



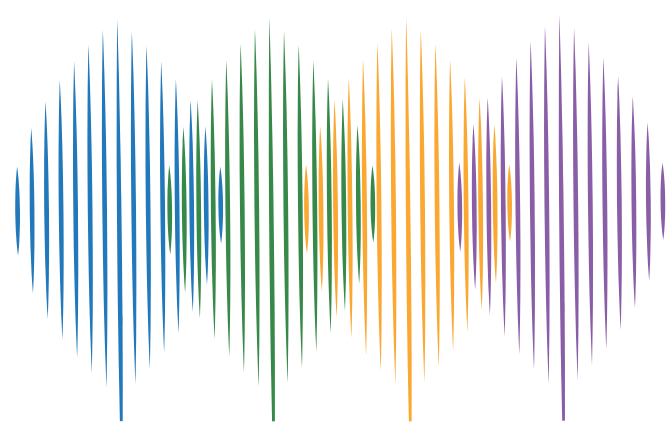
Agricultural mechanization for smallholder farmers in Pakistan

Results of a multistakeholder policy dialogue

Policy brief



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Key messages

- Low mechanization is always included in all local and international situation analysis reports of Pakistan's agriculture sector as one of the key barriers to agricultural growth, along with non-availability of quality seed, inefficient water use, limited access to credit, poor agriculture markets and inefficient research and development (R&D). Thus, a dismal performance within the agriculture sector, albeit with a few exceptions, directly impacts the food security situation in the country and impedes the achievement of the Sustainable Development Goals (SDGs).
- The issue of a low level of farm mechanization among smallholders in Pakistan was addressed by the Food and Agricultural Organization of the United Nations (FAO), Pakistan in collaboration with the federal Ministry of National Food Security and Research (MNFS&R) during 2022–2024, under the project "*Developing capacities in agricultural innovation systems: scaling up the Tropical Agriculture Platform Framework*" (TAP-AIS), funded by the European Union. Pakistan is one of nine countries in Africa, Asia-Pacific and Latin America and the Caribbean in this global TAP-AIS project.
- A policy dialogue process was conducted during March–June 2024 with all stakeholders, including academia, R&D organizations, various ministries and departments, regulatory bodies, private industrial sector, farmers, farmer organizations, extension and advisory service organizations and non-governmental organizations (NGOs). The study included key informant interviews with 48 stakeholders, province-level consultation workshops in Punjab and Sindh, and a national policy dialogue event on 29 May 2024 in Islamabad. Led by a senior policy consultant, the process involved in-depth analysis of smallholder farm mechanization regarding the present status, gaps, challenges and possible solutions.
- The unanimous key message of these extensive consultations is directed to the federal MNFS&R: to formulate an exclusive and comprehensive **national policy on agricultural mechanization** especially for smallholder farmers, followed by strategic planning of its implementation. The proposed national policy should include:
 - mechanisms for enhanced collaboration and cooperation among all stakeholders, especially between various federal ministries and provincial agriculture departments;
 - inclusion in the policy of emerging and disruptive technologies, such as precision agriculture, satellite imagery, artificial intelligence (AI), robots, 'internet of things' (IoT), information and communication technology (ICT), etc.;
 - development of standards, certification, testing and evaluation regimes;
 - capacity development especially of human resource at all levels (engineers, technicians, operators);
 - promotion of R&D in agricultural mechanization;
 - enabling environment for local manufacturers, including special economic zones, and subsidy and rebate on taxes and duties, in particular of raw materials;
 - defining the role of service providers in providing rental services to smallholder farmers of expensive machinery with limited but vital usage;
 - access to easier and quick credit facilities by smallholder farmers for the purchase of farm machinery;
 - promotion of inclusive development by ensuring that mechanization benefits all farmers, including women and marginalized groups; and
 - regional and international collaboration on farm mechanization.
- The adoption of low-cost agricultural mechanization can significantly improve productivity and reduce labour costs for smallholder farmers in Pakistan. Mechanization supports sustainable farming practices, enhancing the efficient use of resources and contributing to the reduction of environmental impact.

