus on applied research into cultivation methods, modern processing technologies, or the development of value-added products. As a result, Pakistan lags far behind countries like Indonesia or South Korea, where R&D underpins thriving seaweed industries.

The lack of organized cultivation further exacerbates the problem. Seaweed in Pakistan is still harvested from the wild, often unsustainably, leading to inconsistent supply and environmental degradation. The infrastructure and technical knowledge required for aquaculture-based production are virtually non-existent, leaving the sector vulnerable and unscalable.

Compounding these issues is low awareness and investment. For most entrepreneurs, seaweed remains an alien concept. Its diverse commercial uses, from bio-stimulants to nutraceuticals, are largely unknown, meaning capital flows into higher-value industries are scarce. Without targeted promotion, potential investors fail to see seaweed as an opportunity worth pursuing.

In essence, the seaweed sector suffers not from a lack of natural resources but from systemic neglect. Unless these barriers are addressed through strategic policies, research collaboration, organized farming, and awareness campaigns, Pakistan risks losing out on a valuable opportunity to transform its blue economy.

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Conclusion

Pakistan's blue economy holds immense promise, and seaweed represents one of its most overlooked treasures. With more than 200 species found along its 1,050 km coastline, Pakistan has the natural endowment to become a competitive player in the global seaweed market. Yet, systemic neglect manifested in the absence of supportive policies, weak research and development, unorganized cultivation, and low investor awareness has left this resource underutilized. The result is a sector with vast ecological, economic, and social potential that remains untapped.

Globally, seaweed has transformed coastal economies, fueling billion-dollar industries in food, pharmaceuticals, cosmetics, agriculture, and renewable energy, while simultaneously contributing to climate resilience and nutrition security. Pakistan, by contrast, exports only raw material worth a negligible $2.1 million annually, missing opportunities for value addition, job creation, and foreign exchange earnings.

Realizing seaweed's potential requires a paradigm shift: the development of a dedicated national seaweed policy, investment in aquaculture and processing technologies, and strong linkages between research institutions, industry, and coastal communities. By empowering local communities especially women and fostering sustainable cultivation practices, seaweed can become more than just a marine resource. It can serve as a cornerstone of Pakistan's sustainable development, enhancing livelihoods, boosting exports, and positioning the country as a leader in the emerging blue economy.

