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Pathways to strengthening capabilities: A case for the adoption of climate-smart agriculture in Pakistan

Muhammad Saqib Sultan [a] *, **Muneeb Ahmed Khan** [b], **Haroon Khan** [c], **Bashir Ahmad** [b]

[a] Brandeis University, 415 South Street, Waltham, 02453, MA, USA
[b] National Agricultural Research Centre, Park Road, Islamabad, Pakistan
[c] Climate Change Centre, The Agricultural University, Peshawar, Pakistan
* *Corresponding author. Email: saqib@brandeis.edu.*

ABSTRACT

Pakistan has an agro-based economy with a high dependency on the sector, contributing 19.2% to the country's GDP. The country's geographical position makes agriculture highly vulnerable to climate change as it frequently faces periods of extreme weather events - flooding, droughts, and heatwaves. Due to growing environmental issues and institutional incapacities, there is an observed trend of urbanisation and depleting natural resources. Changes in land use and water scarcity cause reduced productivity and compromised economic growth. The country needs to adopt Climate-Smart Agriculture (CSA) as an adaptation measure against climate change. CSA is an approach to adopting agricultural systems strategies to minimise climate impacts and preserve natural resources. This study explores the intervention that enhanced the capabilities of provincial agriculture service-delivery organisations in the adoption of CSA. It produced a country-specific CSA resource kit and delivered training for agriculture extension officers and frontline government officers in Balochistan and Khyber Pakhtunkhwa provinces. The Pakistan Agriculture Research Council (PARC) and the Asia-Pacific Network for Global Change Research (APN) jointly delivered the project in line with the broader mission of research support, building government capacities and suggesting science-based response strategies as adaptation measures. The project experience highly recommends the adoption of CSA in Pakistan.

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KEYWORDS

Adaptation, capacity building, climate-smart agriculture, food security, high-efficiency irrigation systems, sustainable development

HIGHLIGHTS

- Expert review of the existing training curricula led to the formulation of an updated Climate-Smart Agriculture (CSA) resource kit
- Country-specific knowledge resources on CSA adoption have been developed
- The agriculture officers from Baluchistan and Khyber Pakhtunkhwa benefited from the capacity development programme
- Knowledge products have been produced on i) high-efficiency irrigation systems, ii) integrated pest management, iii)stress tolerant crops, iv) crop rotation, and v) crop diversification
- Country-specific knowledge products have been translated into the local language, Urdu

1. MAIN BODY

1.1. Introduction

Climate change affects many elements of life worldwide, including human health, agriculture, food security, water supply, transportation, energy, and ecosystems, among others. Agriculture is one of the most vulnerable sectors to the anticipated climate change. Crop failures and animal losses will rise because of changing and unpredictable rainfall patterns, droughts, higher temperatures, increased and amplified severe weather, and pest and disease outbreaks. Pakistan's agro-based economy depends significantly on the agriculture sector's performance. The economy has resisted change towards an industrial base. The agriculture sector is still the second largest contributor to the economy with 19.2% GDP share, 38.5% employment opportunities. Around 70% of the population, mostly rural, depends on the sector for their livelihood (Government of Pakistan, 2021a). The agriculture sector has grown tremendously over the past seven decades. The growth mainly originated from expansion in the irrigation water network, improved production, harvesting technologies, improved seeds with high production and resistance to diseases, better fertilisers, and efficient usage, liberalisation of price and marketing policy and other public policies. However, the overall agricultural productivity is lower than the global average, and the country could not achieve self-sufficiency in food production (Husain, 2019). The lower agricultural productivity can be linked to various aspects such as existing archaic practices in various parts of the country, changing climate, lower adaptive capacity, and lack of access to country-specific scientific and applicable knowledge on Climate-Smart Agriculture (CSA), which has become a need of the hour.

Climate change is occurring globally with varying effects on regions, whereas developing countries are least prepared to adapt. Pakistan has experienced almost all types of natural calamities, such as droughts, heatwaves, increased melting of glaciers, glacial lake outburst floods (GLOFs), and massive flooding. The country remains the fifth most affected by climate change shocks from 1990 through 2018 and the 36^{th} least-ready country in the ND-Gain Country Index (World Bank Group, 2021). Currently, like neighbouring India, Pakistan is also experiencing an unprecedented heatwave that marked a "year without spring", which is highly unlikely to occur without the influence of global warming. Droughts and heatwaves have also taken a toll on human lives over the past three decades, as a country-specific study has reported that Pakistan has experienced 126 heatwaves of varying duration in different parts of the country from 1997 to 2015 and is likely to increase in the future (Harvey, 2022; World Bank Group, 2021).

