PROJECT COMPLETION REPORT

Empowering Small-Scale Farmers through Community-Based Drone for Climate Resilient Agriculture

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Project title:	Empowering Small-Scale Vulnerable Farmers through Community-Based Drone Project for Climate Resilient Agriculture
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1. Message from the Chief Executive Officer

Innovating Climate Resilience: Empowering Communities for a Sustainable Tomorrow

I am pleased to present this report with a strong sense of pride and responsibility, highlighting the achievements and transformative impact of the Empowering Small-Scale Vulnerable Farmers through Community-Based Drone Project for Climate Resilient Agriculture. This initiative reflects our enduring commitment to advancing innovative, community-driven solutions that strengthen agricultural systems and enhance the livelihoods of vulnerable farming communities.

Pakistan continues to face escalating challenges from climate change, environmental degradation, and biodiversity loss. Increasingly frequent floods, prolonged droughts, erratic weather patterns, and declining soil health are placing immense pressure on agriculture and rural livelihoods. At the same time, unsustainable natural resource use and limited access to modern technologies constrain effective adaptation efforts, making ecosystem restoration and wildlife conservation more critical than ever.

In response, this project has introduced a forward-looking and practical model that combines precision agriculture with strong community engagement. By integrating drone-based technologies, targeted capacity building, and inclusive participation, the initiative has enabled farmers to make informed decisions, optimize resource use, and adopt climate-resilient practices. Beyond improving agricultural productivity, the project has contributed to environmental sustainability, reduced stress on natural resources, and fostered a culture of innovation particularly among youth and women. It stands as a compelling example of how technology, when grounded in local ownership can deliver meaningful and lasting impact.

I extend my sincere gratitude to our valued partners including the Federal Ministry for Economic Cooperation and Development (BMZ) and the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH for their financial and technical support. I also acknowledge the Government of Khyber Pakhtunkhwa particularly the Agriculture Department, Mobilink Microfinance Bank, MS Worldwide and other stakeholders for their collaboration and commitment to the successful implementation of this initiative.

I deeply appreciate the dedication of the Farmer Field Schools (FFSs), Youth Agricultural Committees (YACs), farmers, women, community leaders and the Rural Aid Pakistan team. Their active participation, motivation and tireless efforts have been instrumental in driving this success and ensuring sustainable change at the grassroots level. Their commitment continues to inspire a shared vision of resilience and environmental stewardship.

Together we are not only addressing today’s challenges but also shaping a more sustainable, climate-resilient and prosperous future.

Mirza Moqeem Baig
Chief Executive Officer
Rural Aid Pakistan

2. Executive Summary

In recent years, the agriculture sector in Khyber Pakhtunkhwa has faced mounting challenges brought on by the increasing severity and unpredictability of climate change. Erratic rainfall, shifting weather cycles, frequent floods, and prolonged droughts have adversely affected the productivity and resilience of farming communities particularly smallholder farmers in flood-prone districts such as Nowshera. These communities, which rely heavily on traditional farming practices and limited access to modern technologies or financial services, are disproportionately vulnerable to climate shocks. They are confronted not only with declining yields but also with rising input costs, limited knowledge of climate-resilient practices, and minimal institutional support. Addressing this growing crisis requires a transformative and localized approach that goes beyond conventional interventions.

In this context, Rural Aid Pakistan with the technical and financial support of GIZ Pakistan under its Climate Financing Programme, launched an innovative pilot project titled **"Empowering Small-Scale Farmers through Community- Based Drone Project for Climate Resilient Agriculture."** The initiative was implemented in District Nowshera over a 12-month period and aimed to develop and test a scalable, community-led model of precision agriculture. This model integrated drone-based crop monitoring, participatory learning through Farmer Field Schools (FFS), financial literacy and institutional strengthening each designed to reinforce the capacities of vulnerable farming communities to adapt, innovate, and thrive in the face of climatic uncertainty.

The intervention sought to reorient traditional farming systems by introducing precision technologies that enable efficient use of water, fertilizers, and pesticides, thereby enhancing productivity while minimizing environmental harm. By embedding innovation within the community itself particularly among rural youth and women the project demonstrated a practical pathway toward sustainable agricultural transformation. The project targeted three strategically selected Union Councils within District Nowshera: UC Pashtoon Ghari, UC Kurwai, and UC Muhib Banda. These areas were chosen based on their high exposure to flooding, soil degradation, and limited access to extension services. The project adopted an inclusive, gender-sensitive, and socially aware approach, ensuring the meaningful participation of youth, elderly farmers, women, and persons with disabilities (PWDs).

The implementation was structured around four interlinked components:

1. Farmer Field Schools (FFS) and Community Capacity Building:
A total of 60 Farmer Field School sessions were organized to build grassroots awareness and technical knowledge on climate-smart agriculture. These sessions included practical demonstrations and learning-by-doing exercises covering topics such as soil fertility management, water conservation, crop stress identification, pest control, sustainable use of inputs, climate change adoption and environment protection. A total of **2040 individuals (men 1279, women 761)** participated in these sessions.

The sessions created a strong foundation of local knowledge, which is essential for the long-term adoption of resilient agricultural practices.

2. Drone-Led Precision Agriculture:
Fifteen (15) youth from the target areas were identified and trained in drone operations and basic remote sensing skills. These individuals were equipped to conduct crop assessments and generate actionable data on crop health, water stress, and nutrient deficiencies. During the pilot, **75 farmers were supported** through drone-led services, and more than **120 acres of farmland** were assessed across **three different intervals**, providing real-time insights and facilitating targeted interventions. This contributed to **up to 40% savings in water and fertilizer usage** and enhanced productivity on selected plots. Moreover, the pilot established a strong case for institutionalizing drone-based assessments as part of the provincial agricultural extension strategy.

3. Financial Literacy and Access to Microfinance:
To enable farmers to make informed financial decisions and access much-needed credit, the project conducted 30 financial literacy sessions. These focused on budgeting, loan application processes, record-keeping, and financial planning. **A total of 1,019 participants** benefited from these sessions (Men 514, Women 505). Building on this, the project facilitated the submission of **202 loan applications**, of which **109 were from men and 93 from women farmers.** These loans were primarily used for the purchase of seeds, fertilizers, and irrigation inputs.

4. Institutional Capacity Building:
Recognizing the need to embed this approach within existing governance structures, the project also invested in institutional training. **25 agriculture officers** from the Department of Agriculture were trained in GIS-based mapping, drone data interpretation, and remote sensing protocols. These officers are now positioned to lead precision farming interventions at the district level, making the pilot not only community-owned but also system-reinforced.