References: Amir et al; FAO; Grand View Research; ITC; Shameel; WWF-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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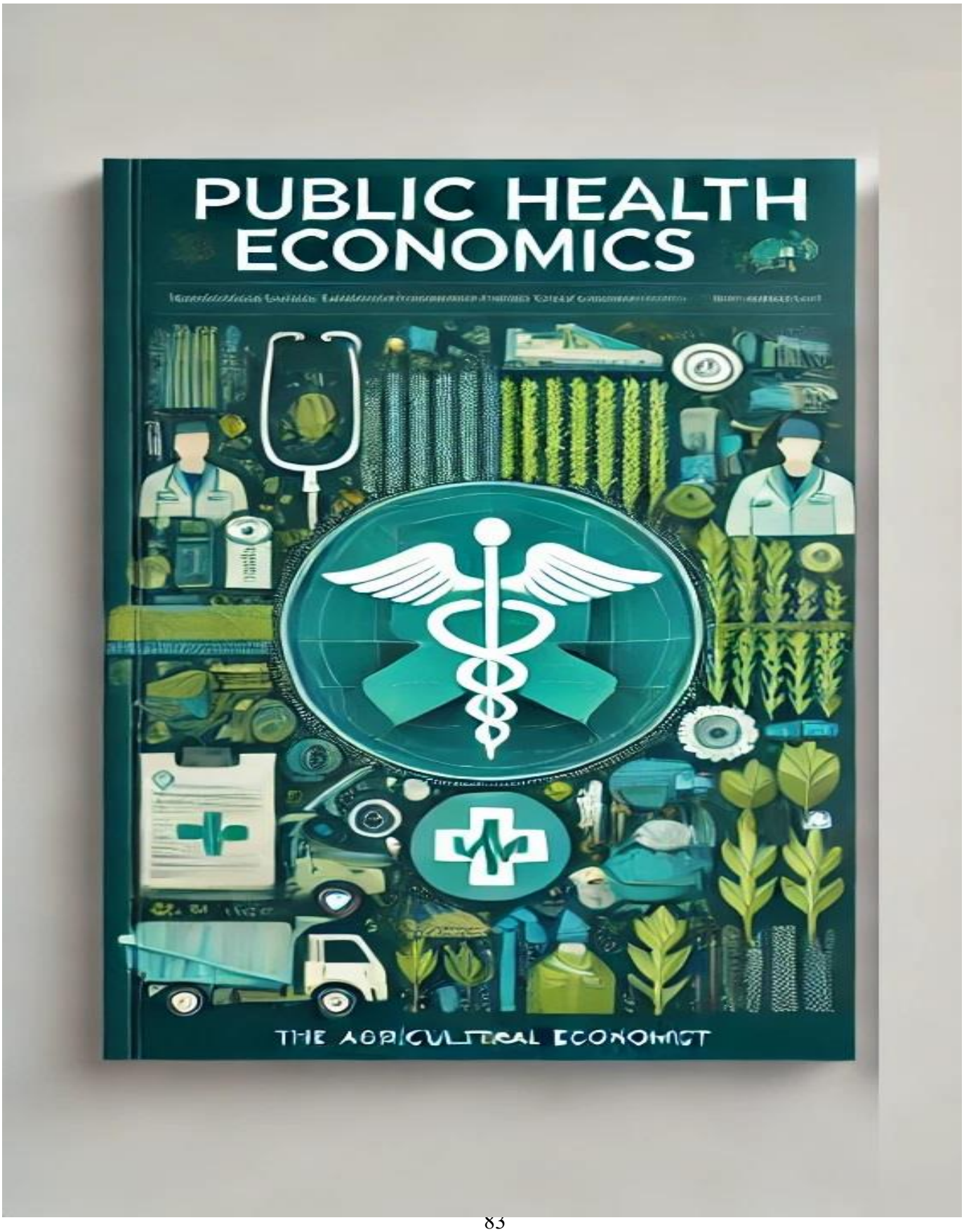
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Protecting Farming Communities from Pesticide Risks

Explore how to safeguard farming communities from pesticide exposure by addressing hidden risks, gender gaps, and the realities of rural life. Learn about practical protocols for community awareness, secure storage, and inclusive training to protect women and children from disproportionate harm.

Muhammad Hamid Bashir

9/10/2025

Pesticide exposure remains a largely invisible public health threat, particularly in smallholder farming communities where traditional gender roles shape daily agricultural labor. While men typically handle spraying, women and children are disproportionately affected through indirect pathways. They may encounter residues while laundering contaminated clothing, entering recently treated fields, or handling improperly stored chemicals. These exposure routes, often overlooked in conventional safety programs, pose long-term health risks including developmental issues in children, hormonal disruptions, and chronic illnesses in adults.

Addressing this silent crisis requires more than standard protective equipment or generic safety advisories. A gender-aware, community-based protocol recognizes the lived realities of all members and focuses on practical, low-cost interventions. Examples include scheduling re-entry into fields to minimize secondary exposure, safe storage of chemicals away from homes, and segregating work clothing to prevent contamination. These measures, though simple, can have a profound impact on reducing health risks without affecting productivity.

The approach emphasizes community participation and local adaptation. Extension workers, NGOs, and farmer cooperatives play a crucial role in training and implementation, ensuring that protocols are culturally appropriate and widely adopted. By embedding gender considerations into pesticide management strategies, communities can protect the most vulnerable, sustain agricultural output, and foster healthier living environments. Ultimately, this paradigm shift demonstrates that safeguarding public health and maintaining productivity are complementary objectives rather than competing priorities, offering a scalable model for rural agricultural communities across Pakistan and similar contexts worldwide.