Acronyms and abbreviations

ACIAR	Australian Centre for International Agriculture
ADB	Asian Development Bank
AEI	Agriculture Engineering Institute
AI	Artificial intelligence
AIS	Agricultural innovation systems
AMRI	Agriculture Mechanization Research Institute
CAD	Computer-aided design
CAM	Computer-aided manufacturing
CPEC	China–Pakistan Economic Corridor
EDB	Engineering Development Board (of Mol&P)
ESCAP	Economic and Social Commission for Asia and Pacific
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross domestic product
HEC	Higher Education Commission
hp	horsepower
ICT	Information and communication technology
IFPRI	International Food Policy Research Institute
IoT	Internet of things
IRRI	International Rice Research Institute
JICA	Japan International Cooperation Agency
KII	Key informant interview
KP	Khyber Pakhtunkhwa
MNFS&R	Ministry of National Food Security and Research
Mol&P	Ministry of Industries and Production
MoST	Ministry of Science and Technology
NARC	National Agriculture Research Centre
NAVTC	National Vocational and Technical Training Commission
NGO	Non-governmental organization
PBS	Pakistan Bureau of Statistics
PEC	Pakistan Engineering Council
PIDE	Pakistan Institute of Development Economics
PSQCA	Pakistan Standards and Quality Control Authority
R&D	Research and development
SAARC	South Asian Association for Regional Cooperation
SACAN	South Asian Consortium of Agriculture Network
SBP	State Bank of Pakistan
SDGs	Sustainable Development Goals
SME	Small and medium enterprise
TAP	Tropical Agriculture Platform
UN	United Nations
USDA	United States Department of Agriculture

What is the issue?

Pakistan needs to accelerate its economic growth from 2.5 percent today to 6–8 percent per year in order to become an upper-middle income country by its centenary in 2047 (World Bank, 2022). However, over the past two decades, the country's per capita gross domestic product (GDP) growth has been low. The agriculture sector has all the potential to achieve the targets, provided due policy reforms are made. According to FAO (2009), the agricultural sector's mechanization level is low, particularly among smallholder farmers. This is compounded by issues such as fragmented landholdings, which make it difficult to use large-scale machinery efficiently. Smallholder farmers in Pakistan, which own less than 12 acres of land and comprise over 92 percent of overall farmers, face numerous challenges that hinder their productivity and overall agricultural output. These challenges include high labour costs, low productivity and limited access to modern agricultural machinery. Pakistan's agricultural sector remains largely labour-intensive, which leads to inefficiencies and high production costs. Smallholder farmers struggle to compete with larger, mechanized farms due to these limitations.

Mechanization can play a critical role in addressing these challenges by improving operational efficiency and productivity. Mechanized farming allows for timely and precise agricultural practices, which can lead to increased yield and reduced wastage. However, the transition from traditional to mechanized farming is fraught with difficulties for smallholder farmers.

Policy dialogue methodology

The issue of low farm mechanization among smallholders in Pakistan was addressed during 2022–2024 by the Food and Agriculture Organization of the United Nations' (FAO) Country Office in Pakistan in collaboration with the federal Ministry of National Food Security and Research (MNFS&R) under the project *"Developing capacities in agricultural innovation systems: scaling up the Tropical Agriculture Platform Framework"* (TAP-AIS), funded by the European Union. Pakistan is one of nine countries in Africa, Asia-Pacific and Latin America and the Caribbean in the global TAP-AIS project, coordinated by FAO's Office of Innovation.

In 2022, the TAP-AIS project assessed the agricultural innovation systems in Pakistan using seven innovation case studies nominated by key organizations, under three thematic areas: digital transformation, product innovation and service innovation, including a case study on *"Development of a 'Super Seeder' and its adoption by farmers who follow a rice-wheat harvesting pattern"*. Validation of assessment results with key stakeholders led to a decision to focus TAP-AIS Pakistan on low-cost mechanization for smallholder agriculture and to strengthen this innovation system by organizational capacity development and a policy dialogue process to enhance the enabling environment. The assessment highlighted key constraints to innovation and advised

that specific federal and provincial policy interventions are required to address these constraints (FAO, 2024).