Beyond these components, the project prioritized inclusion and social integration. The formation of women's groups, youth committees, and farmer clusters ensured continuous dialogue and feedback, enabling adaptive learning and fostering trust between implementers and beneficiaries. The local drone-trained youth have now become key resource persons in their respective communities, paving the way for long-term sustainability.

In total, the project reached nearly **3,000 direct beneficiaries** across all its activities. Its outcomes such as reduced input costs, better crop monitoring, increased access to credit, and enhanced institutional collaboration indicate that precision agriculture, when rooted in local ownership and supported by digital tools, can significantly improve climate resilience for Pakistan's smallholder farmers. This pilot not only demonstrated feasibility but also laid the groundwork for scale-up across other vulnerable districts. As Pakistan grapples with intensifying climate pressures, such models will be critical in safeguarding food security, enhancing farmer incomes, and building adaptive rural economies for the future.

3. Background and Context

Agriculture remains the backbone of livelihoods across much of rural Pakistan, and particularly in the province of Khyber Pakhtunkhwa (KP), where more than 80% of the population is either directly or indirectly reliant on agriculture for income and food security. However, this sector is under severe stress from an increasingly unpredictable and volatile climate. In recent decades, the frequency, duration, and severity of extreme weather events have escalated bringing with them wide-ranging social, economic, and ecological consequences for communities that are already resource-constrained.

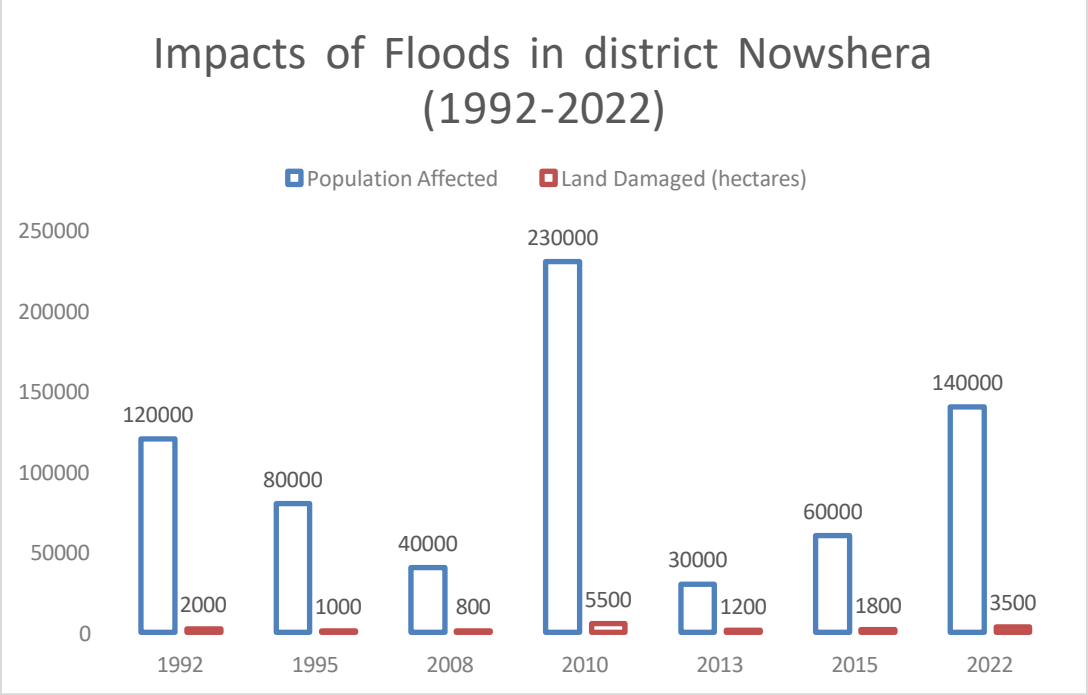
District Nowshera, located in the heart of KP and bordered by the Kabul and Bara Rivers, stands as a critical yet increasingly vulnerable agricultural hub. Once known for its fertile soils and consistent irrigation from river-fed canals, Nowshera has experienced repeated shocks due to climate variability, urban sprawl, and infrastructural strain. Over the past two decades, the district has been struck by major floods with increasing regularity. Historical flood data indicates that Nowshera suffered devastating floods in 1992, 2005, 2010, 2012, and more recently in 2022. Among these, the 2010 super-flood and the 2022 monsoon floods were particularly destructive—displacing thousands of families, inundating standing crops, and damaging irrigation infrastructure.

The 2010 floods alone affected more than 150,000 people in Nowshera district, submerging over 40% of cultivated lands. These catastrophic events led not only to crop failures but also to soil erosion, loss of seed stock, and the destruction of traditional farming assets like livestock and storage units. The economic toll for farming households was immense, with many falling into cycles of debt and food insecurity. In 2022, unusually high monsoon rains once again led to river overflows and flash flooding in Nowshera's low-lying areas, with reports of standing water persisting for weeks and significantly delaying sowing seasons.

Climate data shows that KP's average annual temperature has increased by 0.6°C to 1°C over the last 50 years, accompanied by more erratic rainfall patterns. District Nowshera's geographic location at the confluence of mountainous runoff and river floodplains makes it highly susceptible to both glacial meltwater surges and seasonal rainfall extremes. This combination of climate exposure and socio-economic vulnerability makes adaptation not just a priority but a necessity.

Farmers in Nowshera typically operate on fragmented plots of 1–2 acres and grow water-intensive crops such as sugarcane, wheat, and maize using traditional flood irrigation methods. With limited extension services, low input affordability, and poor access to weather data, most smallholder farmers remain unaware of climate-resilient techniques. In the absence of systemic support, many turn to overuse of chemical fertilizers and pesticides in an attempt to boost yields—further degrading the soil and exacerbating long-term vulnerability.

Women farmers, who often manage agricultural duties in addition to household responsibilities, face additional layers of marginalization due to mobility constraints, gender norms, and lack of ownership over productive assets. Likewise, youth in rural KP remain under-engaged in agricultural innovation due to limited training and employment opportunities. The result is an agriculture sector that is aging, under-performing, and misaligned with the growing climatic and demographic challenges of the province.