The Hidden Burden: Why a Gender Lens is Non-Negotiable

The health risks of pesticide use extend far beyond the fields where chemicals are sprayed. Research increasingly shows that women and children in farming communities shoulder a disproportionate share of the burden, not because they are directly applying pesticides, but because of the invisible roles they play in the agricultural household. One critical pathway is re-entry exposure. Women and children often enter fields within hours or days of spraying to gather fodder, collect produce, or simply pass through. Studies show this routine practice results in significantly elevated pesticide metabolite levels, with women recording nearly 40% higher concentrations than those who avoided early re-entry.

The danger does not end at the field's edge. Once contaminated clothing returns home, the task of washing it, typically assigned to women, becomes another overlooked hazard. Dermal absorption during laundry has been shown to rival exposure levels faced by low-level sprayers. Compounding this is the problem of unsafe storage, where pesticides are often kept within homes due to lack of secure facilities. This practice has been linked to accidental poisoning in children, some of the most tragic and preventable outcomes of pesticide misuse.

These risks are not random; they are systemic. Women are routinely excluded from training programs and decision-making about pesticide use. They are rarely provided with personal protective equipment designed to fit their bodies, leaving them exposed even when they are aware of the dangers. Without addressing these entrenched gender gaps, interventions will remain inadequate. A gender lens is not an optional add-on to pesticide safety strategies but a necessary foundation. Recognizing and responding to these hidden burdens is the only way to reduce health risks equitably and build agricultural systems that are both safe and sustainable.

A Blueprint for Safety: A Field-Ready Community Protocol

Reducing the hidden risks of pesticide exposure requires more than individual caution. It calls for a shared, community-level commitment where every member, from sprayers to caregivers, has a role in prevention. This protocol offers a practical, adaptable framework that communities can implement immediately, combining low-cost solutions with inclusivity and collective ownership.

Preparation begins before a single drop is sprayed. Announcing spray days through community boards, mosques, and digital groups such as WhatsApp allows households, especially women and caregivers, to plan ahead. Coordinated scheduling ensures that spraying takes place during low-activity hours and avoids windy conditions that cause dangerous drift. Meanwhile, safe childcare spaces, hosted in schools or community halls, provide protection for children, who are among the most vulnerable.

Safety must also extend into the home. Secure storage of pesticides in locked boxes, never in repurposed food containers, is non-negotiable. To prevent

secondary exposure, decontamination zones should be set up outdoors where sprayers can leave contaminated clothing and boots before entering the house. Laundry practices are equally critical: pesticide-soiled garments must be washed separately, with gloves worn during handling, and washing areas cleaned immediately afterward.

In the field, safer application methods protect both sprayers and the surrounding community. Regular calibration of spraying equipment prevents chemical overuse and lowers exposure, while targeted or spot spraying, central to Integrated Pest Management, significantly reduces the volume of pesticides used. Clear pictorial signs marking treated areas and indicating re-entry intervals ensure that families, including children, do not enter fields prematurely.

The importance of protective gear cannot be overstated, but availability and fit often remain barriers. PPE must be sourced in a range of sizes to ensure protection for both men and women. In areas where specialized PPE is unavailable, practical alternatives like long-sleeved clothing, closed shoes, hats, and simple masks should be promoted as effective substitutes.

Finally, safety cannot be achieved without shared decision making. Women must be included in planning discussions on pesticide use, application timing, and protective measures. Training women as sprayers or IPM scouts not only builds local expertise but also ensures that safety strategies reflect diverse perspectives. By embedding inclusivity and collaboration into every step, this community protocol provides a realistic path toward safer, healthier farming systems.

