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PROMOTING CLIMATE-RESILIENT FARMING PRACTICES IN FLOOD- AND DROUGHT-PRONE COMMUNITIES

Farhan Ahmad[1*]

[1] Agriculture Officer, Islamic Relief Pakistan
*Correspondence: farhan.syk@gmail.com

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ABSTRACT

Climate change poses a growing risk to agriculture-dependent livelihoods in northern Pakistan due to unpredictable rainfall, flooding, drought, and increased pest pressures. A Climate-Resilient Agriculture (CRA) capacity-building initiative was carried out in the Districts of Buner and Shangla under the Resilient Recovery and Adaptation Project (RRAP), supported by UNDP. This article records the design, execution, and results of community-driven CRA sessions led by Islamic Relief Pakistan (IRP) Agriculture Officers. Through participatory training, the initiative introduced climate-smart agricultural practices, soil and water conservation, integrated pest management, and livelihood diversification. Quantitative participation data and qualitative responses suggest significant community involvement and a strong willingness to implement practices such as mulching, crop diversification, and efficient irrigation. Despite challenges such as limited access to robust seeds and compromised irrigation systems, the program improved farmers' resilience and risk awareness. The results highlight the success of targeted, affordable CRA strategies in enhancing resilience in at-risk agricultural families.

Keywords: Climate-resilient agriculture, adaptation, water management, livelihoods, RRAP–UNDP

ABSTRAK

Perubahan iklim menimbulkan risiko yang semakin besar bagi mata pencaharian yang bergantung pada pertanian di Pakistan utara karena curah hujan yang tidak dapat diprediksi, banjir, kekeringan, dan tantangan hama yang meningkat. Inisiatif peningkatan kapasitas Pertanian Tangguh Iklim (Climate-Resilient Agriculture/CRA) dilaksanakan di Distrik Buner dan Shangla di bawah Proyek Pemulihan dan Adaptasi Tangguh (Resilient Recovery and Adaptation Project/RRAP), yang didukung oleh UNDP. Artikel ini mencatat desain, pelaksanaan, dan hasil sesi CRA berbasis komunitas yang dipimpin oleh Petugas Pertanian Islamic Relief Pakistan (IRP). Melalui pelatihan partisipatif, inisiatif ini memperkenalkan praktik pertanian cerdas iklim, konservasi tanah dan air, pengelolaan hama terpadu, dan diversifikasi mata pencaharian. Data partisipasi kuantitatif dan tanggapan kualitatif menunjukkan keterlibatan komunitas yang signifikan dan kemauan yang kuat untuk menerapkan praktik-praktik seperti mulsa, diversifikasi tanaman, dan irigasi yang efisien. Terlepas dari tantangan seperti akses terbatas terhadap benih yang kuat dan sistem irigasi yang terganggu, program ini meningkatkan ketahanan dan kesadaran risiko petani. Hasilnya menyoroti keberhasilan strategi CRA yang terjangkau dan tepat sasaran dalam meningkatkan ketahanan keluarga pertanian yang berisiko.

Kata kunci: Pertanian yang tahan terhadap perubahan iklim, adaptasi, pengelolaan air, mata pencaharian, RRAP–UNDP;

INTRODUCTION

Agriculture continues to be the foundation of rural economies in Pakistan, providing jobs for a substantial segment of the population and playing a crucial role in food security and income generation. Nonetheless, climate change poses an

increasing threat to this sector, especially in mountainous, rain-dependent regions such as Districts Buner and Shangla. Communities in these areas are facing more unpredictable rainfall, extended dry periods, unexpected floods, and increasing temperatures, all of which disrupt planting schedules, reduce crop yields, and worsen pest and disease outbreaks. Smallholder farmers, typically depending on small plots of land and conventional methods, are particularly susceptible to these climate-related disturbances (Kusumiyati et al., 2024; Ahmad et al., 2024; Ahmad et al., 2023).

The effects of climate variability go further than just crop losses. Flooding harms irrigation systems, watermills, and agricultural land, whereas drought diminishes water supply for crops and animals. These pressures diminish household earnings, heighten food insecurity, and drive at-risk families to harmful coping methods. With the escalation of climate risks, there is an immediate need for effective, cost-efficient, and regionally appropriate methods that enable farming communities to adapt while maintaining productivity (Ahmad et al., 2019; Ahmad et al., 2021).