Historically, Pakistan remains highly vulnerable to climate change. Statistics from 2000 to 2019 have ranked the country among the top ten most climate-affected countries in the Global Climate Risk Index 2021, which is an indication of a climatic future as well - proved by 2022 ”super-floods” (German Watch, 2021). Natural calamities cause unprecedented losses and Pakistan remains a rare example globally, with approximately USD 4.5 billion in losses through natural calamities alone in 2010, with severe effects on the agriculture sector (FAO, 2018). Recently, the country has been facing a catastrophe of unknown precedent in 2022 as torrential rains caused super flooding, one-third of the country is inundated with floodwater, and more than 30 million people have been internally displaced. This flooding has played havoc with infrastructure, dwellings, basic facilities, and agricultural land. Besides the losses to human lives, hundreds of thousands of livestock perished, and standing crops on millions of hectares of land were destroyed, causing food shortages (Kawoosa, Bhargava, Katakam, & Sharma, 2022; UNHCR, 2022). The focused areas, particularly Khyber Pakhtunkhwa, are highly vulnerable to natural calamities and even hit hard by the 2022 countrywide flooding; Balochistan, the largest province by area, has faced frequent droughts and is severely affected by water scarcity although it largely depends on the agriculture sector for livelihoods and employment – also been massively affected by recent floods.

Being an open industry, the agricultural sector is the first and foremost witness to environmental changes. Though predicting future climate and weather patterns remain quite difficult, the IPCC observed that climate change is already affecting through increasing temperatures, changing precipitation patterns and frequent occurrences of extreme events. Studies suggest that the agriculture sector will face the loss of crops, the loss of agro-biodiversity and ecosystem services, and the incidence of pest and disease outbreaks with increasing temperature (FAO, 2016; Asian Development Bank, 2017). Climate change has varying effects in every region, whereas most developing countries have been hit hard. Based on indigenous and local knowledge, climate change is affecting food security in drylands, particularly in Asia, among other regions. Yields of some crops, e.g., maise and wheat, in many lower-latitude regions have been affected negatively (Mbow et al., 2019).

The rising temperature shall modify the growth cycles of various crops and livestock sub-sectors, leading to reduced yields. It is estimated that with the rise in temperature (+0.500°C–2.00°C), agricultural productivity will decrease by around 8% to 10% by 2040 (Dehlavi, Gorst, Groom, & Zaman, 2015). The changing temperature will further lead to frequent and intense flooding, salinisation of farmlands, soil erosion and reduced pasture output affecting crop and livestock production. Further, faster melting of glaciers in northern areas will result in the loss of standing crops and trigger climate-induced migration, which has been observed in the country (Khan, Sultan, & Khan, 2022). Similarly, increased temperatures, change in rainfall patterns, and increased frequency of extreme weather events also adversely affect livestock productivity. The negative effects of high temperatures on feed intake, reproduction, and livestock performance are evident. An increase in temperatures also causes decreased forage quality and availability, reduced water availability, increased heat stress, and the emergence of diseases in livestock.

Water is a key agricultural input, which is becoming scarce in Pakistan due to growing consumption, lack of reservoirs and storage, and persistent environmental issues. The country’s water resources comprise surface water and groundwater. Numerous rivers in the country drain water from glaciers of the Hindukush Karakoram

Himalaya (HKH) region that contribute up to 80% of the flow in the Indus River system. Monsoon rains also contribute a huge amount of water, which is a source of irrigation and hydroelectric power generation; however, water from these monsoon rains cannot be utilised properly for irrigation as Pakistan does not have enough storage capacity. Sometimes these rains cause major flooding in the country. Despite that, the per capita water availability is below 1,000 cubic meters compared to 5,000 cubic meters in 1950, which is alarming. The country consumes 90% of available water in agriculture, whereas 50% of this available water resource goes waste due to archaic irrigation practices. The per capita water availability is receding fast due to unchecked water extraction, climate change, and poor water management practices (Siddiqui, 2013; Sultan, 2019). Under worsening climate and seasonal weather patterns, water reservation capacity, and irrigation practices, the water crisis will likely deepen in the country, challenging the agriculture sector at large. The country must address the issue by adopting high-efficiency irrigation systems.

