COMMITTED POLICY BRIEF

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Pakistan

Agricultural Sector Transformation in Pakistan: The Need for Holistic Science-Driven Policy Making

- The agricultural transformation in Pakistan faces multi-dimensional problems with many constraints, that extend beyond climate change and food security. These complexities involve diverse factors such as smallholder farms, political economy, science & technology, and biodiversity.
- Despite its comparative advantages, Pakistan's limited progress becomes apparent when compared to its neighbors. Understanding the historical evolution of complex agri-food systems can shed light on why past interventions have been ineffective.
- Pakistan's modeling capacity in agriculture lags behind energy, water and other key sectors. Elevating this capacity is the key to managing the complexity of agri-food systems in Pakistan.
- A systems-based approach is essential for Pakistan to address its complex agricultural challenges and achieve sustainable development for an ever-increasing population in the face of growing climate change effects.

A paradigm shift, grounded in systems thinking and investment in capacity building for integrated modeling tools, is crucial for the transformation of Pakistan's agricultural sector towards sustainability.

COMMITTED: Climate pOlicy assessment and Mitigation Modeling to Integrate national and global TransiTion pathways for Environmental-friendly Development

The goal is to reinforce global climate change mitigation efforts by supporting the work of researchers and experts from Asia on national and sectoral greenhouse gas emissions modelling. This is done by strengthening capacity building for GHG emissions modelling and exchanging best practices and know-how between leading modellers from the EU and Asia working closely with the government.

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Historical Context

Pakistan's agricultural sector failed to fully capitalise on the advantages it inherited at independence, including a well-developed irrigation system and subsequent key agreements like the Indus Water Treaty (1960) and the Interprovincial Water Accord (1991). As a result, agricultural growth rates have declined, and the productivity of irrigated agriculture has been compromised due to poor management of water resources.

Multifaceted Challenges

Poverty-driven Population Growth Pakistan is the fifth most populous country in the world and is expected to reach 338 million in 2050, putting immense pressure on the agricultural sector for food, feed, and fiber. Around 63% of the population lives in rural areas with multidimensional poverty at 49.8%, posing a significant obstacle to agricultural development.

Challenges Posed by Climate Change Pakistan ranks among the top ten most climate-vulnerable countries, with climate change risks exacerbating low crop yields due to its arid climate, glacial melt reliance, monsoon shifts, and rising temperatures. From 1999 to 2020, natural disasters in Pakistan caused US$ 30 billion in losses, severely impacting agriculture through droughts and floods. The sector also contributes substantially to greenhouse gas (GHG) emissions, accounting for 45.6% of Pakistan's total emissions in 2018, primarily from livestock and soil management. These emissions increased by 143.8%, from 71.6 to 174.6 Mt of CO_2-e between 1994 to 2015. While the sector still holds great potential, its expansion under the current model would further enhance GHG emissions. It is estimated that a 1% increase in agricultural and livestock productivity would lead to a 28% rise in CO_2 emissions.

Land Use Change and Downsizing Farms Urban expansion and land-use changes are significantly reducing agricultural land and disrupting value addition. Irrigation-induced land inequality, a key social engineering tool during the colonial era created eight million smallholder farms in Pakistan. The average farm size further fell from 3.72 ha in 1990 to 2.14 ha in 2019, isolating farmers from markets and limiting value addition.

Non-Adoption of Agricultural Technology Insufficient investment in science and technology as well as education limits optimal farming practices on fragmented lands, with only 35% of farmers accessing modern equipment. Consequently, average wheat and rice yields are 70% and 61% lower than international averages, worsened by limited mechanisation and digital technology access.

Constraints in the Policy Domain

Over the years, agricultural policy has predominantly concentrated on narrowing yield gaps through increased input utilisation, rather than prioritising technical advancements and innovation. Adaptation efforts are mainly driven by the private sector. Corporate farming has grown, while smallholders struggle, and subsidies favor fertiliser companies, textile magnates, and sugar mill owners, limiting support for the disadvantaged.

Since the 1990s, Pakistan's agricultural research investment has sharply declined, resulting in budget cuts, brain drain, and outdated infrastructure Research spending is now less than 0.2% of GNP, falling behind Bangladesh, Sri Lanka, and Nepal in per-acre investment. Extension services focus mainly on traditional productivity, with undertrained staff unable to assist farmers in value addition or market linkages.

Pakistan is committed to international climate goals but lacks the institutional capacity to access global climate funds. Its Nationally Determined Contributions (NDCs) target a 50% reduction in GHG emissions by 2030, contingent on securing US$ 40 billion in international grants. There is also no green transition plan for a larger GHG-emitting agricultural sector.

Are Recent Initiatives the Turning Point?

Despite numerous challenges, the agricultural sector continues to receive substantial funding from international donors and development banks due to its importance in socio-economic development. In 2024, the launch of the Digital Agriculture Consortium (DAC) in partnership with the United Nations Food and Agriculture Organization and Pakistan's Ministry of National Food Security and Research highlights growing interest in using digital tools to transform agriculture by providing farmers with vital data. Additionally, initiatives like the China-Pakistan Economic Corridor (CPEC) and the Green Pakistan Initiative aim to boost productivity, technology adoption, and attract international investments in agriculture, while grassroots efforts and programs like the Better Cotton Initiative (BCI) support sustainable farming and improve livelihoods.

The key questions are why such initiatives are not scaling beyond pilot projects, why investments are not delivering results, and why a fundamental transformation has yet to occur!!