A multistakeholder policy dialogue process was therefore carried out during March–June 2024, led by a senior policy consultant, involving an in-depth analysis of smallholder farm mechanization in Pakistan regarding the present status, gaps, challenges and possible solutions. The study was based on the following three main components:

In-depth analysis of secondary data

A review of a wealth of already published local and international analysis reports was carried out. Most studies were conducted by international development partners, such as Asian Development Bank (ADB), Economic and Social Commission for Asia and Pacific (ESCAP), FAO, International Food Policy Research Institute (IFPRI) and International Rice Research Institute (IRRI). Other reports were published by national institutions and research organizations, including Pakistan Institute of Development Economics (PIDE), Agriculture Department, Punjab, Engineering Development Board (EDB) of the Ministry of Industries and Production (MoI&P), University of Agriculture, Faisalabad, and Pakistan Agriculture Coalition, etc.

Primary data collection

True ‘on the ground’ information was gathered by meeting high-profile responsible position holders in both public and private sectors. In total, 48 key informant interviews (KIIs) were held with stakeholders in seven categories (Table 1). Most KIIs were held by visiting their offices or premises. A few interviews were held virtually. The questionnaires used were developed after long discussion in several sessions with the project team in Rome, Islamabad and Lahore. The replies and comments during KIIs were captured and noted. Some interview sessions were also recorded with due permission. Photographs were also taken for the record.



The Millat Tractor Manufacturing Plant in Lahore, visited as part of the policy dialogue meetings.
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Table 1. Main stakeholders in key informant interviews (KIIs)

Category	Responsibilities	# Persons
Policy/decision makers	Federal government/provincial government – public sector	15
Regulators/certification	Mol&P; PSQCA; MoST	3
Manufacturers	Millat Tractors, Greenland-Daska, Noorani, Faisalabad	5
Researchers	Federal and provincial centres: AEI-NARC; AMRI; Agriculture Engineering Sindh	8
Academia	Higher Education Commission; Pakistan Engineering Council; University of Arid Agriculture, Rawalpindi; Sindh Agriculture University, Tandojam	10
Users/farmers	Progressive farmers	4
Think-tanks, NGOs	SACAN, CABI	3
TOTAL		48

Source: Authors' own elaboration.

AEI = Agriculture Engineering Institute; AMRI = Agriculture Mechanization Research Institute, Multan; CABI = Centre for Agriculture and Biology International; Mol&P = Ministry of Industries and Production; MoST = Ministry of Science and Technology; NARC = National Agriculture Research Centre, Islamabad; PSQCA = Pakistan Standards and Quality Control Authority; and SACAN = South Asian Consortium of Agriculture Network.

Consultative workshops

For collective and inclusive discussion, two consultative workshops were organized in Punjab and Sindh: at Four Points by Sheraton, Lahore on 16 May 2024 and at Indus Hotel, Hyderabad on 21 May 2024, respectively. These were attended by director generals, deans, chairs and high-profile stakeholders across the agricultural mechanization value chain of the respective province.

A national policy dialogue event and final project workshop, held in the federal capital Islamabad on 29–30 May 2024, validated the results of KIIs and province-level workshops. As consultative workshops could not be held in the other two provinces of Pakistan (Baluchistan and Khyber Pakhtunkhwa [KP]), key stakeholders from these two provinces were invited along with the main actors from the Punjab and Sindh provinces. Involvement of all four provinces was a special intentional effort as agriculture is now a devolved subject by the 18th Amendment of the constitution of Pakistan and all four provinces must have consensus for any national-level policy.

The policy dialogue on strengthening innovation systems for agricultural machinery for smallholders in Pakistan identified, by consensus, the absence of a national policy on agricultural mechanization as a prime reason for slow progress in mechanization and, consequently, low farm productivity. Thus, the development and adaptation of such a farm mechanization policy by the federal government will significantly contribute to evolving a workable ecosystem for agricultural mechanization in the country.

The present policy brief is expected to assist policy makers to develop a national agricultural mechanization policy or strategy by involving all stakeholders of this value chain (academia, R&D organizations, ministries and departments, industry, service providers, regulators, farmers and NGOs). It is hoped that a strategic implementation plan will also be prepared by the focal federal MNFS&R to accelerate farm mechanization and to achieve the assigned targets in the proposed national policy.

Agricultural mechanization policy: present status and recent initiatives

Various initiatives have been undertaken by the government and other stakeholders to promote mechanization among smallholder farmers. In Pakistan, agricultural mechanization dates back to the early 1960s when deep tube wells with mechanical power (diesel) for irrigation were introduced.