In this landscape, adaptation must move beyond reactive responses and toward proactive, data-driven, and inclusive solutions that build the resilience of farming systems and communities. This requires a fundamental shift in how knowledge is delivered, how technologies are adopted, and how institutions respond to localized risks.

The Government of Khyber Pakhtunkhwa, recognizing these challenges, has called for increased investment in climate-smart agriculture, including early warning systems, efficient irrigation, and the integration of geospatial tools. However, implementation has often been fragmented due to a lack of community ownership, institutional capacity, and scalable models that demonstrate the viability of such innovations.

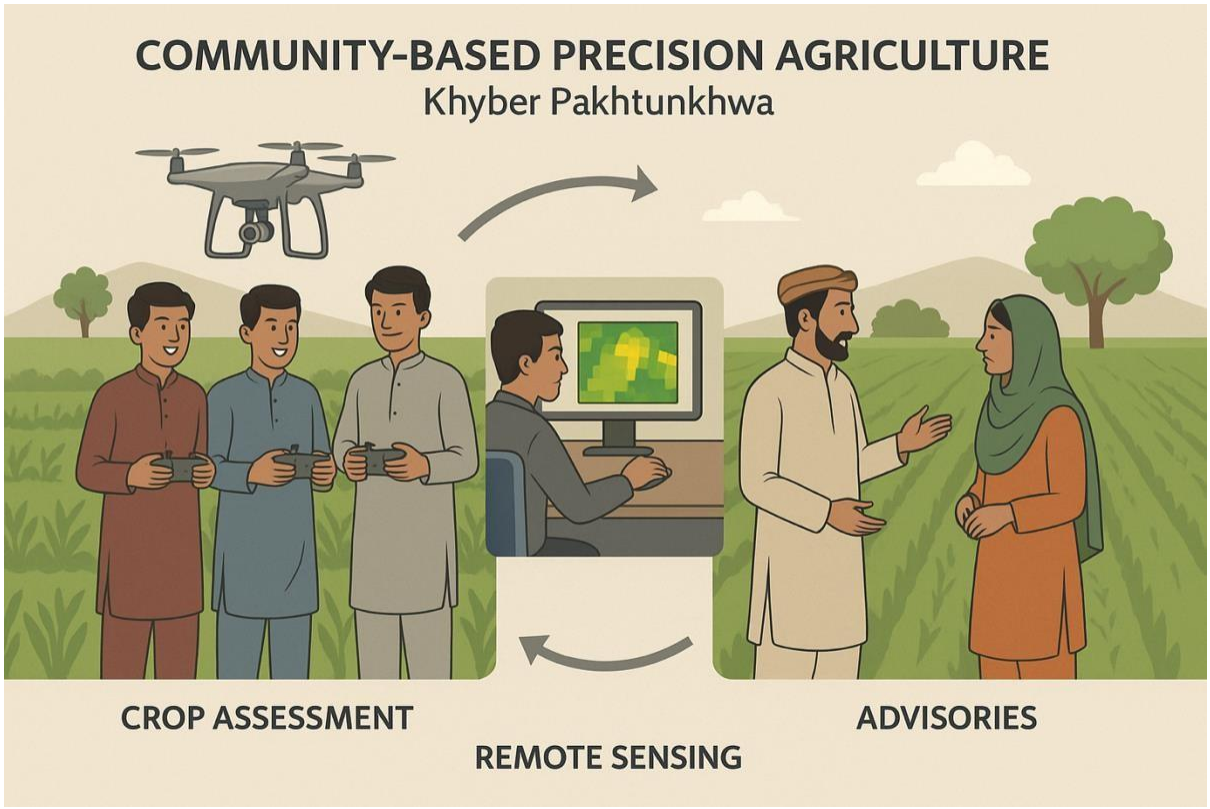
The "Community-Based Drone Project for Climate Resilient Agriculture" was conceptualized precisely within this context. It aimed to operationalize the idea of resilience through local empowerment, digital technology, and institutional collaboration. By focusing on District Nowshera—a hotspot of climate-induced risk the project tested a model that could be scaled and adapted across other vulnerable districts of KP.

The project's baseline assessment identified three Union Councils (Pashtoon Ghari, Kurwai, and Muhib Banda) where the confluence of high flood recurrence, weak extension support, and socio-economic deprivation created urgent need for intervention. These areas had witnessed multiple cropping failures in recent years due to either delayed rains or excessive runoff. Moreover, post-flood assessments revealed a lack of timely crop health information, inefficient resource allocation, and severe limitations in accessing recovery funds or microloans.

To address these multidimensional challenges, the project structured its activities to simultaneously build capacity at three levels: the **community level** (through Farmer Field Schools and youth drone training), the **institutional level** (through agriculture officer training), and the **individual household level** (through financial literacy and credit facilitation). The intention was to develop a holistic model that interlinks awareness, access, and action—placing farmers at the center of decision-making.

4. Why Precision Agriculture?

Precision agriculture refers to the use of modern technologies, such as drones, sensors, GPS mapping, and data analytics, to monitor and optimize crop production. It shifts the paradigm from uniform treatment of fields to site-specific management, enabling farmers to apply water, fertilizer, and pest control where and when they are needed most. For climate-vulnerable regions like Nowshera, where resource inefficiency can make or break a harvest, precision agriculture offers a pathway to resilience.



In Pakistan, the adoption of precision agriculture has remained limited due to high costs, lack of awareness, and limited institutional support. However, global evidence shows that even low-cost drone interventions can lead to significant improvements in crop health monitoring, early detection of stress, and efficient irrigation planning. For smallholder farmers, this means less guesswork and more informed decisions that directly improve productivity and reduce waste.

The use of drones in this project allowed communities to visualize the invisible such as nutrient deficiencies or irrigation gaps at early stages. It created a culture of curiosity, evidence-based problem-solving, and innovation among rural youth. Moreover, precision agriculture aligns with Pakistan's broader commitments to sustainable development and climate adaptation by improving efficiency, reducing emissions, and safeguarding ecosystems.

Through this project, precision agriculture was not introduced as a foreign or elite solution but as a practical, accessible, and community-owned tool for survival and prosperity. As the pilot demonstrated, when paired with capacity building, inclusive financing, and institutional partnerships, precision agriculture can serve as a cornerstone of a climate-resilient future in Khyber Pakhtunkhwa and beyond.

5. Project Objectives

5.1 Overall Goal:

To pilot a replicable, community-led model of precision agriculture that enhances climate resilience and productivity among smallholder farmers in flood-prone areas of District Nowshera.