Beyond Chemicals: Cultivating Healthier Alternatives and Making Safety Stick

The long-term solution to pesticide-related health risks lies in reducing dependency on synthetic chemicals altogether. Integrated Pest Management (IPM) offers a practical and affordable pathway, especially for small-holder farming communities. Botanical extracts such as neem-based sprays, chili-garlic mixtures, and simple soap solutions have proven effective against a range of pests while posing minimal health risks. Cultural practices also play a powerful role: crop rotation disrupts pest life cycles, field sanitation limits breeding grounds, and adjusting planting times reduces pest pressure. Equally important is the conservation of natural predators like ladybugs, spiders, and wasps, whose populations collapse when broad-spectrum insecticides are overused. Encouraging these biological allies restores ecological balance while reducing chemical reliance.

Yet alternatives will not succeed unless safety practices take root at the community level. This requires more than distributing guidelines; it demands thoughtful implementation. Gender-balanced training ensures that women, who often face the highest exposure yet are excluded from conventional safety sessions, gain equal access to knowledge. Holding training at accessible times and locations, ideally with female facilitators, makes participation possible for caregivers. Empowering local women as peer educators strengthens adoption, as practices taught by trusted community members carry more weight than external instructions.

Overcoming literacy barriers is another priority. Pictorial job aids, simple illustrations showing safe storage, correct use of protective gear, or proper handling of contaminated clothing, allow all community members to understand and apply key steps regardless of reading ability. Finally, measuring impact ensures accountability and refinement. Tracking indicators such as the percentage of households adopting safe storage, the frequency of PPE use, or reductions in reported pesticide-related symptoms provides tangible evidence of progress. Together, these measures move safety from theory to practice, embedding healthier habits into daily agricultural life.

Conclusion

Protecting farming communities from pesticide exposure requires moving beyond narrow, individual-focused safety messages to a broader vision that addresses hidden risks, entrenched gender gaps, and the realities of rural life. The evidence is clear: women and children bear a disproportionate burden of exposure, not because they are spraying, but because of the daily, overlooked tasks they perform, entering fields too soon, washing contaminated clothes, or living in homes where chemicals are poorly stored. Any strategy that ignores these pathways will fall short. What this article shows is that safety is not just about masks and gloves, it is about community awareness, cultural adaptation, and equal participation. A practical, field-ready protocol, built on timely communication, secure storage, safe laundering, and inclusive training, offers a realistic path forward.

The real breakthrough, however, lies in reducing reliance on chemicals altogether. By promoting Integrated Pest Management, botanical alternatives, and ecological practices, communities can protect health while sustaining productivity. Change will not happen overnight, but with gender-balanced training, peer educators, and impact monitoring, safer practices can become embedded in daily routines. Protecting the vulnerable is not an obstacle to farming, it is the foundation of resilient, healthy agricultural systems. This shift is both urgent and achievable, offering a model for rural communities across Pakistan and beyond.

References: Atuhaire et al.; FAO; GLOBALG; IDRC; Lekei et al.; WHO

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

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Türkiye's Agricultural Productivity Paradox

Explore Türkiye's agricultural productivity paradox, revealing the gap between its high-value crop production potential and actual economic outcomes. Learn how traditional practices and inefficiencies hinder smallholder farmers, leading to overuse of inputs and environmental degradation.

Mithat Direk

9/5/2025

In economic theory, efficiency is pursued along two complementary pathways: extracting the maximum output from a fixed set of inputs or achieving a given level of output at the lowest possible cost. Both approaches aim to optimize resource use and enhance overall productivity. In agriculture, this translates to higher yields, lower input costs, and improved profitability for farmers. Despite its fertile land, favorable climate, and diverse cropping systems, Türkiye grapples with a persistent productivity paradox. The country ranks among the world's leading agricultural producers yet yields for staple and high-value crops often fall below global benchmarks. Resource use, fertilizers, water, labor, is frequently inefficient, reducing potential income and undermining the long-term sustainability of the sector.

This paradox is mirrored in broader economic behaviors. For example, in the real estate sector, households often replace or renovate newly purchased homes before occupancy, even when existing structures are functional. Such actions reflect a systemic inefficiency in resource allocation, where energy, time, and capital are expended without proportional gains. When a similar mindset permeates agriculture, it manifests as overuse of inputs, suboptimal crop management, or reliance on traditional practices that limit productivity. The result is a gap between physical output and economic value scenario where land and labor produce crops, but potential income remains unrealized.