Mechanization vs “tractorization”

During the 1970s, the Government of Pakistan implemented a straightforward farm mechanization policy to increase the availability of farm power through the import and manufacture of four-wheel tractors, and subsidized schemes for tractor purchases. There are two tractor manufacturing industries in Pakistan and over one million tractors are in operation in the country. The majority of tractors are of 30–50 horsepower (hp) while very few, mostly imported, are of 85–100 hp.

The government policy is to increase the efficiency of tractor use and the level of farm productivity by encouraging the adoption of cultivation attachments. Land preparation for almost all the crops is mechanized as locally fabricated attachments, like plough, chisel and leveller, are easily available. Moreover, sowing by seed drill attachments, cutting of harvest by clipper and grain recovery by threshers are fully mechanized, particularly in wheat production. However, there is uneven mechanization in the agriculture sector. Currently, refurbished, more efficient combine harvesters along with rice transplanters and rice harvesters (such as those from Kubota), are gaining significant attention from farming communities.

Agricultural machinery implements

The manufacturing of agriculture machinery and implements in the country is reasonably well developed. The market size for agricultural machinery has consistently expanded over time due to increasing demand for efficient and advanced farming equipment. As the market grows, the quality of machinery has become critically important, with farmers seeking reliable, durable, and high-performing equipment to improve productivity. However, the quality of machinery is still low in terms of yielding good results at farm level. There are clusters for such manufacturing, mostly in Punjab, especially in Daska, Lahore, Chicha Watni, Multan and Rahim Yar Khan. Manufacturing facilities in the other three provinces are either totally absent or at a rudimentary stage.

Many of the local entrepreneurs produce substandard machineries and sell these to the farmers at the lowest price, which creates a negative impact among the farmers. In general, family-owned business mindset prevails in the farm implement industry, with very little incentive for innovation. Hence, the industry mainly remains non-innovative and operates at a lower level of technology. There is lack of automation of the production systems and scant realization of the need for R&D. The private sector blames the low-quality manufacturing and lack of innovation on limited access to finances, non-availability of “industry-ready” university graduates, lack of skilled workforce, over-regulation and the imposition of double duties or taxes on raw materials and finished products.

Quality standards, certification, testing and evaluation regime

There is no system in place for quality testing of raw materials and finished products in the agricultural machinery sector in Pakistan. The end-user farmers are therefore suffering due to poor quality, frequent breakdowns and interruption of farm operations, high cost of repair and maintenance, and premature conversion of implements into junk and scrap.

Two ministries claim to be custodians of standards and certification: the Engineering Development Board (EDB) of the MoI&P has prepared standards and drawings of nearly 70 implements. The EDB is also responsible for the certification of tractors in the country. The Pakistan Standards and Quality Control Authority (PSQCA), under the Ministry of Science and Technology, is mandated to issue Pakistan Standards. The PSQCA, using an expert panel, has developed standards of 53 implements, and further work is continuing. However, these standards are voluntary for adoption and not mandatory, thus with less utility. The new national policy on agricultural mechanization should resolve these contentious, territorial issues which at present is hampering the quality of agriculture implements.

Professionals and skilled workforce for technical support

There are three universities in Punjab and one each in Sindh and KP that award a bachelor's agricultural engineering degree duly recognized by Pakistan Engineering Council (PEC). The curriculum is revised every four years and this process is led by PEC and assisted by the Higher Education Commission (HEC). There are also a few polytechnic institutes that produce skilled technicians after high school certificate. However, the recent trend is in the subjects of computers and mobiles, and declining enrolment in agricultural machinery education is in evidence. At vocational level, the National Vocational and Technical Training Commission (NAVTTTC), a body of vocational training in Pakistan, recently listed over fifty short courses but did not cover agricultural machinery. Thus, there is acute shortage of skilled operators and mechanics for repair and maintenance. With the inclusion of technologically advanced equipment like drones, precision agriculture gadgets, solarization of tube wells, etc., there is an urgent need to launch a crash programme for short-term training of youth to develop skills for operation and maintenance of such complex equipment. The proposed agricultural mechanization policy should encompass capacity building as an integral component.

Government policies

The public sector (government) provides the enabling environment in which other actors of national innovation systems function. At present, there is no specific or exclusive national agricultural mechanization policy either at federal or provincial levels. The agriculture policies of Pakistan (national and provincial) have a very minor portion related to agricultural mechanization or do not mention it at all. The National Food Security Policy 2018 and agriculture policies of provinces, partly mentions the agricultural mechanization aspect, as given in Table 2.