5.2 Specific Objectives:

- To enhance farmers' knowledge of climate-resilient and sustainable agricultural practices.
    - To train local youth in drone operation and remote sensing for crop monitoring.
    - To provide farmers with financial literacy and access to micro-loans.
- To institutionalize GIS-based crop monitoring practices among Agriculture Department officials.
- To reduce the climate impacts by water conservation, environment protection, climate smart agricultural practices and strengthening the farmer field schools at community level

6. Target Areas and Beneficiaries

The project targeted three Union Councils (UCs) in District Nowshera, known for their vulnerability to flooding and agricultural distress:

1. UC Pashtoon Ghari
2. UC Kurwai
3. UC Muhib Banda

Primary Beneficiaries:

- Smallholder farmers
- Youth (male and female)
- Women farmers
- Persons with Disabilities (PWDs)
- Elderly farmers

Secondary Beneficiaries:

- Agriculture extension officers
- Local government institutions

7. Community-led Precision Agriculture

At the heart of the Community-Based Drone Project was a strong commitment to social integration and participatory development. This component served as the foundation for the successful implementation of precision agriculture by ensuring that local communities were not only recipients but active drivers of innovation and resilience. Social integration in this context referred to the intentional inclusion of diverse community members, especially the often-marginalized groups such as women, youth, the elderly, and persons with disabilities (PWDs) into the design, planning, and implementation of project activities.

The first step in this process was the **formation of inclusive community groups**, including **farmer groups, women's clusters**, and most notably, the establishment of **Youth Agricultural Committees (YACs)**. The formation of YACs was a strategic move, recognizing the latent potential of educated but underemployed rural youth to act as agents of change in their own communities. These committees were not formed arbitrarily; rather, a structured process of **community engagement, identification and sensitization** was undertaken to select young men and women who had basic literacy and a demonstrated interest in agriculture or technology.

Once established, the YACs served as **Community Support Groups**, taking ownership of localized training, demonstration, and outreach. The members of these committees referred to as **Educated Youth Volunteers** were trained in a range of technical and soft skills that positioned them as the operational backbone of the project. These included:

- **Drone Operations:** Youth were trained to operate drones for crop monitoring, soil assessment, and digital mapping.
- **Crop Health Reading:** They were taught to identify early signs of crop stress, pest infestations, and nutrient deficiencies using visual and remote sensing techniques.
- **Soil Testing Techniques:** Through practical exercises, youth volunteers learned how to conduct basic soil pH, moisture, and nutrient testing.

- **GIS-Based Remote Sensing:** Advanced sessions included understanding and interpreting drone imagery to identify variations in vegetation health, irrigation needs, and spatial distribution of crop diseases.

In this model, social integration extended far beyond token participation. By embedding YACs within each target Union Council (Pashtoon Ghari, Kurwai, and Muhib Banda), the project created a **locally anchored system** for data collection, farmer advisories, and technology dissemination. These committees acted as the bridge between technical experts and grassroots farmers. After drone assessments were completed, the YAC members, using printed maps conducted advisory sessions directly **in the agricultural fields**, where they engaged farmers in interpreting the data, discussing crop strategies, and recommending timely interventions.

This method helped to:

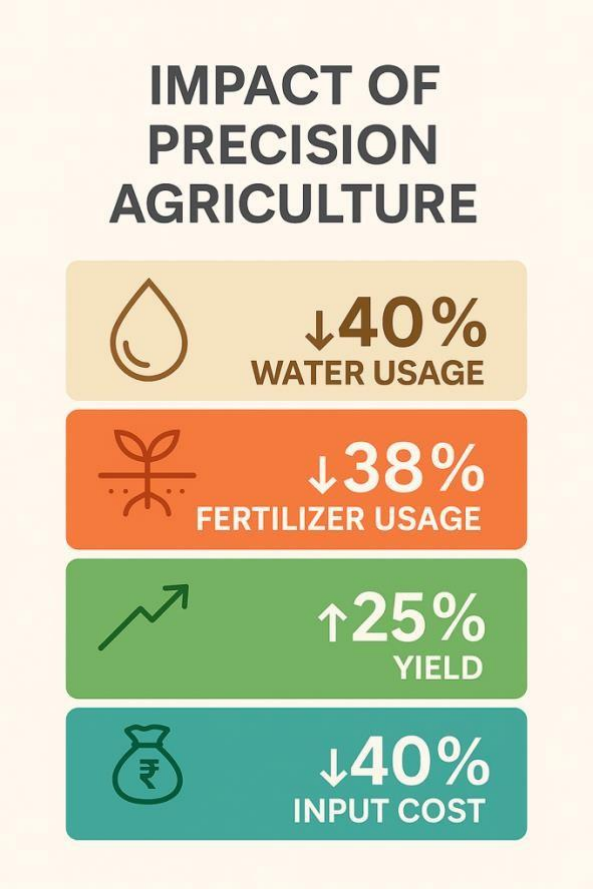
1. **Demystify technology** and build trust among traditional farmers.
2. **Promote peer learning**, as farmers were more receptive to advice from youth they knew personally.
3. **Ensure gender inclusion**, with female YAC members engaging women farmers in culturally appropriate settings.
4. **Reduce dependency** on external trainers or extension agents.

Community mobilization efforts were also conducted to sensitize local stakeholders on the purpose and benefits of the project. These efforts included village meetings, mosque announcements, household visits, and collaboration with local religious and social influencers to create awareness. Through this, the project cultivated an environment where precision agriculture was not seen as an alien or elite concept, but as a home-grown solution.

The implementation of drone-assisted precision agriculture across 120 acres of wheat fields, benefiting 75 small-scale farmers across three Union Councils of District Nowshera, has yielded remarkable results both in terms of economic efficiency and environmental sustainability. This pilot initiative, driven by trained youth from the local communities, demonstrated that digital farming technologies can be successfully integrated into rural Pakistan's smallholder context when paired with capacity-building and localized support.

Crop monitoring was conducted at three distinct intervals during the wheat growing cycle using drone-based imaging and GIS-enabled data analysis. The findings were then interpreted by trained Youth Agricultural Committee (YAC) members, who provided field-based advisory services to the farmers. The outcomes of this intervention were not only measurable but also transformational.