Bridging this gap requires a dual focus: first, on technical improvements such as precision farming, irrigation efficiency, and crop selection; second, on economic decision-making that aligns farm management with cost-effectiveness and market signals. Only by integrating efficiency at both the physical and economic levels can Türkiye fully harness its agricultural potential and secure sustainable gains for farmers, rural communities, and the broader economy.

The Productivity Paradox in Turkish Agriculture

Turkish agriculture is dominated by smallholder farms, often managed using practices passed down through generations rather than systematically optimized for economic efficiency. This reliance on tradition, while culturally significant, sometimes constrains productivity and limits the adoption of modern, cost-effective approaches. A striking example of this dynamic is the so-called "input race," in which farmers, motivated by social competition and the desire to match or exceed their neighbors' practices, apply increasing amounts of fertilizers, water, or pesticides without rigorously evaluating the economic returns.

This behavior illustrates the classic economic principle of diminishing marginal returns. When inputs exceed an optimal threshold, each additional unit produces progressively smaller gains in output and can even reduce overall efficiency. In Turkey, this is evident in the widespread overuse of nitrogen fertilizers. While farmers may perceive higher yields, the economic reality is often the opposite: increased costs for inputs, accelerated soil degradation, and contamination of water resources, all without a proportionate rise in marketable crop output. The focus shifts from income maximization to an illusion of productivity, where visible yields are prioritized over net profitability.

Addressing this paradox requires a reorientation of farm management strategies toward efficiency rather than volume. Precision agriculture, soil testing, and data-driven nutrient management can help farmers identify optimal input levels, improving both environmental sustainability and economic outcomes. Coupled with extension services and training programs, these approaches can bridge the gap between traditional practices and modern efficiency, ensuring that Turkish agriculture not only produces more but does so in a financially and ecologically sustainable way. By realigning incentives and knowledge, smallholders can transform the productivity paradox into a pathway for resilient and profitable farming.

Türkiye's Position in the Global Arena: A Tale of Quality vs. Quantity

Türkiye occupies a prominent place in global agriculture. It ranks first in Europe and fourth worldwide in vegetable production (TÜİK, 2023) and is a leading producer of high-value crops such as apricots, cherries, figs, hazelnuts, and quince. This impressive portfolio underscores the country's agro-climatic diversity and traditional expertise in horticulture. Yet, beneath these headline figures lies a persistent efficiency gap that limits economic returns for farmers.

Open-field tomato production offers a stark illustration. While greenhouse systems yield 70–80 tons per hectare, some open-field operations struggle to produce just 5–10 tons per hectare (TÜİK,

2023). By contrast, countries like the Netherlands leverage controlled-environment agriculture, precision technology, and rigorous input management to exceed 500 tons per hectare (FAO, 2022). The gap is not merely technical; it reflects a broader orientation toward economic efficiency and systematic productivity planning.

Global leaders in high-yield agriculture, Netherlands, Israel, and Spain, treat farming as a knowledge-intensive, industrial activity. Every decision, from nutrient application to water use, is evaluated for its return on investment, ensuring that inputs translate directly into economic gain. Türkiye, while celebrated for the superior taste, aroma, and quality of its produce, often prioritizes tradition and visual yield over financial efficiency. This focus on qualitative attributes, though valuable for niche markets, cannot fully offset the economic costs of lower yields and higher input use.

Bridging this quality-quantity divide requires integrating advanced agronomic practices, data-driven decision-making, and optimized resource management without compromising the distinctiveness of Turkish crops. By aligning the country's celebrated quality with higher efficiency, Türkiye can enhance farm profitability, strengthen its global competitiveness, and sustain its agricultural leadership in both local and international markets.