Although Pakistan has made significant progress in land utilisation over the years, deforestation and land use change have become major concerns in the last two decades. The growing population and urbanisation trend have put pressure on agricultural production and urban housing, which has led to the plunder of agricultural land. One such example is a major housing project on the outskirts of the historic city Multan, which, jointly with other housing projects, has cleared around 2,000 acres of mango orchards. In a country already facing various environmental and economic challenges, this is severe yet not the only example of an onslaught of real estate development in the country that has reduced agricultural land over the past two decades (Ahmed, 2017; Rashid & Moulvi, 2021) . This change in land-use issue certainly requires a policy response for the protection and efficient utilisation of agricultural land. Considering the limited land resources and economic dependence on a single crop, local farmers must adopt crop diversification strategy. Efficient land use can ensure improved agricultural productivity and yields and lower dependence on a single crop, which is a common practice in the country (Husain, 2019).

FAO frameworks on enabling policy environment for CSA recommend that the interventions on adopting climate-smart agriculture systems should focus on filling policy gaps and contribute to the country-driven capacity development programs (FAO, 2018). This study aims to explore the intervention toward adopting CSA that addresses the multifaceted challenges of the agriculture sector. The project has produced scientific knowledge resources; designed and delivered capacity-building programs to enhance the capabilities of agriculture extension services in Balochistan and Khyber Pakhtunkhwa. The final product came out in the form of locally applicable and ready-to-use scientific solutions, nature-based adaptation strategies, and enhanced institutional capabilities, which would contribute to the country's sustainable development efforts and the larger mission of the global fight against climate change. The intervention has widely benefited the agriculture extension services in Pakistan by enhancing the capabilities of provincial Agriculture Service Delivery Organizations (ASDOs) on CSA and further embedding CSA capabilities development in the mandate of provincial agriculture departments.

2. METHODS

One of the project's key objectives was to strengthen linkages between science and practices, which remains a leading force throughout the project implementation. The project brought together CSA experts and leaders from national and provincial partner organisations. The experts defined methodologies and designed a capacity-building framework for enhancing the capabilities of provincial agriculture extension officers and Agriculture Training Institutes (ATIs). Following the capacity-building framework and various methods, the project has delivered institutional