Quantitative data revealed a 40% reduction in water usage through more efficient irrigation scheduling. Similarly, fertilizer consumption dropped by 38%, as the drone-generated crop health maps enabled farmers to apply nutrients only where necessary. The input cost per acre also declined by 40%, offering significant economic relief to low-income farming families. Most notably, despite the reduction in inputs, crop yields increased by approximately 25%, rising from 1.2 to 1.5 tons per acre on average, demonstrating the effectiveness of data-driven decision-making in agriculture.



Beyond individual farmer benefits, the project has also contributed to environmental and climate sustainability. Reduced chemical use means less runoff into local water bodies, improved soil health, and decreased greenhouse gas emissions associated with excessive fertilizer use. More efficient water utilization also alleviates stress on regional water resources, which are under increasing pressure due to climate change and over-extraction.

The success of this pilot underscores the potential of community-led precision agriculture to transform traditional farming practices into adaptive, resource-efficient, and climate-resilient systems. It serves as a strong case for scaling similar interventions in other vulnerable districts across Khyber Pakhtunkhwa and beyond.

8. Farmer Field School (FFS) Participation

The Farmer Field School (FFS) initiative under the Community-Based Drone Project was a cornerstone component designed to enhance the technical and practical knowledge of smallholder farmers, with a specific focus on the wheat crop. Conducted in close collaboration with the **District Agriculture Extension Department** and supported by senior experts from the **Directorate General of Agriculture Extension Peshawar**, the FFS activity aimed to equip farmers, both men and women, with essential knowledge and techniques to improve productivity, sustainability, and climate resilience.

The activity officially commenced at the onset of the wheat cultivation season, starting from **land and soil preparation**, and continued through **seed selection, sowing, irrigation, nutrient management, pest and disease control**, up to **final harvesting and post-harvest handling**. This comprehensive cycle allowed participants to engage with real-time crop development stages, thus making the sessions highly practical and relatable.

A total of **60 FFS sessions** were conducted across three Union Councils (Pashtoon Ghari, Kurwai and Muhib Banda) where the project had already established community networks. Each session followed a structured methodology, blending classroom-based instruction with on-field demonstrations. Training modules were adapted to local needs, ensuring cultural relevance and easy comprehension.

The participation was **gender inclusive**, involving both **male and female farmers**, including youth and elderly members of the farming community. To promote inclusion and encourage wide participation, **special arrangements** were made for women's participation, including separate sessions where required, and female facilitators or youth agricultural committee (YAC) members were mobilized to support the training.

Key thematic areas covered during FFS sessions included:

- Importance of timely land preparation and soil structure assessment
- Seed selection techniques and seed treatment for higher germination rates
- Use of compost and organic fertilizers to improve soil fertility
- Irrigation scheduling based on crop stages and water-saving practices
- Identification and control of wheat diseases
- Fertilizer application timing and dosage for optimal nutrient uptake
- Harvesting techniques to minimize post-harvest losses
- Climate smart agriculture practices and kitchen gardening, water conservation and environment protection

Each session also included a component on **climate change awareness**, emphasizing the need for adaptive agricultural practices in light of changing rainfall patterns and temperature stress.

Field demonstrations allowed farmers to directly observe the effects of recommended practices versus conventional methods, thereby promoting experiential learning. Extension officials used comparison plots and performance data to highlight the benefits of improved farming practices.

One of the most impactful elements was the **active supervision and involvement of district-level agriculture officials. These officials** ensured technical accuracy and that farmers' questions were addressed with practical, locally appropriate solutions. Their presence added institutional credibility and encouraged farmers to build stronger links with the government's extension system. In many areas, these FFS sessions marked the **first structured agricultural training** that women had ever attended. Through these sessions, they gained valuable skills and developed confidence and recognition within their communities. This inclusion is expected to have long- term impacts on household decision-making, food security, and gender equity.

The cumulative impact of the FFS component was significant. Farmers reported noticeable improvements in their understanding of wheat crop dynamics and demonstrated greater confidence in implementing new practices. Some of the key outcomes include:

- Increased wheat yield due to better input planning and disease management
- Reduced input costs as a result of optimized water and fertilizer use
- Enhanced soil health through reduced chemical use and increased organic inputs
- Strengthened linkages between farmers and local extension services
- Improved collaboration among male and female farmers through joint learning sessions
- Promoted the climate smart agriculture practices
- Protected the environment by FFSs community based initiatives

Post-harvest feedback collected through the project's monitoring and evaluation system confirmed measurable improvements. On average, farmers reported a **20–25% increase in wheat yield** and **up to 30% reduction in input costs**, especially related to water and fertilizers. This improvement in productivity and efficiency directly contributed to household income stability. Additionally, enhanced soil quality and reduced chemical exposure have created a more environmentally sustainable cultivation model. For many female participants, the training marked their first formal engagement in agricultural education, contributing to their empowerment and expanded roles within family farming systems. Overall, the FFS component has laid the groundwork for long-term behavioral change, with many farmers pledging to train their peers and replicate these practices in the next cropping cycle.

Importantly, the knowledge gained through FFS is expected to have a ripple effect as trained farmers become resource persons within their communities. The project anticipates that a portion of these trained individuals will go on to mentor others and expand the reach of climate-resilient agriculture in the region.

9. Financial Inclusion

The integration of financial literacy into the Community-Based Drone Project was a critical enabler for sustainable climate-resilient agriculture. Recognizing that many smallholder farmers in rural areas of District Nowshera lacked formal exposure to financial systems, budgeting, and credit access, the project introduced a targeted Financial Literacy and Inclusion component. This was designed to build farmers' understanding of how to manage their resources effectively, access agricultural loans, and make informed financial decisions, ultimately allowing them to better invest in their farming practices.

The project conducted a total of 30 financial literacy sessions across the three target Union Councils including Pashtoon Ghari, Kurwai, and Muhib Banda. These sessions were held in both community centers and farmers' fields to ensure maximum convenience and participation. Each session was supported by a tailored Financial Literacy Manual, developed in consultation with financial experts and field mobilizers. The manual was contextualized to reflect the realities of local farming communities, with simplified language, illustrations, and practical examples.

To ensure gender-sensitive delivery, separate sessions were organized for men and women farmers. Female farmers were provided a comfortable learning environment where they could engage freely, ask questions, and share their experiences. In many cases, these sessions marked the first formal financial education women had received, significantly boosting their confidence and awareness of financial services.

Female field facilitators and community mobilizers were engaged to lead the women's sessions, further reinforcing inclusion and trust.