Climate-Resilient Agriculture (CRA) provides a comprehensive approach to tackle these issues. CRA incorporates adaptation to climate fluctuations, reduction of environmental effects when possible, and the preservation or enhancement of agricultural yield. Instead of relying on excessive external inputs, CRA focuses on the effective use of natural resources, diversification of agricultural systems, and decision-making based on knowledge. Methods such as crop diversification, adoption of tolerant varieties, management of soil organic matter, water-efficient irrigation, and integrated pest management can significantly improve farm resilience (Ahmad et al., 2021; Nawaz, 2018).

Acknowledging these necessities, the Resilient Recovery and Adaptation Project (RRAP), with support from the United Nations Development Programme (UNDP), emphasizes advancing CRA as an essential approach to restoring livelihoods and minimizing risks in communities impacted by climate change. Supported by Islamic Relief Pakistan (IRP), the project integrates asset assistance with knowledge-sharing to enhance adaptive capacity among at-risk households.

Within the framework of RRAP, several awareness and training sessions on Climate-Resilient Agriculture were held in the districts of Buner and Shangla. These sessions are aimed at local farmers, community leaders, and at-risk households, emphasizing the need to tackle climate risks seen in the area. The training sought to connect scientific understanding of climate change with actionable strategies farmers can adopt within their current resource limitations.

This article details the organization, materials, and results of the CRA sessions conducted under the RRAP–UNDP. It outlines the methodological framework employed for community involvement, highlights essential practices encouraged throughout the sessions, and examines participation statistics and community feedback. Drawing on evidence from Buner and Shangla, the article adds to the growing body of applied research showing how community-driven CRA interventions can bolster resilience and safeguard livelihoods in areas susceptible to climate change.

RESEARCH METHODS

Study area

The research was conducted in the selected villages of District Buner and District Shangla, Khyber Pakhtunkhwa, Pakistan. Mountainous landscapes mark these areas, a combination of rain-fed and irrigated farming, and significant vulnerability to climate-related risks, especially floods and droughts.

Participants and Facilitators

The participants comprised local farmers, community representatives, and at-risk households. Sessions were conducted by IRP Agriculture Officers skilled in climate-resilient agriculture and community-centred education.

Session Design and Agenda

Each CRA session lasted approximately two hours and followed a structured, participatory agenda (Table 1).

Research design

To obtain comprehensive information on methods, challenges, and economic effects, the study employed a mixed-methods design combining quantitative surveys and qualitative assessments.

Table 1. Data collection methods

No	Description of Session	Method	Responsibility	Timing
1	Recitation of Holy Quran		Participant	5 Minutes
2	Welcome Note and Introduction	Participatory	Program Staff	10 Minutes
3	Introduction to Climate-Resilient Agriculture	Presentation/ Discussion	Agriculture Officer	15 Minutes

No	Description of Session	Method	Responsibility	Timing
4	Climate-Smart Crop Production Practices	Presentation/ Discussion	Agriculture Officer	25 Minutes
5	Water Management for Climate Resilience	Presentation/ Discussion	Agriculture Officer	20 minutes
6	Soil Conservation and the use of fertilizer/organic	Presentation/ Discussion	Agriculture Officer	15 Minutes
7	Questions/Answer session	Group Discussion	Agriculture Officer + Participants	30 Minutes

Data collection and analysis

Sources of data included attendance logs, information on toolkit distribution, facilitator observations, and participant feedback throughout discussions. Descriptive statistics were used to summarize quantitative data, whereas qualitative insights were thematically synthesized.

RESULT AND DISCUSSION

Participation, Coverage, and Inclusiveness

The Climate-Resilient Agriculture (CRA) sessions under the RRAP–UNDP initiative achieved extensive reach across Districts Buner and Shangla, demonstrating effective community engagement and the intervention's significance. A total of 1,949 farmers participated in CRA training sessions, comprising 1,440 from Buner and 509 from Shangla. Attendance records show that the sessions mainly involved smallholder farmers who depend on agriculture as their primary source of income and are thus particularly vulnerable to climate-related risks.