Historical Efforts and the Need for a National Productivity Movement

Türkiye has a long-standing institutional interest in productivity, dating back to the establishment of the Milli Prodüktivite Merkezi (MPM) in 1954. This initiative was a pioneering effort to coordinate cross-sectoral productivity improvements, spanning agriculture, industry, and services. Yet, the dissolution of MPM in 2011, and the absorption of its functions into the Ministry of Industry and Technology, marked a shift away from a dedicated national focus on productivity. Without a centralized, cohesive approach, efforts have remained fragmented, limiting measurable impact in agriculture and other sectors.

A genuine productivity transformation requires a coordinated national movement. Success hinges on collaboration between government agencies, farmers, academic institutions, private enterprises, and NGOs. The government's role is critical in creating an enabling environment through policy reform, technical support, and investment in knowledge systems. Subsidies, for instance, should shift from input-based support to performance-oriented incentives that reward efficiency, sustainability, and adoption of precision agriculture technologies. Extension services must be revitalized to provide independent, data-driven guidance on irrigation, nutrient management, and integrated pest control, reducing reliance on supplier-driven advice. Complementing these efforts, targeted research and development can generate climate-resilient, high-efficiency crop varieties tailored to Turkish agroecological conditions.

The ultimate objective must move beyond raw output to profitability per unit of land and water. A study in Şanlıurfa on cotton farming illustrates this principle: while yield increased with up to ten irrigations, economic returns peaked at seven, as additional water and energy costs outweighed marginal gains. Productivity, therefore, is not about producing more per se, but producing more profitably.

By combining modern agronomic knowledge, technology, and data-driven decision-making with Türkiye's rich agricultural tradition, farmers can enhance both economic returns and global competitiveness. A national movement focused on productivity promises not only higher incomes for producers but also a sustainable, resilient agricultural sector that secures Türkiye's position in global markets.

Conclusion

Türkiye's agricultural productivity paradox highlights a critical disconnect between potential and realized economic outcomes. Despite its favorable agro-climatic conditions and global leadership in high-value crop production, the nation struggles with inefficiencies rooted in traditional practices, input overuse, and insufficient integration of data-driven decision-making. Smallholder farmers often prioritize visible yields or social norms over profitability, leading to excessive fertilizer, water, and pesticide use that diminishes net returns and accelerates soil degradation.

Bridging this gap requires a holistic approach that combines technical, economic, and institutional strategies. Precision agriculture, optimized irrigation, soil testing, and nutrient management can align input use with actual crop requirements, improving both productivity and sustainability. Strengthened extension services and targeted R&D can ensure farmers have access to actionable knowledge and climate-resilient, high-efficiency varieties. At the policy level, shifting subsidies from input-based support to performance-oriented incentives, coupled with a coordinated national productivity movement, can create an environment that rewards efficiency, innovation, and sustainability.

Ultimately, the goal is not merely higher production but higher profitability per unit of land and water. By integrating tradition with modern agronomic practices and economic rationality, Türkiye can transform its agricultural sector into a knowledge-intensive, competitive, and resilient system. Such a transformation promises improved farmer incomes, strengthened food security, and enhanced global competitiveness, ensuring that the country's rich agricultural heritage translates into tangible economic and social gains.

References: TÜİK; FAO; Ministry of Agriculture and Forestry; World Bank; Özertan & Aerni; Akyüz & Yıldırım; Demir & Bayaner

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Happiness Economics: Beyond Economic Output

Discover how happiness economics reshapes our understanding of prosperity. Learn why economic output alone fails to capture quality of life, emphasizing the importance of employment quality, social relationships, health, and trust in institutions for long-term well-being.

Rizwan Arshad

9/18/2025

In recent decades, economists have increasingly recognized that traditional measures of economic performance, such as GDP or per capita income, tell only part of the story. While these indicators reflect material wealth and production, they often fail to capture whether people are thriving, satisfied, or experiencing a sense of well-being. This realization has given rise to the field of happiness economics, an interdisciplinary approach that blends insights from psychology, sociology, and public policy with traditional economic analysis.