- The content of the sessions covered essential topics such as:
- Understanding income and expenditure tracking
- Budgeting techniques for agricultural households
- Principles of savings and planning for seasonal variability
- The purpose and structure of agricultural loans
- How to access loans through Microfinance Institutions
- Managing loan repayments and avoiding over-indebtedness
- Linking financial literacy to agricultural productivity and resilience

Participants were guided step-by-step through the loan application process, particularly for accessing input financing from Mobilink Microfinance Bank. Local community mobilizers, already trained under the project, played an essential role in bridging the gap between the bank and the farmers. They helped farmers fill out application forms, collect required documents (such as CNICs and land ownership papers), and liaised with loan officers for processing.

As a result of this structured facilitation, a total of 202 loan applications were successfully supported and submitted, with 109 male and 93 female farmers applying for loans. The primary objective of these loans was to enable farmers to purchase agricultural inputs—such as certified wheat seeds, fertilizers, irrigation equipment, and tools—at the right time in the cropping cycle, without financial delays. This timely access to inputs is crucial for improving yields, reducing input cost variability, and allowing farmers to adopt new practices such as precision agriculture introduced through other components of the project.

In feedback sessions and follow-ups, several encouraging outcomes emerged:

Farmers who previously relied on informal lending at high interest rates expressed a preference for regulated, affordable microfinance.

Women farmers gained greater decision-making power at the household level, as they were better informed and financially engaged.

A noticeable improvement was observed in the financial planning behavior of farming households, with many starting to budget for future seasons and saving for contingencies.

Community-level discussions around financial resilience increased, showing a shift in attitudes toward formal financial inclusion.

Moreover, by integrating financial literacy with other project components such as the Farmer Field Schools and drone-led precision agriculture the project promoted a holistic approach to sustainable agriculture. Farmers understood that financial literacy was not an isolated skill but a key component in maximizing the benefits of modern agricultural practices. For instance, farmers trained in drone-based crop monitoring were able to use loan financing to purchase recommended fertilizers or address crop stress with targeted irrigation, leading to improved productivity and income.

The long-term implications of this intervention are substantial. By establishing a base of financially literate farmers who are now connected with formal institutions, the project has laid the foundation for continued economic empowerment, especially for marginalized groups such as women, youth, and landless sharecroppers. Mobilink Microfinance Bank has also expressed interest in continuing engagement with these communities, seeing the value in well-prepared loan applicants supported by a structured community network.

10. Institutional Capacity Building for Sustainable Adoption of Precision Agriculture

The sustainability and scalability of any community-driven innovation depend heavily on the strength and readiness of the institutional ecosystem that supports it. In recognition of this, the Community-Based Drone Project placed a strong emphasis on **Institutional Capacity Building**, targeting the key public sector actors responsible for agricultural extension and technology dissemination, most notably, the officers and staff of the **District Agriculture Extension Department** and relevant line departments in District Nowshera.

As climate risks intensify and the pressure on agricultural systems mounts, there is a growing need for government institutions to adapt and evolve beyond conventional extension models. Many of these institutions are understaffed, resource-constrained, and have limited exposure to cutting-edge digital tools like **drone-assisted surveillance**, **remote sensing**, and **GIS-based crop health analysis**. To bridge this critical knowledge gap, the project designed and implemented a dedicated **Institutional Capacity Building module** focused on training key officials in the use of digital agriculture technologies.

Over the course of the project, **25 officers from the Agriculture Department** were selected in coordination with the **Directorate General Agriculture Extension Khyber Pakhtunkhwa**. The selected officials included Assistant Directors, Agricultural Officers, Field Assistants, and Monitoring & Evaluation staff. The selection was inclusive, prioritizing officers from diverse backgrounds, including women officers and those serving in more remote and underdeveloped parts of Nowshera.

The training was not delivered as a one-off orientation. Rather, it followed a **multi-phase, competency-based learning cycle**, allowing officers to build foundational knowledge and progress toward hands-on technical expertise. The capacity-building program was structured around three key pillars:

1. Understanding the Role of Digital Tools in Climate-Resilient Agriculture

The first phase introduced the participants to the concept of precision agriculture and its relevance in the context of Pakistan's rapidly changing agro-climatic zones. Officers were briefed on:

Climate vulnerabilities in Khyber Pakhtunkhwa, especially the rising frequency of floods, prolonged dry spells, and soil degradation.

The role of drone technology in optimizing input use, improving yield, and reducing environmental footprint.

International case studies and success stories of remote sensing and AI-assisted crop diagnostics.

This foundational awareness was critical in shifting the mindset from traditional, manual field visits to embracing data-driven decision-making.

2. Technical Skills in GIS, Drone Operations, and Crop Analysis

The second and most hands-on component of the training focused on **technical skill-building**. In collaboration with trained youth drone operators and GIS experts from MS Worldwide, participants received extensive training on:

Drone hardware components, navigation, flight planning, and aerial surveillance.

Safe and legal drone operations, including airspace regulations and ethical considerations.

Geographic Information Systems (GIS): including geo-tagging fields, collecting NDVI data (Normalized Difference Vegetation Index), and overlaying weather datasets for analysis.

Data interpretation: how to read multispectral images to identify signs of crop stress, irrigation gaps, and nutrient deficiencies.

Workshops were conducted in both classroom and field environments, allowing participants to engage with real-time crop assessments on demo fields. Participants were divided into groups and tasked with executing drone assessments, collecting data, and presenting findings using ArcGIS and open-source platforms.

11. Stakeholder Engagement

a. Opening Ceremony – Stakeholder Engagement in Action

The project *"Empowering Small-Scale Vulnerable Farmers through Community-Based Drone Project for Climate Resilient Agriculture"* was officially inaugurated through a high-level launch event in Peshawar, symbolizing strong multi-stakeholder ownership from the outset. The ceremony was graced by **Mr. Muhammad Sajjad, Minister for Agriculture Khyber Pakhtunkhwa**, who formally launched the initiative and emphasized the importance of adopting drone-based solutions to build climate resilience across flood prone districts.

Mr. Wolfgang Hesse, Cluster Coordinator of GIZ Pakistan, delivered the keynote address, reaffirming GIZ's commitment to supporting innovative, climate-smart agricultural interventions.

Mr. Mirza Moqeem Baig Chief Executive Officer of Rural Aid Pakistan addressed the audience and highlighted the significance of integrating innovation with community-led approaches. In his remarks, he emphasized that climate change is increasingly threatening smallholder farmers particularly in vulnerable regions and that there is a critical need to adopt modern, efficient, and sustainable agricultural solutions. He noted that the introduction of drone technology, combined with capacity building and community engagement, represents a transformative step toward precision agriculture and climate resilience. He further stressed that empowering local communities especially youth and women remains central to ensuring long-term sustainability and ownership of such initiatives.