District	Participant facilitated in CRA sessions
Buner	**1440**
Shangla	**509**
Total	**1949**

Community Perceptions of Climate Change Impacts

Farmers exhibited a strong understanding of climate variability and its impact on agriculture. Participants frequently noted a late start to the rainy season, shorter winters, higher summer temperatures, and an increase in extreme weather events, such as flash floods. Farmers directly associated these observed changes with falling crop yields, heightened pest invasions, and diminished soil fertility.

Numerous participants observed that conventional farming calendars are now unreliable due to the erratic nature of rainfall patterns. This observation underscores the need for adaptive agricultural planning and underscores the importance of CRA training materials. Comparable views

have been recorded in climate-sensitive mountainous areas, where farmers' understanding acts as a crucial signal of localized climate effects.

Awareness and Understanding of Climate-Resilient Agriculture

Before the sessions, most participants had little knowledge of the formal definition of Climate-Resilient Agriculture, even though many were already implementing individual adaptive strategies. Facilitators clarified during interactive discussions that CRA is an integrated approach founded on three main pillars: productivity, adaptation, and mitigation. This approach enabled farmers to link their current practices with broader resilience objectives.

Post-session feedback revealed enhanced understanding of how CRA methods can maintain yields under stress while preserving natural resources. Farmers especially valued the focus on affordable, locally viable methods rather than reliance on costly external resources. This method boosted participants' confidence that adopting CRA is possible within their financial limits.

Adoption Intent and Preference for CRA Practices

Participants showed keen interest in implementing various CRA practices, particularly those that offer instant and apparent advantages. Mulching and composting ranked as highly preferred methods for their dual function of retaining soil moisture and enhancing soil fertility. Farmers also broadly endorsed crop diversification and rotation, acknowledging their importance in lowering the overall risk of total crop failure.

Effective irrigation methods sparked significant debate, especially in villages susceptible to floods and droughts. Farmers recognized that excessive irrigation is both inefficient and detrimental to crops, and they showed readiness to transition to irrigation schedules based on necessity (Sundari et al., 2021; Murtaza et al., 2021).

Table 3. CRA Practices Promoted and Level of Farmer Interest.

CRA practice	Primary benefit	Level of interest
Crop diversification	Risk spreading, income stability	High
Mulching & composting	Soil moisture, fertility	High
Efficient irrigation	Water conservation	High
Integrated pest management	Reduced chemical costs	Medium
Mixed farming/agroforestry	Livelihood diversification	Medium

Water Management as a Central Resilience Strategy

Water management emerged as the most important issue in both districts. Participants acknowledged water shortages in dry periods and crop destruction from waterlogging during intense rainfall as significant challenges. The CRA sessions highlighted effective water utilization, soil moisture preservation, and drainage control as interrelated approaches. Farmers demonstrated significant interest in mulching, adding organic matter, and harvesting rainwater as strategies to enhance soil water retention.

Techniques for drainage, such as raised beds and contour farming, were especially significant in areas affected by flooding. The conversations emphasized that efficient water management enables farmers to manage both drought and heavy rainfall, thereby improving overall system resilience (Khan et al., 2022).

Risk Reduction and Livelihood Protection Outcomes

The sessions focused heavily on proactive risk mitigation via adaptive planning. Farmers were urged to adjust planting schedules based on observed climate patterns and to use early warning information, such as weather forecasts and community notifications. Participants recognized that prompt information could help minimize losses by informing decisions on planting, irrigation, and pest control.

Mixed farming systems were extensively considered a viable strategy for safeguarding livelihoods. Combining crop production with livestock, home gardening, or agroforestry was seen as an effective method to enhance income and food variety. Farmers acknowledged that diversifying crops reduces reliance on a single crop and strengthens household resilience against climate disruptions.

Constraints and Implementation Challenges

Despite favourable feedback, several structural issues were identified. The restricted availability of climate-resilient seed types, impaired irrigation systems, flooding-related land loss, and damage to watermills were significant obstacles.

Table 4. Key Constraints Identified by Participants.

Category	Key challenges
Input	Limited access to resilient seed varieties
Water	Scarcity, damaged canals, destroyed watermills
Land	Flood-induced land loss, protection walls
Finance	Limited capital for adaptation investments

Knowledge & market	Limited exposure to diversification and weak market access

Monetary constraints also prevent farmers from investing in infrastructure improvements. Furthermore, limited market access lowers motivation to diversify beyond basic food crops.