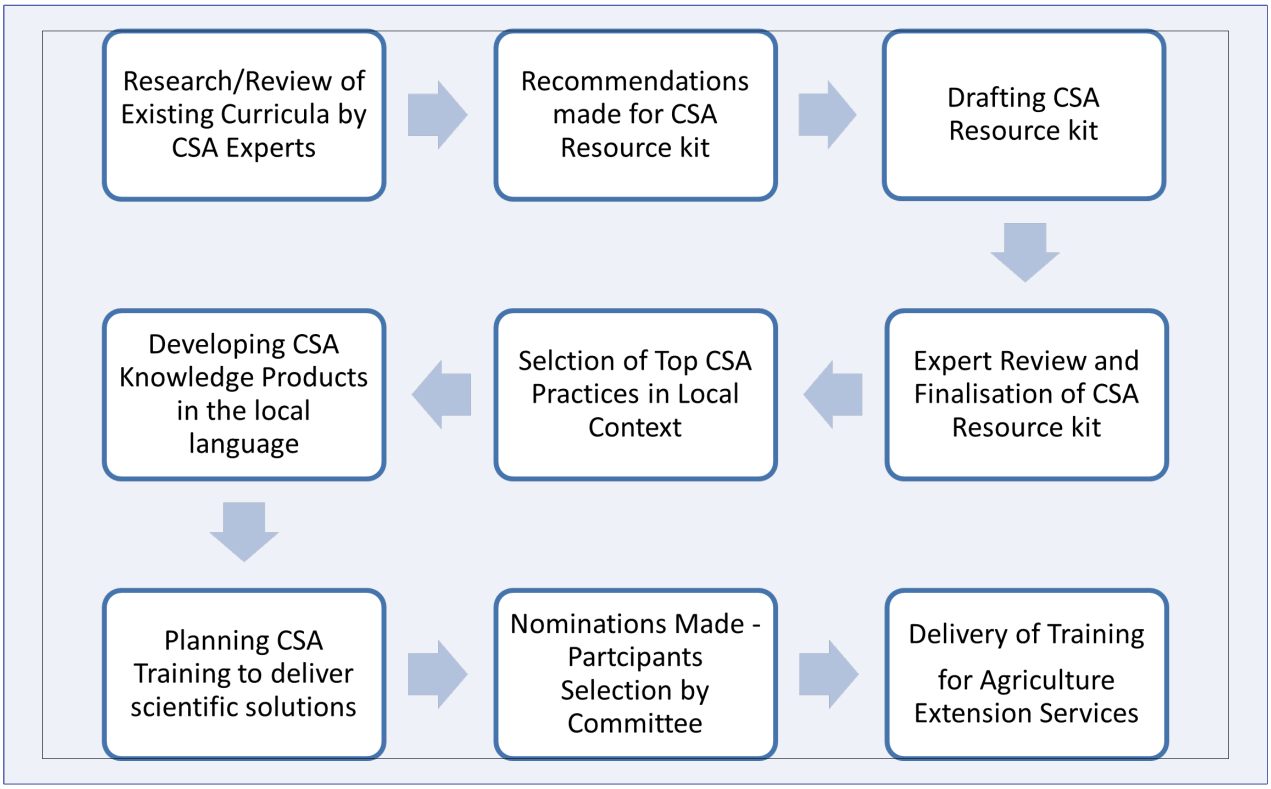

FIGURE 1. The Capacity Building Framework

capacity-building programmes on CSA, which will, in turn, function to strengthen the linkages between scientific solutions and agricultural practice in the larger context of Climate Compatible Development (CCD) in the country.

2.1. Review of existing curricula

To address the challenges in the milieu of climate change, the project adopted the approach of review and research, which started with an expert review of existing curricula available and widely used at the provincial ATIs. Most of the Agriculture Extension Officers in Pakistan enter into the service after completing a graduate degree in agriculture – gain conventional environmental and agricultural knowledge that local universities' curriculum offer – and for professional training, they solely depend on the provincial ATIs. Globally, climate change science has become a highly specialised and top priority to achieve sustainable development, particularly agriculture growth. However, a thorough expert review brought to attention that the existing curricula within governmental organisations in the country lack country-specific scientific adaptation strategies and knowledge on climate change and adaptation.

Considering all these factors, the curricula review brought recommendations to prepare a comprehensive CSA resource kit backed by science and applicable in the local context to be utilised for the project's capacity-building component. Later, this resource was shared with ATIs, agriculture extension services, and other organisations working towards agricultural advancement in the country.

2.2. Research approach

To develop country-specific resources, the project team conducted desk research under the close supervision of Climate-Smart Agriculture experts at Pakistan Agricultural Research Council (PARC) and prepared scientific knowledge resources, which are suitable in the local context. Further, the experts prioritised five key strategies that led to the development of accessible knowledge products for communities that were translated into a local language to educate farmers on CSA approaches. During the research phase, resources at PARC, Climate Change Centre, The University of Agriculture Peshawar, Agriculture Department of Balochistan, curricula of Agriculture Training Institute Peshawar, LEAD Pakistan's library, various online knowledge portals and research by bilateral organisations, and advisory support by CSA experts were widely utilised.

2.3. Capacity building approach

The project adopted the capacity-building approach to enhance the capabilities of provincial Agriculture Service Delivery Organisations (ASDOs). For that purpose, the project has followed the capacity-building framework and built the capacities of District Agriculture Officers of the Balochistan and Khyber Pakhtunkhwa provinces. This training was designed in close coordination among PARC, provincial partners, and ASDOs. The provincial agriculture departments made nominations for the training, whereas a committee selected two batches comprising 31 training beneficiaries through a rigorous process considering the diverse agro-ecologies in the country.

A newly developed comprehensive resource kit was utilised to deliver the training on CSA technologies and adoption strategies. These were in-person training, where experts from various organisations joined to deliver sessions. Each session was precise, insightful, well-designed, and delivered by experts through participatory approaches. The participants acknowledged that sessions were useful and directly related to their day-to-day job. Various supplies were utilised, such as PowerPoint slides, videos, documentaries and local case studies – and knowledge resources were provided to all participants in printed form and in portable drives. Most beneficiaries have marked the training as comprehensive and exceptionally up-to-date through post-evaluation written feedback. The participants were frontline agriculture officers and it is expected that CSA adoption strategies would be implemented at a grassroots level. This project initially benefited two provincial institutes; however, it will further contribute to the larger process of sustainable development in the country through improved capabilities of governmental organisations.

2.4. Consultation Workshop

A national-level consultation workshop brought together agriculture extension experts from Balochistan, Khyber Pakhtunkhwa, Punjab, and Sindh, intending to disseminate knowledge resources and replicate the lessons in other parts of the country. Key stakeholders such as agricultural training institutes, industry experts, policymakers, non-profits, and bilateral organisations working on agricultural advancement in the country were also invited. The consultation workshop aims to share project experience, sensitise policymakers on adopting CSA practices and technologies, and further improve coordination to meet the common objectives. The forum has strongly recommended the integration of the newly developed CSA resource kit into the curricula of ATIs of all provinces in Pakistan.