The event brought together a wide spectrum of stakeholders including the **Additional Secretary of Agriculture**, senior officials from the **District Agriculture Extension Department**, **Planning & Development Department**, civil society leaders, farmers, community leaders, representatives from Mobilink Bank, MS Worldwide and other organizations. The ceremony served as a critical platform to align technical goals with policy-level support. Presentations and discussions highlighted the project's strategic intent: using drones, GIS, and climate-smart techniques to increase productivity, reduce risk, and empower communities. The inclusive engagement at the launch laid a strong foundation for shared ownership, inter-agency coordination, and the active involvement of farmers and youth in shaping a resilient agricultural future.

b. Experience Sharing Workshop

As part of our commitment to participatory development and inclusive learning, an Experience Sharing Workshop was organized to bring together diverse stakeholders, including representatives from the target communities, civil society organizations, local government departments, technical experts, and project staff. The objective of the workshop was to reflect on the implementation journey, celebrate successes, identify challenges, and co-develop strategies for future sustainability. The workshop served as a vibrant platform where beneficiary voices took center stage. Farmers, women, youth, and persons with disabilities from the project areas shared firsthand accounts of how their lives and livelihoods had transformed through interventions such as climate-resilient farming, financial literacy training, and drone-assisted crop monitoring. Their stories highlighted improved crop yields, reduced input costs, enhanced access to financial services, and increased confidence among women and youth to engage in agricultural innovation. Officials from the Agriculture extension department appreciated the community-led model, noting that the project's inclusive design had fostered ownership and strengthened grassroots governance. Development partners shared technical insights, while project teams showcased impact data, learnings, and tools developed during the initiative.

The session concluded with a participatory dialogue on scaling successful practices, addressing remaining gaps, and building institutional linkages for long-term support. The event reaffirmed the value of collaborative learning, community voice and evidence-based planning as critical pillars for sustainable development.

c. Closing Ceremony – Celebrating Impact through Collective Ownership

The project's closing ceremony served as a powerful reflection of the collaborative spirit that defined its success. Held in Peshawar, the event marked the completion of field implementation and highlighted the tangible outcomes achieved in three flood-prone Village Councils of Nowshera. The ceremony was attended by **Dr. Nicolai**, Commission Manager SAR/NAP, GIZ Pakistan; **Mr. Abdul Qayum**, Principal of the Agriculture Services Academy KP; **Dr. Zahid Hanif**, Director Horticulture Extension; as well as senior representatives from Rural Aid Pakistan, MS Worldwide, and Mobilink Microfinance Bank.

Local voices played a central role in the event. Members of **Farmer Field Schools**, **youth groups**, and **community leaders** shared their experiences, demonstrating how the project fostered resilience at the grassroots. Testimonials highlighted improvements in crop yields, access to technology, and women's empowerment through kitchen gardening and financial literacy.

This gathering reinforced the project's long-term relevance and the institutional linkages it created. By successfully combining innovation with inclusive engagement, the project not only introduced drone-led precision agriculture but also fostered a strong sense of community

leadership. The closing event validated the project's achievements and built momentum for scale-up and policy integration in future climate resilience programs

12. Project Challenges and Mitigation

Challenge 1: Resistance to Drone Usage among Traditional Farmers
Many smallholder farmers initially demonstrated hesitation in adopting drone-based technologies due to limited awareness, low digital literacy, and a strong reliance on conventional farming practices. There was a perception that such technologies were complex, costly, and not suitable for small-scale agriculture, which created barriers to early acceptance.
Mitigation: To address this, the project implemented practical field demonstrations and hands-on exposure sessions, allowing farmers to observe drone operations and their direct benefits in real-time. Peer learning was promoted by showcasing early adopters and their positive experiences, which helped build trust and confidence. Continuous engagement, simplified explanations, and community-level dialogue played a key role in gradually shifting perceptions and encouraging wider acceptance.

Challenge 2: Limited Mobility and Participation of Women in Rural Areas
Cultural norms and mobility constraints restricted the active participation of women in training sessions and project activities. This limited their access to knowledge, skills development, and opportunities to benefit fully from project interventions.
Mitigation: The project adopted a gender-sensitive approach by organizing training sessions within accessible village locations and at times convenient for women. Separate sessions were arranged where needed, supported by female facilitators and community mobilizers to ensure a comfortable and inclusive learning environment. This approach enabled greater participation, strengthened women's engagement, and enhanced their role in climate-resilient agricultural practices.

Challenge 3: Connectivity and Data-Sharing Limitations in Remote Areas
Limited internet connectivity and digital infrastructure in rural and remote project areas posed challenges for real-time data transmission, analysis, and communication of drone-generated insights. This affected the efficiency of information flow between field teams and technical experts.
Mitigation: To overcome these constraints, the project introduced offline data collection mechanisms and localized data-sharing protocols. Drone data was stored and processed offline, with periodic synchronization at central locations where connectivity was available. Additionally, trained local youth facilitated data interpretation and dissemination at the community level, ensuring that farmers received timely and actionable information despite connectivity limitations.

13. Project Impacts

1. Transformation Toward Climate-Resilient Agriculture
The project enabled a clear transition from traditional to climate-resilient farming practices by promoting informed and adaptive decision-making.
Evidence: Farmers in flood-prone Union Councils adopted improved irrigation scheduling and crop management practices after participating in Farmer Field Schools (FFSs), demonstrating increased awareness of climate risks and adaptive responses to erratic weather patterns.

2. Empowerment Through Technology and Knowledge
The integration of drone-based precision agriculture enhanced farmers' capacity to make data-driven decisions.
Evidence: Drone assessments provided real-time insights on crop health, water stress, and nutrient deficiencies, enabling farmers to take timely corrective actions rather than relying on conventional guesswork.

3. Strengthened Community-Led Innovation Systems
The formation of Farmer Field Schools (FFSs) and Youth Agricultural Committees (YACs) created strong community-based platforms for continuous learning and innovation.
Evidence: Trained youth and lead farmers conducted field-level advisory sessions using printed drone imagery, directly guiding fellow farmers on crop management practices within their own communities.