The federal and provincial governments routinely provide subsidies and allocate funds for purchasing machinery, especially tractors, in their annual development programmes and budgets. However, these fragmented approaches have achieved limited success due to the absence of a clear policy roadmap. Therefore, there is an urgent need to develop a national policy on agricultural mechanization that incorporates an inclusive approach, involving all stakeholders such as farmers, industry experts, policymakers and local communities.

Table 2. Federal and provincial agriculture policies with a mechanization component

Provinces	Policy	Year	Ministry/Department	Status on agricultural mechanization
Federal level	Food Security Policy	2018	National Food Security and Research	Partly covered
Federal level	National Agriculture Mechanization Policy	2022	Engineering Development Board, Ministry of Industries and Production (MoI&P)	Deferred from Cabinet in 2022
Punjab	Punjab Agriculture Strategic Plan Part D	2024 – 2033	Agriculture Department, Punjab	Cabinet approval awaited
Sindh	Sindh Agriculture Policy	2018 – 2030	Agriculture Department/Planning & Development Department, Sindh	Not covered/ indirect reference
KP	KP Agriculture Policy	2015 – 2025	Agriculture Department	Partly covered
Balochistan	Balochistan Agriculture Sector Policy and Strategy	2020	Agriculture Department	Not covered; service providers role mentioned

Source: Authors' own elaboration.

Subsidies for machinery purchase

The federal as well as provincial governments have, since the late 1960s, launched several subsidy schemes for agricultural mechanization. Most of these schemes are related to the provision of 30–70 percent subsidies on the purchase of tractors. Later, variable subsidies were also provided for purchasing of implements as well as for laser land levellers.

The adoption of farm mechanization is uneven in the agriculture sector. For example, operations in wheat production are almost 100 percent mechanized but in cotton, all operations except land preparation are mostly labour-driven. The subsidies should target small-scale farm holders and the selection of implements should be according to those farmers' specific requirements. A comprehensive follow-up study is required to analyse the impact of such schemes on socioeconomic aspects of these farmers and their farming operations.

Rental services

Due to small farm holdings, the purchase of expensive farm machinery with seasonal usage is not a workable and intelligent move. Here, service providers or rental service providers contribute a great function of renting expensive and complicated machines for farm operations. The establishment of agricultural machinery service centres that provide rental services for equipment reduces the need for farmers to make large capital investments. These centres offer machinery on a rental basis, making it accessible to a larger number of smallholders. In Punjab, there are more than 20 000 registered service providers who rent, operate and maintain expensive machinery for farm operations as well as for irrigation. This model is a success story in the country. Unfortunately, this ecosystem of service providers is unable to take a prominent position in the other three provinces. There is a need to create an enabling environment and offer larger incentives for service providers in these provinces. They are providing a great service to smallholder farmers, and their role will be expanded in near future with the arrival of drones and solarization.

Technological integration

There has been a push towards the development of affordable and user-friendly machinery that can be easily operated and maintained by smallholder farmers. Innovations include:

- **Multifunctional tools and equipment:** machines that can perform multiple tasks, such as ploughing, seeding and harvesting, reducing the need for multiple machines.
- **Small-scale tractors:** compact and versatile tractors designed for use in diverse farming conditions.
- **'Internet of things' (IoT), satellite imagery, AI, and drones:** emerging technologies are being integrated into farming practices to enhance precision agriculture. These technologies provide real-time data and analytics, enabling

farmers to make informed decisions. For example, drone technology is used for crop monitoring and spraying, while IoT devices help in soil moisture management.

The need is to adopt these technologies at full scale and in the shortest possible time to be well integrated with global development in this sector.

Recent initiatives

Federal government programmes: The federal government has earmarked PKR 5 billion for solarization of tube wells and enhanced the agriculture credit line to PKR 2.5 trillion in the fiscal year 2024–25, announced on 10 June, 2024. Under its Agricultural Credit Programs, grants and low-interest loans are available to help farmers purchase equipment. For instance, the State Bank of Pakistan's (SBP) Refinance and Credit Guarantee Scheme provides credit facilities to smallholder farmers at concessional rates.