3. RESULTS AND DISCUSSION

3.1. Climate-smart agriculture (CSA)

FAO estimates that the world population will increase by one-third and an additional 2 billion people will be living in developing countries by 2050. To meet the expected food demand, the agriculture sector must transform to meet the challenges and increase production by 60% (FAO, 2013a). According to the Pakistan Economic Survey 2020-21, Pakistan is already the fifth most populous country in the world (Government of Pakistan, 2021b) . Increasing population and urbanisation, coupled with changing climate over the past two decades, is affecting overall economic performance and creating an urgency to go through a transformation, making a case for the adoption of CSA to meet ever-growing needs in all provinces.

CSA is the idea of adopting agricultural practices that help transform the agriculture sector and effectively supports the broader sustainable development goals and food security in the context of a changing climate, particularly for smallholders. This is done by enhancing farm

FIGURE 2. Three pillars of CSA – the triple win. (FAO, 2016; World Bank Group, 2021)

and entrepreneurship management through better use of natural resources and adopting appropriate methods and technologies (FAO, 2013a; Khan et al., 2022). The concept aims to address three areas: sustainably increasing agricultural production and incomes, adaption and resilience to climate change, and reduction of greenhouse gas emissions (FAO, 2013a). CSA can be applied through various strategies to fulfil global food demands and ensure food security whilst implementing sustainable practices in the agriculture sector.

A CSA model for any specific location is the integrated landscape approach, which is based on rational management and utilisation of natural resources in an ecosystem (FAO, 2013a). This aims to improve livelihood options, especially for smallholders, through enhanced capabilities to rationally utilise the available resources such as quality seeds, fertilisers, pastures and livestock feed, land, water and energy; and manage the production, post-harvest and marketing practices tactfully. The CSA model aims to enhance resilience, improve the adaptive capacity of farmers, and decrease pressure on scarce resources (FAO, 2013a; Khan et al., 2022).

However, it is a well-established fact that sustainable agricultural production and CSA alone cannot meet the expectations for meeting challenges posed by climate change. In the coming years, there will be tremendous pressure on agriculture to meet the food demands of the ever-increasing population under climate change scenarios. Current food wastage, around one-third of the produced food, which is roughly 1.3 billion tons, is wasted worldwide every single year (FAO, 2013b) and is aggravating the overall impacts of climate change. Reducing food losses from the whole production and supply chain require integrating the value chain approach within the landscape approach, thereby increasing the resilience of all stakeholders. Therefore, the CSA approach takes into account the social, economic, and environmental well-being of all the stakeholders and components, including farming communities, consumers, ecosystems, and natural resources.

3.2. Climate-smart agriculture: A reference manual

The United Nations Framework Convention on Climate Change (UNFCCC) report states that there is a need for integrated programs in developing countries, which should take into account the role of research, capacity building, and strengthening existing resources. They should develop new capacity-building resources for enhancing capabilities, technical knowledge, and skills for adaptation (United Nations Framework Convention on Climate Change, 2002). FAO states that CSA is not one specific agricultural technology or a single practice that can be applied universally but rather various approaches that address climate change, create synergies and benefits, reduce trade-offs, and are applied appropriately considering social, economic and environmental aspects of a country or in a site-specific context (FAO, 2013a).

In Pakistan, there was a need to develop a comprehensive training module to build the capacities of agriculture extension officers to understand climate change and its impacts on agriculture and natural resources in the country context. PARC and APN, alongside provincial partners, have taken a knowledge-advancing capacity-building initiative by developing a country-specific training module on CSA to fill this knowledge gap. This is a comprehensive capacity building knowledge product that comprises updated and detailed technical information on climate change, impacts on agriculture, climate smart technologies, practices and adoption techniques. Considering other aspects, experts suggest that adopting CSA in all provinces can potentially contribute to the Nationally Determined Contributions targets of the country.

The training module comprises four sections. The first part of the module comprises basic knowledge and key concepts of climate science, such as atmosphere, weather, climate variability, climate change, global warming, greenhouse gases, and natural and anthropogenic drivers of climate change. The second part covers the overall impacts of climate change, impacts on agriculture and food security with a special focus on agronomic crops, horticultural crops and livestock, fisheries, forestry, soil, and water resources. The third section of the module covers CSA, which is the core topic; it discusses the landscape approach and its importance for agricultural transformation, salient practices of CSA, and their relevance to local agricultural conditions. The section also includes the concept and its relation to adaptation, mitigation and food security. The fourth module covers the concept of climate and gender inclusion, enabling environment, institutional capacity building, policy advancement relevant to CSA, and barriers and opportunities for CSA in Pakistan (Khan et al., 2022).