4. Youth as Catalysts of Change
Local youth emerged as key drivers of technological adoption and knowledge dissemination.
Evidence: Youth trained in drone operations and GIS mapping actively conducted crop monitoring and supported farmers with interpretation of results, positioning themselves as local resource persons and service providers.

5. Enhanced Inclusion and Women's Empowerment
The project strengthened women's participation in agriculture and decision-making processes through targeted and inclusive approaches.
Evidence: Women farmers actively participated in dedicated FFS sessions and financial literacy trainings, with many engaging in improved agricultural practices and contributing to household-level planning and resource management.

6. Improved Environmental Stewardship and Resource Efficiency

The adoption of precision agriculture significantly enhanced the responsible use of natural resources and strengthened environmentally sustainable practices. Capacity-building of Farmer Field Schools (FFSs) in climate-smart agriculture, kitchen gardening, water conservation, and environmental protection led to meaningful behavioral change within communities. These interventions improved household and community environments through the adoption of climate-resilient practices, promotion of women-led kitchen gardening, tree plantation, and increased environmental awareness facilitated by FFSs.

Evidence: A total of 17,900 trees were planted through FFS initiatives, and over 700 women-led kitchen gardens were established. Additionally, drone-based analysis enabled the precise application of water and fertilizers, reducing resource overuse and minimizing environmental impacts such as soil degradation and chemical runoff.

7. Strengthened Institutional Collaboration and Capacity
The project enhanced coordination between communities and government institutions while strengthening technical capacity within the public sector.
Evidence: Agriculture Department officials received hands-on training in GIS mapping and drone data interpretation, enabling them to support modern, data-driven extension services at the district level.

8. Replicable Model for Sustainable Development
The project demonstrated a practical and scalable model for climate-resilient agriculture that can be adapted in other regions.
Evidence: The integrated approach combining technology, community engagement, and institutional strengthening has been recognized by stakeholders as a viable framework for scaling precision agriculture initiatives in other climate-vulnerable districts.

14. Lessons Learned

1. Integrating Indigenous Knowledge with Modern Technology Enhances Adoption
The project demonstrated that the successful introduction of advanced tools, such as drone-based precision agriculture, depends on aligning them with local knowledge and traditional farming practices. When farmers are able to relate new technologies to their existing experience, acceptance increases significantly, leading to more effective and sustained adoption.

2. Community Ownership is Key to Long-Term Sustainability
Active involvement of local communities in planning, implementation, and decision-making processes proved critical for sustainability. Structures such as Farmer Field Schools (FFSs) and Youth Agricultural Committees (YACs) fostered a strong sense of ownership, enabling communities to continue utilizing and promoting project interventions beyond the project lifecycle.

3. Youth Engagement Drives Innovation and Continuity
Engaging and training local youth in drone operations and agricultural technologies created a pool of skilled resource persons within the community. This not only supported effective project implementation but also ensured continuity, as youth became champions of innovation and facilitators of knowledge transfer at the grassroots level.

4. Gender-Inclusive Approaches Require Context-Specific Strategies
The project highlighted that meaningful participation of women can be achieved through culturally sensitive and flexible approaches. Tailored interventions such as localized training, dedicated sessions, and female facilitators are essential to overcome social barriers and ensure equitable access to knowledge, resources, and opportunities.

5. Localized Solutions are Essential to Address Infrastructure Constraints
Challenges related to limited connectivity and infrastructure emphasized the importance of adaptable, context-driven solutions. Offline data management, decentralized information sharing, and reliance on trained local actors proved effective in ensuring continuity of operations and timely delivery of services in resource-constrained environments.

15. Project Contribution to Achieving Sustainable Development Goals (SDGs)

The project made significant contributions to the achievement of multiple Sustainable Development Goals (SDGs) through integrated community-based climate action, water conservation, climate smart & sustainable agriculture, and capacity building interventions in target communities.

SDG 1: No Poverty
The project contributed to poverty reduction by strengthening the livelihoods of vulnerable households through improved agricultural productivity, kitchen gardening, and climate-smart farming practices. Enhanced skills and access to sustainable income-generating practices reduced household economic vulnerability and improved resilience against climate-related shocks.

SDG 2: Zero Hunger
Through the promotion of kitchen gardening, improved farming techniques, composting, and efficient water use, the project enhanced household food security and nutrition. Farmers, women, and youth were equipped with practical knowledge to increase crop yields and diversify food production at the household and community level.

SDG 3: Good Health and Well-being
Improved food security, increased availability of nutritious vegetables, and enhanced environmental conditions contributed to better health outcomes. Awareness sessions on environmental protection and safe water use further supported healthier community practices.

SDG 5: Gender Equality
Women played a central role in project implementation particularly through Farmer Field Schools, kitchen gardening, financial literacy and other activities. Their active participation in kitchen gardening, climate awareness, and community mobilization strengthened their decision-making role and promoted gender-inclusive development practices.

SDG 6: Clean Water and Sanitation
The project promoted efficient water management practices including water-saving irrigation techniques, awareness on sustainable water use, and conservation practices. These interventions contributed to improved community understanding of water scarcity and responsible usage.

SDG 13: Climate Action
A core achievement of the project was strengthening community resilience to climate change through adaptation and mitigation measures. Activities included tree plantation, biodiversity conservation, climate-smart agriculture, and capacity building of local communities to respond to climate risks. The project strengthened environmental education through community-based activities, awareness sessions, and youth engagement programs. Farmers, youth and women were actively involved in tree plantation, climate awareness campaigns, and eco-club activities, fostering long-term behavioral change.

SDG 15: Life on Land
The project significantly contributed to ecosystem restoration and biodiversity enhancement through large-scale tree plantation, protection of natural resources, and promotion of sustainable land-use practices. Community stewardship improved survival rates of planted trees and strengthened local environmental ownership.

SDG 17: Partnerships for the Goals
The project strengthened multi-stakeholder collaboration among communities, local institutions, schools, and relevant stakeholders. These partnerships enhanced knowledge sharing, resource mobilization, and sustainability of interventions beyond the project lifecycle.

16. Conclusion

The Community-Based Drone Project in Nowshera is a landmark model in Pakistan's journey towards climate-resilient agriculture. It has effectively blended innovation, inclusion, and sustainability. The project's outcomes demonstrate that with the right tools, knowledge, and support, even the most vulnerable communities can lead the transformation of their agricultural future.

Rural Aid Pakistan remains committed to scaling this model across Pakistan and welcomes further collaboration for broader impact.