The Federal Planning Commission's recent agricultural transformation plan overlooks profound environmental, institutional, and social constraints, as well as fails to address long-term challenges like climate change, technological advancements, and regional politics. Focusing solely on short-term food

security, this initiative, like many others of the past, has failed to effectively address the growing rural poverty, increased vulnerability to extreme weather, dwindling water resources, aggravated land degradation, and unfair local market dynamics (see Figure 1).

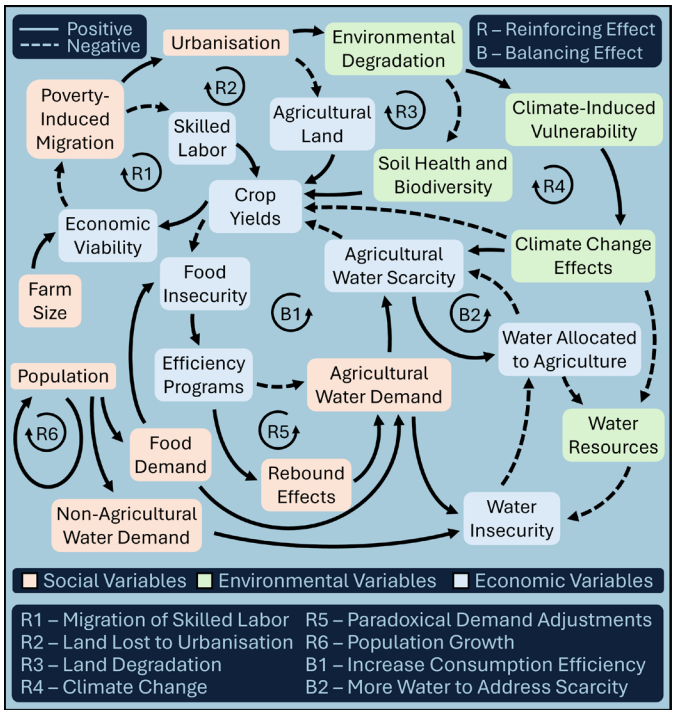

Figure 1: *A system diagram representing Pakistan's agricultural sector. The balancing loops represent traditional policy levers, whereas the reinforcing loops represent existing and emerging challenges.*

At the heart of these failures lies a critical shortfall in setting and agreeing on clear, evidence-based and mutually determined short and long-term targets (5-year, 25-year, 50-year) for key areas such as food demand, production losses, dietary shifts, crop yields, GHG emissions, trade volumes, freshwater use, urban land expansion, ecosystem services, biodiversity, and afforestation. In contrast, studies from countries like the UK and India show that formulating pathways and transition plans requires extensive expert dialogues and stakeholder engagement on such targets.

A Deeper Challenge: The Lack of Holistic Systems-Thinking Capacity

Despite a general decline in evidence-based policy making in the agricultural sector, the availability of data, facilitated by digitization and global data access, is no longer a primary barrier. A systems-based holistic approach is required that integrates understanding, planning, investment portfolio optimisation, and policy design of the agri-food sector, which is intricately connected in a nexus with the energy, water, and land sectors. Recent studies showcase the potential benefits of this capacity (see Figure 2).

Pakistan has long suffered from poor planning and development capacity across all sectors. Blind investments in surplus idle capacity of power projects, for example, have severely damaged the economy. Misaligned water infrastructure priorities have exacerbated problems like groundwater depletion, water contamination, and urban flooding. In both water and energy sectors, this limited capacity is acknowledged and there is evidence that efforts are being made to develop and utilise models and planning tools for energy and water resource management. Public and private sector teams, as well as academic institutions, are utilising tools like the Integrated Basin Management Resource (IBMR) developed by the Water and Power Development Authority (WAPDA) and energy planning models designed by the Pakistan Atomic Energy Commission (PAEC) to improve planning.

In the agricultural sector, however, this understanding is completely missing. Pakistan is not actively involved in international consortia for agri-food systems modeling having very few teams in academia, research organisations, or planning departments that employ models to optimise land use, forecast crop yields, estimate carbon footprints, and integrate these assessments with socio-economic planning. Furthermore, to the best of our knowledge, educational programs for training human resources in developing and operating such models are currently non-existent in the country.

Figure 2: *Advocating for holistic systems-thinking: Insights from recent studies on the Indus River Basin.*

Recommendations

To transform Pakistan's agricultural sector, it is essential to establish a comprehensive toolkit of integrated modeling and assessment tools to compare options, assess impacts, optimise investments, and predict cross-sector spillovers between water, energy, land, and climate. Transformation must go beyond food security, incorporating livelihoods, climate resilience, and environmental sustainability. Realistic, multi-dimensional targets should be set through stakeholder engagement and expert consultation. Modeling and assessment tools should account for the complexity of these targets and associated constraints, especially those linked to the political economy in a multi-sectoral dynamic framework. Capacity building in integrated tools is urgently

needed, with academic centres playing a key role in development and training. Provincial and federal systems analysis units should be established, and a consortium of tools, led by organisations like the Global Change Impact Study Centre (GCISC) and the National Agricultural Research Centre (NARC), should ensure effective, data-driven planning.

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The Centre for Water Informatics and Technology (WIT) at Lahore University of Management Sciences (LUMS) is a leading research hub addressing critical water challenges in the Indus Basin through innovative hydroinformatics and systems analysis. Established in 1985 as a private, not-for-profit university, LUMS is one of South Asia's top academic institutions known for its commitment to outstanding learning, quality research, and teaching excellence. It is renowned for its exceptional academics and holistic campus experience, emphasising merit, innovation, and collaboration, with an increasing focus on tackling the major challenges confronting the Global South.
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PBL Netherlands Environmental Assessment Agency

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