3.3. CSA knowledge products

During the project implementation, it was observed that the major inhibiting factors in mainstreaming CSA in Pakistan are the limited capacities of agriculture extension departments. We learned from the analysis of the existing knowledge resources that available materials are complex, and the climate aspect is not being covered. Further, existing archaic practices by small landholders and lack of advisory build the case for developing updated knowledge resources that should address the challenges of climate change (Khan et al., 2022). For the inclusion of local farmers, CSA experts recommend educating farmers through simplified knowledge products on CSA practices. The CSA knowledge products, which consist of technical yet simplified information on the adoption of CSA practices, have been translated into a local language, Urdu.

3.3.1 High-efficiency irrigation systems (HEIS): Water scarcity in Pakistan is acute and there is a significant decrease in groundwater level. With increasing temperatures and irregular rainfall patterns, areas such as Balochistan have reported fast-declining groundwater of up to three metres per year. The agriculture sector consumes the largest chunk of available water; further existing irrigation practices would lead to stress on water resources (World Bank Group, 2021). The CSA experts have recommended promoting and implementing the HEIS, such as sprinkler irrigation, drip or trickle irrigation – surface and sub-surface – bubbler irrigation, rain guns, and centre pivot irrigation system. These modern irrigation systems are suitable for most soil types and landscapes and non-levelled surfaces, save a considerable amount of water and serve as valuable adaptation measures.

3.3.2 Integrated pest management (IPM): A study by FAO defines the IPM as a holistic approach that finds sustainable solutions for pest problems and supports sustainable agricultural production. It helps in the prevention and control of pests through the integration of appropriate biological, cultural,

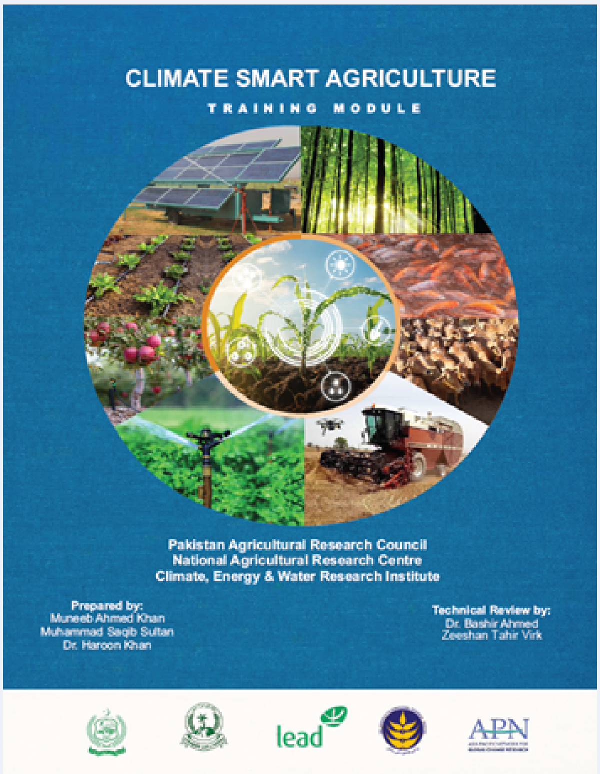

FIGURE 3. CSA training module– A reference manual. (Khan et al., 2022).

physical, and chemical measures to minimise economic costs and reduce health and environmental risks (FAO, 2020).

CSA experts recommend that the adoption of the IPM approach will protect biodiversity and improve pollination mechanisms leading to a non-chemical cure for the pest problem (Khan et al., 2022). Under the IPM, the overuse of pesticides is discouraged as it creates a problem for the overall health of the crop ecosystem; only selective and ecologically least disruptive pesticides should be used alongside the non-chemical pest control measures (Royer, Mulder, & Cuperus, 1999). Judicious use of pesticides helps reduce the production cost at a farm level and improve profitability by reducing environmental and economic damages.

3.3.3 Stress-tolerant crops: Stress-tolerant crops and varieties can improve productivity and save natural and financial resources. Farmers can cultivate stress-tolerant crops and varieties to optimise their production in changing climates and extreme weather events. Pakistan has experienced frequent drought, rising temperatures and unpredictable weather patterns, making stress-tolerant crops even more important (Asian Development Bank, 2017). CSA experts recommend stress-tolerant crops to fight changing climate due to their high tolerance against CO_2 levels, rising temperature, rain-fed conditions, drought and salinity levels. Similarly, some of the crops have unique traits that include resistance to water logging/flooding conditions; have the ability to mature faster when considered for rain-fed areas to avoid sensitive growth stages; can withstand higher insect pest populations; can resist existing and emerging diseases, and have adjustability to different cropping calendars (Burke & Lobell, 2010; Khan et al., 2022). These traits vary in different crops, depending on the area and weather conditions; these crops are indeed a solution against climate change and a key part of CSA.

