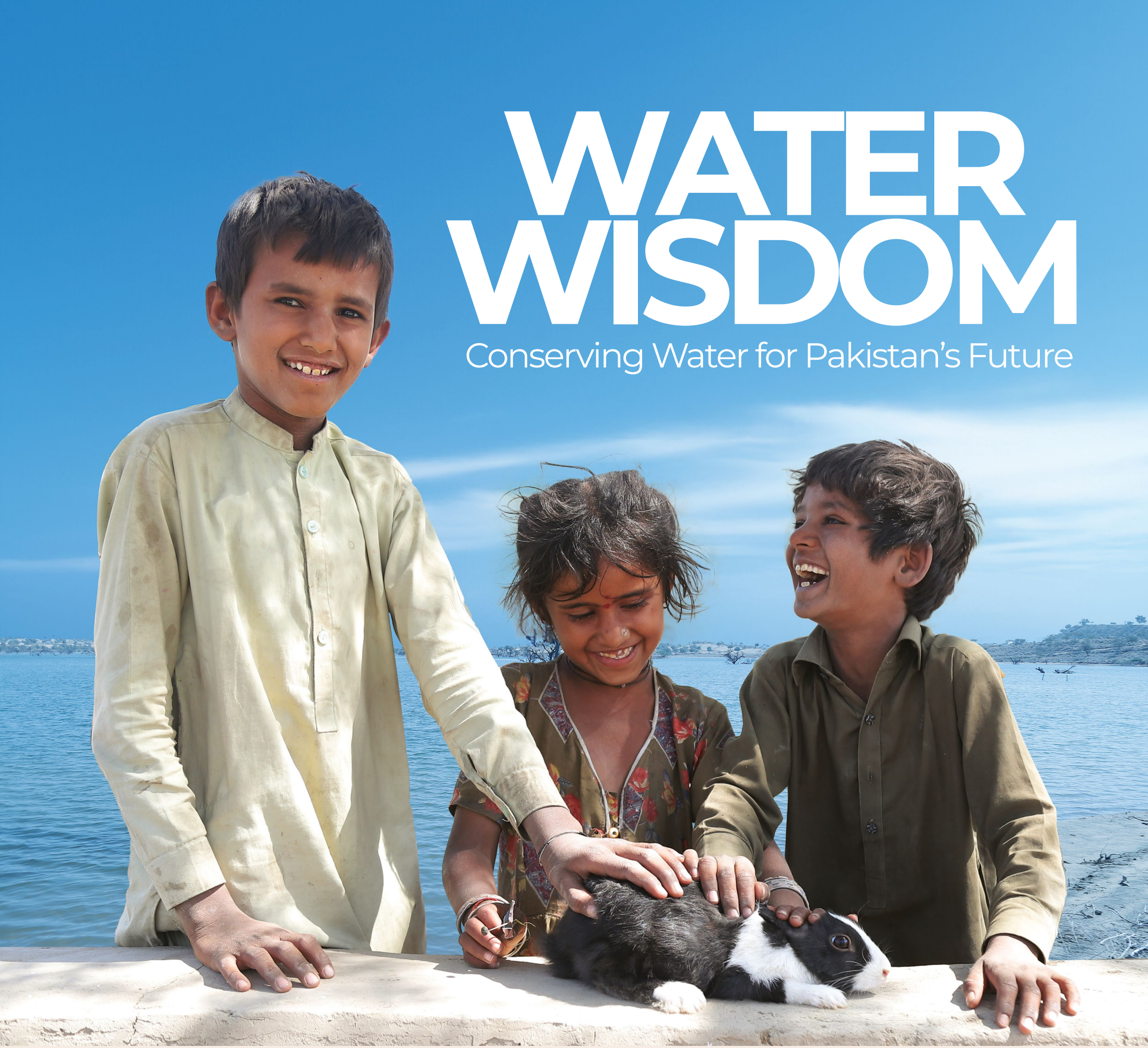
WATER WISDOM

Conserving Water for Pakistan's Future



WATER WISDOM

Conserving Water for Pakistan's Future

adpc

© 2025 Climate Adaptation and Resilience for South Asia (CARE) / Asian Disaster Preparedness Center, SM Tower 24th Floor No. 979/66-70 Phahonyothin Road, Phaya Thai Sub-District Phaya Thai District, Bangkok 10400 Telephone: +66 2 298 0681-92

Website: www.adpc.net

This publication is produced by Asian Disaster Preparedness Center (ADPC), developed as part of the project titled "Climate Adaptation and Resilience (CARE) for South Asia" funded by the World Bank (WB Reference: P171054). The findings, interpretations, and conclusions expressed in this work do not necessarily reflect the views of ADPC, its Board or the governments they represent. The boundaries, colors, denominations, and other information shown on any map in this work do not imply any judgment on the part of ADPC concerning the legal status of any territory or the endorsement or acceptance of such boundaries.