Monetary constraints do more than delay a single purchase; they create a persistent investment trap. When farmers lack cash or affordable credit, they postpone or forgo investments in irrigation, storage, transport, and processing that would raise yields, reduce postharvest loss, and enable them to meet quality standards required by higher-value markets. Without those assets, the expected returns from diversifying into vegetables, fruits, pulses, or cash crops appear uncertain or negative, so farmers rationally stick to staple food crops that require the least upfront cost (IIIE, 2024; McIntosh et al., 2017; Mangaanyi et al., 2024).

Underlying mechanisms that deepen the problem

1. **High fixed costs and lumpy investments.** Infrastructure (wells, cold rooms, drying floors, packhouses) requires large, one-off spending that smallholders cannot spread across many seasons (McIntosh et al., 2017).
2. **Risk and information asymmetry.** Credit providers see smallholders as risky due to weather and price volatility, and because of weak collateral; farmers lack reliable market price information, so both sides avoid lending and investing (Mcintosh et al., 2017).
3. **Weak value-chain linkages.** When traders and processors are distant or intermediated by many agents, farmers face uncertain demand and payment delays, reducing incentives to change cropping patterns (IIIE, 2024; McIntosh et.al., 2017).

Consequences for livelihoods and local economies

1. **Low productivity and income stagnation.** Sticking to low-value staples limits income growth and resilience to shocks (IIIE, 2024).
2. **Seasonal gluts and waste.** Poor storage and transport mean harvests cannot reach higher-paying markets, depressing prices at harvest and increasing postharvest losses. (McIntosh et.al., 2017; Mangaanyi et.al., 2024).
3. **Limited rural employment and value addition.** Without local processing or aggregation,

opportunities for off-farm jobs and entrepreneurship remain scarce (McIntosh, et.al., 2017.

Evidence highlights and real-world patterns

1. Market access interventions can raise incomes but must change intermediation. Reviews show that simply connecting farmers to markets is insufficient unless interventions reduce contractual uncertainty and reshape intermediary relationships (IIIE, 2024; Mcintosh et.al., 2017.
2. Context matters. Successful cases combine finance, infrastructure, and guaranteed offtake or contract farming so farmers can justify investments (Mcintosh, et.al., 2017; Mangaanyi et.al., 2024).

Practical interventions to break the cycle

1. **Blended finance and tailored credit products.** Use partial guarantees, micro-leasing for equipment, and seasonal loans timed to harvests, so repayments match cash flows.
2. **Shared infrastructure and cooperatives.** Promote farmer cooperatives or public-- private aggregation hubs that spread the fixed costs of storage, cooling, and grading.
3. Market information and contract innovations**.** Mobile price platforms, forward contracts, and buyer-led aggregation reduce price risk and improve demand signals.
4. Phased diversification pilots**.** Start with low-risk, high-return crops and provide bundled support (inputs, training, market linkages) so farmers see tangible gains before scaling.
5. **Policy and public investment.** Targeted rural roads, electrification, and market regulation to lower transaction costs and attract private buyers (IIIE, 2024; Mcintosh, et.al., 2017; Mangaanyi et.al., 2024).

Risks, trade-offs, and implementation cautions

1. **Debt risk.** Poorly designed credit can increase vulnerability if yields or prices fall; safeguards and insurance are essential.
2. **Elite capture.** Infrastructure and subsidies can be captured by better-connected farmers unless governance and inclusive targeting are enforced.
3. **Market dependency.** Overreliance on a single buyer or export market can create new vulnerabilities; diversify buyers and build local demand.

4. **Sequencing matters.** Infrastructure and market guarantees should precede or accompany credit and training; doing so in the wrong order wastes resources (Mcintosh et al., 2017). **Bottom line**: monetary constraints and limited market access form a reinforcing cycle that keeps farmers in low-value cropping. Breaking it requires coordinated, sequenced interventions that combine finance, shared infrastructure, reliable market linkages, and strong governance, so farmers can confidently invest and diversify (IIIE, 2024; McIntosh et al., 2017; Mangaanyi et al., 2024).