3.3.4 Crop rotation: Crop rotation is an important adaptation tool at the farm level that positively impacts the whole ecosystem, water use efficiency, and higher yields. This helps in soil carbon sequestration, increasing soil organic matter

FIGURE 4. CSA knowledge products - Translated into local languages for farmers.

content, nutrient cycling, improving soil microbial activity and thus soil fertility, improving the water holding capacity of soils and suppressing weeds, insects and diseases, further leading to a healthy ecosystem. The crop rotations help in fulfilling the objectives of CSA through a well-planned and adapted pathway, which makes agricultural systems more resilient (Khan et al., 2022; Meyer-Aurich, Weersink, Janovicek, & Deen, 2006).

3.3.5 Crop diversification: Crop diversification refers to growing a mix of crops on a particular farm or a piece of land at the same time. These crops could be cereals, oil seeds, pulses, fodders, fibre crops, sugar crops, vegetables, fruits, etc., depending on the needs of farmers, market situation, or national preferences. Crop diversification is a cost-effective methodology that small landholders can also afford. Increasing genetic diversity, different varieties, or multiple species on a farm can reduce certain risks, such as adverse weather conditions, diseases and insects, market uncertainties, and risks related to mono-cropping. The genetic diversity of crops show resilience against temperature, precipitation, and other phenomenon related to climate change (Scherr, Shames, & Friedman, 2012; Khan et al., 2022)

Besides these prioritised five strategies, various other practices are recommended in the local context. Practices that increase soil organic carbon retain productive soils, need fewer chemical inputs, and support essential ecosystem services such as nitrogen cycling, all of which contribute to increased production, adaptation, mitigation, and resistance to climate change. The following measures should be implemented:

- Conservation tillage, reduced tillage, or zero tillage
- Integrated soil fertility management using inorganic and organic fertilisers; nitrogen fertiliser management; use of mulch, compost, manure, or green manure in place of inorganic fertilisers
- Erosion management, for example, lowering the slope's degree and length by progressive and bench terracing – protective soil cover from mulch, agricultural wastes, or cover crops
- Soil compaction control, restoring deteriorated soils and fallowing.

Reiterating the fact that CSA is not a specific technology or a tailored product to be implemented around the world, but is a holistic approach applied considering local agro-ecological conditions. Experts suggest these practices and technologies for capacity building and practical applications at