Happiness economics examines how various factors, ranging from income and employment to social relationships, health, and governance, affect subjective well-being. It challenges the assumption that higher income automatically leads to greater happiness, emphasizing the importance of relative income, inequality, job security, and social support networks. For example, studies have shown that beyond a certain threshold, additional income contributes little to long-term life satisfaction, while social connections, purpose, and work-life balance often have stronger and more lasting effects.

The field also explores how policies influence well-being. Governments can enhance happiness through measures such as progressive taxation, universal healthcare, education access, labor protections, and urban planning that prioritize green spaces and community engagement. Cross-country comparisons have revealed intriguing patterns: nations with lower GDP but strong social cohesion, trust in institutions, and work-life balance often report higher levels of life satisfaction than wealthier but more unequal societies.

Happiness economics is not without debate. Critics question the reliability of subjective measures and the extent to which governments can or should act to optimize well-being. Nevertheless, the growing body of empirical research offers a valuable complement to traditional economic analysis, highlighting that prosperity is not only about material growth but also about fostering environments where people can lead meaningful, fulfilling lives.

Key Concepts and Measurement in Happiness Economics

Happiness economics shifts the focus from conventional financial indicators to subjective well-being (SWB), emphasizing how individuals perceive and experience their lives. SWB encompasses three interrelated dimensions. Life evaluation reflects a cognitive assessment of one's life, asking people to rate their overall satisfaction. Affective experience captures the day-to-day emotional landscape, including the frequency and intensity of positive and negative feelings. Eudaimonia goes deeper, reflecting a sense of purpose, meaning, and fulfillment that transcends momentary pleasure. Together, these dimensions provide a holistic understanding of well-being, capturing both the material and psychological aspects of life.

Measuring SWB relies on large-scale surveys, such as the Gallup World Poll and the OECD Better Life Index, which collect self-reported data from millions of respondents worldwide. Bhutan's Gross National Happiness (GNH) Index represents a pioneering national approach, valuing sustainable development, cultural preservation, and governance quality alongside economic output. Such frameworks challenge the traditional dominance of GDP, highlighting the importance of policies that foster life satisfaction, social cohesion, and mental health.

A central debate in happiness economics concerns the relationship between income and well-being. The Easterlin Paradox (1974) suggested that while higher income correlates with happiness at a point in time, long-term national income growth does not necessarily increase average happiness beyond a saturation point. More recent research, however, indicates a log-linear relationship: income growth continues to improve well-being, though with diminishing returns. Absolute income is critical for meeting basic needs and reducing poverty, particularly for those below a certain threshold (around $75,000 per year in the U.S.). Beyond this, relative income and hedonic adaptation, where individuals quickly adjust to new circumstances, play a larger role, meaning additional income yields smaller gains in happiness.

By integrating these insights, happiness economics provides a nuanced framework for understanding the complex interplay between material conditions, psychological factors, and social context in shaping human well-being.

The Critical Pillars of Well-Being: Beyond Income

Happiness demonstrates that long-term well-being depends on more than just financial resources. Employment, for instance, is not merely about having a job but about the quality and conditions of work. Secure, compensated positions that provide autonomy, manageable hours, and opportunities for personal growth significantly enhance life satisfaction. Conversely, job insecurity, stressful work

environments, and long commutes can negate the positive effects of higher income. The World Happiness Report 2023 underscores that "good jobs" are a critical driver of national well-being, highlighting the central role of meaningful employment in fostering both economic and psychological stability.

Equally important are social connections. Strong relationships with family, friends, and communities are consistently the most reliable predictor of happiness. The Harvard Study of Adult Development, a longitudinal study spanning over 80 years, concluded that meaningful, supportive relationships are key to living a fulfilling and healthy life. In contrast, loneliness and weak social ties are associated with higher rates of mental and physical illness, reduced life satisfaction, and even premature mortality. Social capital, therefore, is not just a cultural asset but a tangible determinant of national well-being.

Health and mental well-being form another foundational pillar. Physical wellness and access to affordable healthcare directly influence life satisfaction, as evidenced by the COVID-19 pandemic, which caused widespread declines in well-being and a surge in anxiety and depression globally. Public health investment is, in this sense, both a social and economic imperative.