Provincial governments programmes: The provincial government of Punjab announced its budget on 11 June 2024, which earmarked 126 percent more for agriculture than in the fiscal year 2023–2024. A sum of PKR 9 billion has been reserved for the promotion of mechanization by distributing 53 implements at subsidized rates. Similarly, PKR 30 billion has been allocated for a tractor scheme and PKR 9 billion for solarization of water tube wells. The Punjab Government is also negotiating a loan of USD 200 million with ADB, of which USD 70 million will be available for establishing and improving centres for standards, certification, testing and evaluation in Punjab.

The Government of Sindh is providing subsidies for solarization of tube wells as well as for laser land levellers. Following in the footsteps of the Punjab government's initiatives, solar-based cold storage and high-efficiency irrigation system for water management are being installed on a subsidized basis.

Main results of the policy dialogue

Identified barriers to mechanization

The policy dialogue under the TAP-AIS project during March–June 2024 involved inputs from a wide range of stakeholders, including farmers, policymakers, researchers, academicians and industry experts, as described in the methodology section above. These detailed individual and group discussions focused on identifying current barriers to agricultural mechanization and exploring potential solutions. The findings of the KIIs were synthesized and notes were exchanged with the project's policy dialogue team, resulting in a list of key issues.

The draft list of key issues was exhibited at the two consultative workshops in Punjab and Sindh. Comments were noted and necessary adjustment to the list were made. An improved version was then shared and validated at the national policy dialogue event in Islamabad on 29 May 2024, where participants presented their view points on the

issues and possible solutions, resulting in the following final list of **actions required to address current barriers to mechanization of smallholder agriculture in Pakistan**, in order of priority:

1. the development of a separate national agricultural mechanization policy – a road map for achieving a global level of standards of mechanization;
2. put in place standards, testing and evaluation of raw materials, parts and complete machines and machine implements – a strict regulatory regime;
3. human resources development at basic and higher levels;
4. set up a short-term skills development programme of machine operators;
5. improved repair and maintenance of machines, and spare parts availability;
6. increased access to machine repair workshops at village level;
7. improved enabling environment for local manufacturing;
8. encouragement of service providers;
9. devise strategies for a major role of the private sector;
10. address the poor or lacking repair and maintenance facilities at village or town level;
11. capacity building of bank staff dealing with agricultural loans;
12. address the lack of collaboration among stakeholders; and
13. establishment of a mechanization research centre in Sindh.

Validation and refinement at policy consultations at province and national levels

As mentioned, the two consultative workshops in the provinces of Punjab and Sindh, respectively, validated the results and further refined the list of issues and their solutions, but priorities varied slightly between provinces and stakeholder groups. The workshop in Sindh, for example, emphasized more on service providers and developing a R&D centre on agricultural mechanization, as these are absent in their province. However, there was unanimous concern regarding the poor and substandard quality of locally manufactured agriculture implements. There are no uniform standards for machinery and machinery implements, and thus farmers have to rely on the manufacturer for repairs or replacements of defective parts. Another frequently raised issue was the lack of skilled operators, as tractor operators are often responsible for both operating the equipment and performing its repair and maintenance.

The manufacturers, on their part, complained about the double taxation on raw materials and then on finished products. Further, they complained about non-availability of quality raw materials and very limited collaboration between academia and research organizations, and industry. Another issue relates to the import of substandard, second-hand machinery. These inefficient machines have led to a dual

loss: reduced tax revenue for the government and harvest losses for the farmers. Such negligence on the part of the regulatory agencies has resulted in the discouragement of a local manufacturing industry.

During the deliberations, the industry representatives assured full cooperation in the pursuit of mechanization of agriculture in the country. The FAO team visited exhibitions of all series of tractors and implements at the Millat tractor company in Lahore (joint venture with Massey Ferguson, UK), the largest in the country, and discussed the present challenges and future plans. The local industry is fully capable of fulfilling most of the country's need of agricultural machinery provided the government policies support them in a constructive manner. The domestic manufacturers declared that they do not need any extra favour except creating an enabling ecosystem of indigenous manufacturing to cater for the needs of the farmers.

The academic institutions, though limited in number, are highly motivated to be part of any endeavour for agricultural mechanization in the country. They emphasized the revision of curricula and equipping their departments of agricultural engineering with modern instruments (computer-aided design [CAD], computer-aided manufacturing [CAM], laser cutter, etc.), and establishing greater linkages with the industry for internships and in executing joint projects on developing and manufacturing new machines.