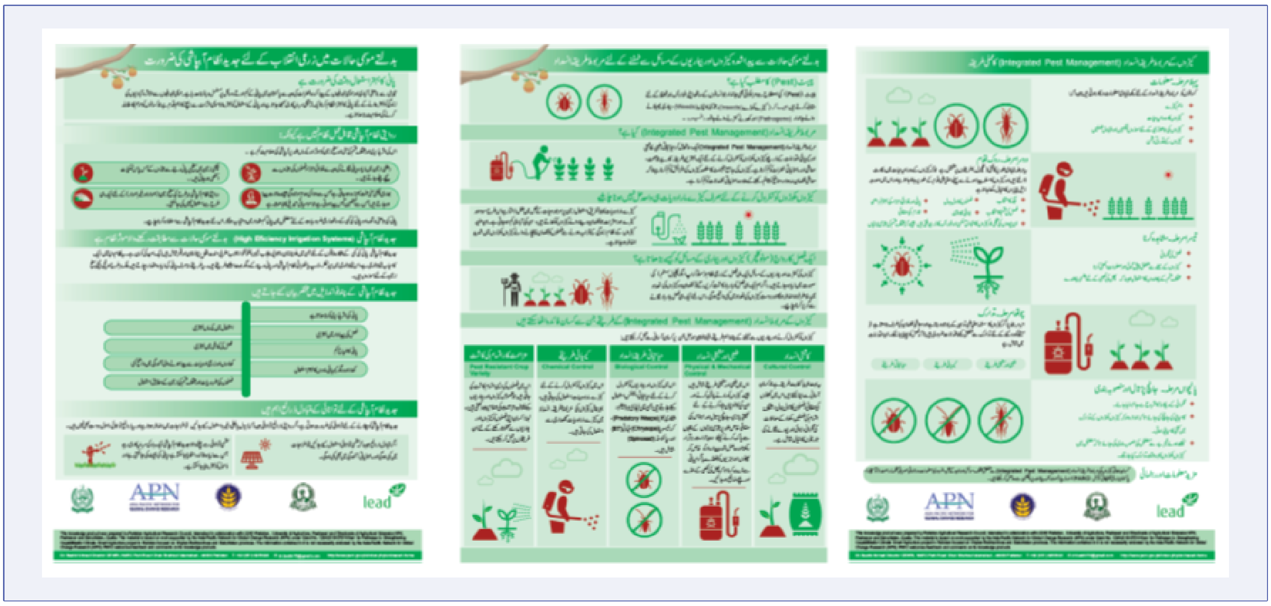

FIGURE 5. CSA knowledge products - Translated into the local language for farmers.

the field level. For that purpose, the CSA toolkit has effectively covered sustainable crop and livestock production to meet CSA objectives – adaptation, mitigation, and food security – and it is a key source of CSA knowledge in the local context for policymakers, agriculture officers, and farmers. A few prominent practices, technologies and approaches include crop and enterprise diversification, stress-tolerant crop varieties and livestock breeds, low water requiring crops, animal manure management, and utilisation of renewable energy sources to reduce fossil fuels dependence.

Each CSA practice and approach has multi-faceted benefits. For example, practices such as conservation tillage, residue management, utilisation of barren lands for food and feed production, improving water-holding capacity of soils, organic matter addition, crop rotations, crop diversification, manure management, and efficient irrigation systems, all are part of sustainable soil management. The potential benefits of these practices are very high, as they reduce soil degradation and erosion and improve soil fertility, structure and carbon sequestration. Considering conditions in agro-ecology, integration of various CSA practices and technologies reduces climate change impacts, leads to a reduction in GHG emissions, improves sustainable productivity and resilience, increases the compatibility of agriculture with ecosystems, and promotes rational use of natural resources.

3.4. CSA Capacity Building – a way forward

Despite advances in the agriculture industry over the years, productivity growth in the agriculture sector has been modest. The sector used to be dominant, contributing the most to the economy, but this has decreased over time. According to research, the agriculture sector has financed Pakistan's early industrialisation. This decrease in agricultural production is the result of various issues, including the absence of regulatory frameworks, the inadequacy of agricultural research, and the lesser capacity of agriculture extension services to meet developing difficulties. A study published by Oxford University Press states that agricultural institutes in Pakistan could not keep pace as required by the challenges and vulnerabilities of the sector. There is a lack of funds, lower integration and coordination in research, extension, and policy-making institutions. The organisational structure and strong research environment have not been fostered. Further, the extension system in Pakistan has been plagued with severe organisational problems coupled with lower funding and poor staff education and training (Husain, 2019). After the 18th amendment to the constitution, now agriculture sector is predominantly a provincial subject and it requires the attention of the provincial governments for reforms and capability development to meet the challenges (Shah, 2012).

Agricultural extension services are among the driving forces responsible for improved productivity by directly transferring the latest knowledge on agriculture to the farmers. This project has strengthened the capacity of agriculture extension services for adopting CSA and has contributed by developing a specialised resource kit on CSA practices and technologies in the country context (Khan et al., 2022). CSA experts have conducted professional learning sessions, have developed the capabilities of provincial agriculture extension officers, and focused on enabling extension officers to adopt the concept of CSA and relay their advisories in a manner that is compatible with climate change. Despite this project delivery, there is still not just a need but also a demand for capacity building of the institutions regularly and continuously throughout the country while utilising the resource kit, which covers greater knowledge and strategies for most local agro-ecological zones.

4. CONCLUSION

Agriculture is the foundation of food security and economic development in Pakistan, meets the livelihood needs of the majority of the rural population, and provides feed for livestock, raw materials for industry, and value-added products for both domestic consumption and international markets (Khan et al., 2022). However, the lack of capabilities to tackle the emerging challenges remain evident, and the development of knowledge products and capacity building was a much-needed intervention. The country's complex issues, such as alarming population growth and urbanisation trend, demand higher agricultural production. It needs agricultural diversification, switching to higher-value nutritious crops, and better management of natural resources, such as water, that can be achieved through the sector's transformation to CSA. This requires building institutional capacities on CSA and attuning the country's agriculture sector under a climate-compatible development (CCD) framework. To accomplish the agricultural growth ambitions and growing food demands, a lack of institutional capacities remains a major hindrance. It thus needs support through country-specific research and capabilities development. The adoption of CSA is one of the key interventions that can assist the country in enhancing its agricultural production, improving livelihoods, gaining economic growth, and achieving the larger goal of sustainable development.

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