Finally, freedom, trust, and institutional quality are indispensable. Citizens who perceive their governments as honest, effective, and protective of individual rights report higher life satisfaction. Likewise, social trust, the belief that others will act fairly and reliably, correlates strongly with national happiness. Together, employment quality, relationships, health, and institutional trust illustrate that well-being is a multidimensional construct, demanding policy attention that extends well beyond income alone.

Macroeconomic and Policy Implications of Happiness Economics

Happiness economics challenges traditional policy frameworks that equate national success with GDP growth alone. By emphasizing subjective well-being (SWB) alongside economic output, it urges governments to rethink the metrics by which they allocate resources and design policies. New Zealand's Wellbeing Budget (2019) and Scotland's National Performance Framework exemplify this shift, prioritizing investments that enhance life satisfaction, mental health, social cohesion, and environmental quality, rather than narrowly focusing on economic growth. Such approaches recognize that long-term prosperity is inseparable from the quality of life experienced by citizens.

Mental health policy emerges as a critical economic priority. The Lancet Global Health (2020) estimates that the global economic cost of mental illness will exceed $6 trillion by 2030. Expanding access to mental healthcare is thus both a social imperative and a strategic economic investment, reducing productivity losses and healthcare expenditures while improving overall societal resilience.

Social safety nets similarly play a pivotal role. Programs such as unemployment insurance, pensions, and universal healthcare reduce the anxiety associated with economic shocks and provide citizens the security necessary to pursue education, entrepreneurship, or other risk-taking behaviors that stimulate economic dynamism.

Urban and community planning also directly affects well-being. Investments in public spaces, walkable neighborhoods, efficient transport systems, and shorter commute times strengthen social ties and enhance life satisfaction, demonstrating the economic value of human-centered design.

Despite progress, challenges persist. Measuring SWB remains difficult due to subjectivity, transient moods, and cultural variations in response styles. Establishing causal links between policy interventions and well-being requires sophisticated longitudinal and experimental data. Politically, prioritizing well-being over GDP demands innovation, coordination, and long-term vision.

Future directions point toward integrating big data and AI to track happiness in real time, exploring the biological and psychological underpinnings of well-being, and fostering international cooperation to exchange evidence-based practices. By embedding happiness into macroeconomic policy, nations can create societies that are not only wealthier but genuinely more fulfilled.

Conclusion

The study of happiness economics fundamentally reshapes how we understand prosperity, demonstrating that economic output alone is insufficient to capture the quality of life. While income and material resources remain important, especially for meeting basic needs, they are only part of a broader picture. Long-term well-being depends critically on employment quality, social relationships, health, and trust in institutions. Secure and meaningful work, supportive communities, accessible healthcare, and transparent governance consistently emerge as key determinants of life satisfaction across nations.

Policy implications are equally significant. Governments that prioritize subjective well-being alongside traditional economic indicators can achieve more sustainable and inclusive growth. Well-being budgets, social safety nets, and urban planning that foster community connectivity illustrate how targeted interventions can enhance life satisfaction, productivity, and resilience. Mental health represents both a social and economic priority, as untreated illness carries substantial costs for individuals and society.

Yet challenges remain in measurement, causality, and political implementation. Subjective well-being is influenced by cultural norms, transient moods, and adaptation, making data collection and interpretation complex. Translating insights into actionable policies requires long-term vision, cross-sectoral coordination, and innovative governance structures.

Ultimately, happiness economics underscores that human flourishing

cannot be reduced to GDP. By integrating material, psychological, and social dimensions into economic analysis, policymakers can create environments where individuals not only survive but thrive. Prosperity, therefore, is redefined as the capacity of societies to foster meaningful, satisfying, and resilient lives for all citizens.

References: Helliwell et al; Killingsworth; OECD; Stevenson & Wolfers; The Lancet Global Health; Waldinger & Schulz; Easterlin

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