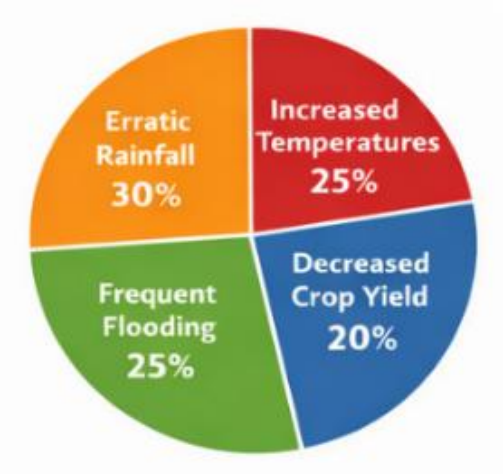

Figure 3. Perceived Impacts of climate on agriculture

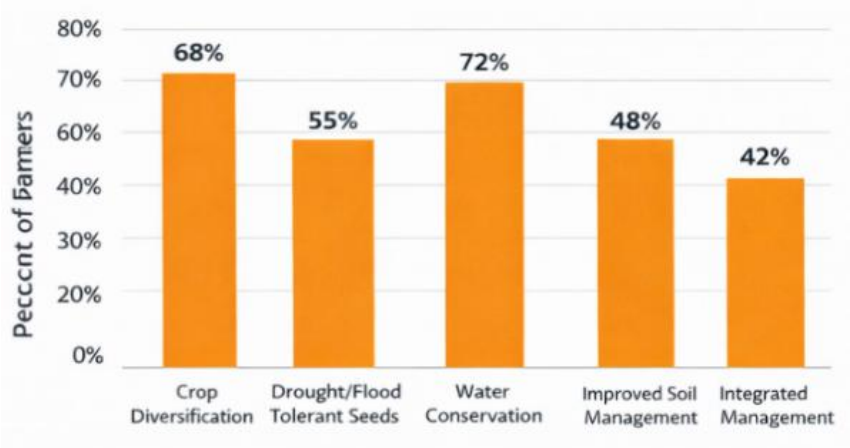

Figure 4. Preferred Climate-Resilient Practices

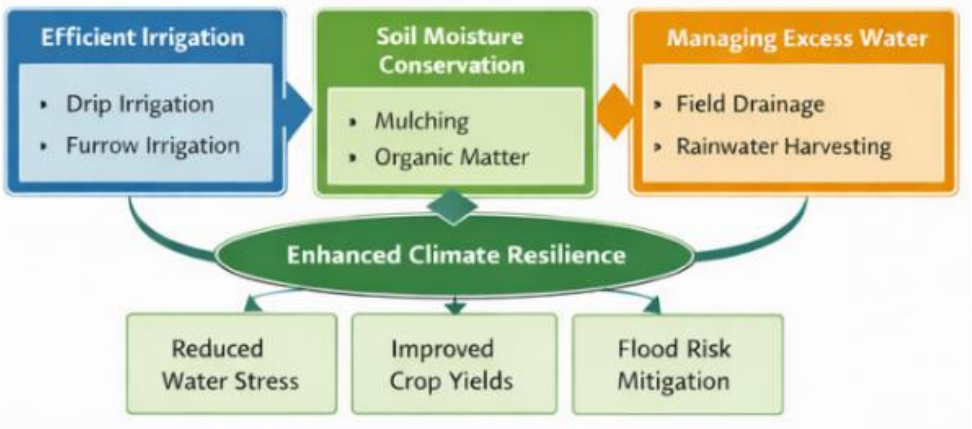

Figure 5. Climate-Resilience Water Management Strategies

Conclusion

The sessions on Climate-Resilient Agriculture conducted through the RRAP–UNDP project in Buner and Shangla Districts showcased the importance of community-driven, participatory strategies for climate adaptation. The initiative enhanced farmers' awareness of climate risks. It encouraged viable adaptation strategies focused on water management, soil conservation, and livelihood diversification by integrating hands-on training with the provision of farming toolkits. Elevated participation rates and favorable community responses suggest significant promise for the adoption of CRA practices. However, to achieve lasting effects, it is essential to address structural challenges such as deteriorated irrigation systems, limited access to resilient resources, and weak market connections. Combining CRA training with infrastructure, input, and market support will be crucial to developing sustainable, resilient rural economies.

Authors declaration

Consent to participate

Authors are agreed

Consent to publication

The authors agree to publish this data

Conflict of interest

The authors declare no conflict of interest

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