Multiple consultation sessions and detailed in-depth discussion led to the formulation of this document. The national policy dialogue event in Islamabad was attended by almost all the key stakeholders, including experts from KP and Baluchistan where the project team was unable to hold consultative workshops due to limited time and the prevailing security situation. Suggestions from the two provinces, KP and Baluchistan, further refined the priority list of issues of agricultural mechanization. By addressing these barriers comprehensively, the mechanization of agriculture in Pakistan can be significantly improved, leading to increased productivity and sustainability for smallholder farmers.

Recommendations

Policy reform

After extensive deliberations, this policy dialogue concluded that the absence of a road map with clear-cut and specific targets is a root cause of slow progress in agricultural mechanization in the country. Therefore, a consensus emerged that, first and foremost, the task should be to form a working group involving all stakeholder representatives for developing a national agricultural mechanization policy aimed at addressing the unique challenges faced by smallholder farmers. The working group may start by conducting a comprehensive needs assessment to understand the specific mechanization requirements. The present TAP-AIS project partly contributed to this end, and the upcoming (July 2024) Agricultural Census by Pakistan Bureau of Statistics (PBS), Government of Pakistan will add value to this task.

The proposed **national policy on agricultural mechanization** for smallholder farmers should include the following main components:

- **Mechanisms for enhanced collaborations and cooperation:**

The focal ministry, MNFS&R may set up a working group on agricultural mechanization with representatives from all stakeholders. This multistakeholder platform should include government agencies (federal and provincial), academia, research organizations, private sector, NGOs and farmer organizations. Additionally, government should promote the formation of farmer cooperatives to pool resources, share knowledge, and jointly invest in machinery. There is a need to develop and disseminate low-cost mechanization solutions through partnerships and cooperative models.

- **Inclusion of emerging and disruptive technologies like precision agriculture, satellite imagery, AI, robots, IoT, ICT etc. in the policy:**

The horizon of agricultural mechanization is now encompassing emerging and disruptive technologies. It is the right time to integrate advanced technologies like IoT, satellite imagery, AI and drones into agricultural practices. The proposed policy should promote the use of precision agriculture technologies to enhance productivity and resource efficiency. Training and support for the adoption of digital tools and platforms should be part of this scheme. Further, there is a need to launch a "Smart Farming Initiative" that subsidizes IoT devices, drone technology, and AI-based farming solutions.

- **Development of standards, a certification system, and testing and evaluation regimes:**

At present there are neither mandatory standards and specifications nor a certification system in place for agriculture implements. Therefore, the quality and performance of locally fabricated machinery and implements are well below the international standards. There is an urgent need to establish a testing and certification centre with international collaboration. The Pakistan Standards and Quality Control Authority (PSQCA) and Engineering Development Board (EDB) should jointly work for developing standards and a certification system for agricultural machinery in the country.

- **Capacity development of human resource at all levels (engineers, technicians, operators, extension workers and farmers):**

There are five universities which award a bachelor's degree in agricultural engineering. The infrastructure of agriculture engineering departments needs to be transformed, especially in the Sindh, KP and Baluchistan provinces. Periodic revision of curricula to include electronics and computational sciences courses is also required. A mechanism needs to be developed for strong linkages of academia with the industries.

Sophisticated machines need skilled operators for effective utilization. Moreover, the repair and maintenance of machines at the doorstep of farmers by skilled technicians is essential, as most farm operations are time bound and a long wait is not desirable. The vocational training centres in the public sector need to be modernized and such centres need to open up in all districts of the country. Also, agriculture engineers should be included in extension teams for better demonstration and guidance on farm machinery to the farmers. Farmers should be educated on the benefits and proper use of mechanization through extensive training programmes. Training materials should be developed and distributed in local languages, covering the operation, maintenance, and benefits of various types of machinery.

- **Research and development (R&D):**

The capacity and performance of the main actors within the national innovation system, such as research institutions, educational organizations, businesses and government agencies, are directly impacted by various elements. A critical analysis has revealed that the innovation component is practically non-functional in agricultural mechanization programmes. The proposed policy should prioritize the modernization of the existing R&D centers of the Agriculture Engineering Institute (AEI), formerly known as the Farm Machinery Institute (FMI), the National Agriculture Research Centre (NARC) in Islamabad, and the Agricultural Mechanization Research Institute (AMRI) in Multan under the provincial government of Punjab. Additionally, this modernization formula should be replicated in the remaining provinces to effectively enhance innovation within the research component of agricultural mechanization.

- **Enabling environment for local manufacturers, including special economic zones, and subsidy and rebate on taxes and duties, in particular on the import of raw material:**

Incentives, such as tax breaks and grants, should be provided to private companies developing affordable mechanization solutions. Public-private partnerships to foster innovation in agricultural technology should be facilitated. An "Agricultural Innovation Fund" should be created to support startups and small and medium enterprises (SMEs) focused on mechanization technologies. There should be provision for developing local manufacturing hubs for machinery production and maintenance in Specialized Economic Zones along the China–Pakistan Economic Corridor (CPEC) routes. Moreover, the government should provide "matching grants" in technology transfer and technical assistance to improve performance and automation of farm implements manufacturers.

- **Role of service providers in providing rental services of agricultural machinery to smallholder farmers:**

It is the private sector that has to lead the commercialization of farm mechanization technology and ensure availability of farm tools and services to the farmers. Agriculture service providers are emerging as great facilitators of

agricultural mechanization in Punjab by offering rental services of expensive machinery and machinery with limited but vital usage. This success model should be replicated in other provinces. The availability of interest-free loans for mechanization service providers will ensure supply of wide-ranging mechanization services to farmers. Bank loans through e-credit schemes can be offered on the purchase of farm implements to the registered agricultural service providers, with special consideration for rural youth.

- **Access of easier and quick credit facilities to smallholder farmers for the purchase of farm machinery:**

Financial incentives should be part of the proposed policy in order to facilitate the purchase of machinery through accessible financial products. A new design of microfinance schemes – an agricultural mechanization loan scheme – at low interest rate should be developed with financial institutions and flexible repayment options, and also with government guarantees.

- **Promoting inclusive development by ensuring that mechanization benefits all farmers, including women and marginalized groups:**

Due to urban migration of the rural male population to business centres in the metropolis, farm operations are increasingly being managed by marginalized groups. Specifically, rice transplantation and cotton-picking responsibilities often fall on women. Therefore, it is crucial to acknowledge and integrate the vital role of women and marginalized groups within the agricultural mechanization policy framework. This acknowledgment should ensure that policies are inclusive, addressing the unique challenges faced by these groups and providing them with the necessary support and resources to enhance their contributions to agricultural productivity.

- **Regional and international collaboration for adopting good practices:**

International development partners, especially United Nation (UN) organizations, United States Department of Agriculture (USDA), Japan International Cooperation Agency (JICA), Australian Centre for International Agriculture (ACIAR) and some bilateral arrangements like the CPEC has helped Pakistan in developing an ecosystem of agriculture mechanization. There is need to learn from and collaborate with regional neighbours on best practices in agricultural mechanization. Opportunities for such collaboration include:

- Engage in bilateral and multilateral collaborations with countries like Bangladesh and India through the South Asian Association for Regional Cooperation (SAARC) Agriculture Centre, Dhaka, Bangladesh.
- Participate in regional forums and initiatives focused on agricultural innovation.
- Form a "Regional Mechanization Alliance" to facilitate knowledge exchange and joint ventures.



Panel discussion at the national policy dialogue event on strengthening innovation systems for agricultural mechanization for smallholder farmers in Pakistan, 29 May 2024, Islamabad, © FAO/Per Rudebjer

Conclusion

By implementing these recommendations in a phased manner, the government can significantly enhance the mechanization of agriculture for smallholder farmers in Pakistan. This comprehensive approach will address financial, technical, capacity and infrastructural barriers, fostering a more productive and sustainable agricultural sector. Agricultural mechanization was not a priority in the overall national agricultural budget until recently. The recently announced budget shows how the government's support for farm mechanization has increased.

This brief has examined the present status and potential for maximum utilization of farm mechanization in Pakistan. Despite commendable achievements in the mechanization of tillage operations in wheat, other major crops are not fully mechanized in the country. This study strongly recommends that, in light of these extensive consultations, a road map in the form of national agricultural mechanization policy should be developed urgently. The immediate first step would be to set up a multistakeholder platform or working group on agricultural mechanization for building a national policy.

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