Rights and Permissions: The material in this work is subject to copyright. ADPC encourages dissemination of its knowledge. This work may be reproduced, in whole or in part, for non-commercial purposes as long as full citation to this work is given. Reproduction of this publication for resale or other commercial purposes is prohibited without prior written permission of the copyright holder.

Citation: Soomro, Z. A., Gupta, N., Basnayake, S., and Maqbool, I. 2025. Water Wisdom - Conserving Water for Pakistan's Future: ADPC.

All queries on rights and licenses, including subsidiary rights, should be addressed to ADPC; Email: adpc@adpc.net.

Design and Composition: Shiraz Imam, Publication Expert

Photo Credits: Muhammed Haseeb

Permission: Verbal consent was provided on 23 September, 2024 by Mr Sheva Ram (father of one male and female child) and Mr. Bhamro (father of one of the male children) of Village: Lakhi Bali, District: Umar Kot, Pakistan to publish the photographs of their children on the cover page of the book.

Date of Publication: June 2025

TABLE OF CONTENTS

About the Book 04
Message, Secretary, Sindh Irrigation Department 06
Message, Secretary, Sindh Agriculture Department 07
Introduction 08
Water Resources of Sindh Province 10
Climate Dynamics and their Impacts 12
Identification of the Practices: The Process 13
Evaluation Location of the Practices 14
Categorisation of the Practices 15
Selected Best Practices
1. Laser Land Levelling 18
2. Zero Tillage Practices 22
3. Vegetables on Raised Beds 26
4. Bed and Furrow Irrigation for Bananas 30
5. Orchard in Ring Basins 34
6. Intercropping 38
7. Tunnel Farming 42
8. Drainage effluent for raising crops 46
9. Residue Management of Banana 50
10. Hill Torrent Management 56
11. Dryland Agriculture 60
12. Tankaa 64
13. The Great Wall of Surajpura 68
14. Promotion of Saline Aquaculture 70
15. Urban Water Management System 76
Acknowledgement 80
Know More (References) 82
Glossary of Terms 84

New Phuleli Canal, Kotri Barrage, Sindh

“Anyone who can solve the problems of water will be worthy of two Nobel prizes - one for peace and one for science”

- John F Kennedy

About the Book

The compendium on adaptive water resources management practices in Sindh titled “Water Wisdom - Conserving Water for Pakistan’s Future” is a comprehensive collection of technologies to address pressing challenges in water resource use and management faced by farmers in Pakistan’s second most populous province. This compendium supports the implementation of the Sindh Water Policy 2023. The Policy underscores the critical need for innovative and adaptive water management strategies to ensure sustainable development and regional well-being.

The significant contribution of the Government of Sindh, various provincial and federal departments, and local stakeholders has enriched this compendium. It is intended to provide technical insights and inspire collective action towards climate change adaptation, water sector resilience, and sustainable water resources management.

The compendium captures fourteen (14) best practices from Sindh, Pakistan, and one from the State of Rajasthan, India. These practices are selected to suit the local socio-cultural values and agricultural practices.

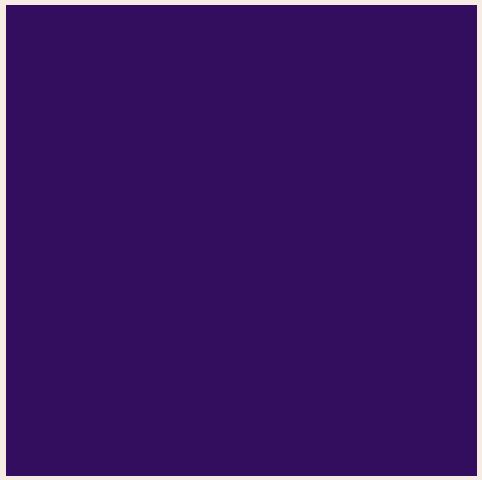
The compendium also aims to raise awareness and sensitize decision-makers, service providers, professionals, and farming communities on beneficial conventional and non-conventional water resource uses that can mitigate the current and future impacts of seasonal climatic variations in surface run-off, river flows, canal supplies, groundwater recharge, and discharges.

The description of each practice is accompanied by a list of references for the reader to consult for detailed information and practical guidance. By adopting and scaling up the identified best practices, Sindh can move towards more efficient water use, improved agricultural productivity, and enhanced resilience to the adverse impacts of climate change. If widely implemented these adaptive practices will contribute to securing water availability for diverse demands, including environmental flows, and fostering economic growth and food security in Sindh, Pakistan.

“Villagers fetching water from hand pump at Babook Village, near Manchar Lake, Sindh (photo: Z. A. Zameer)”

Manchar Lake (Photo: Z. A. Soomro)

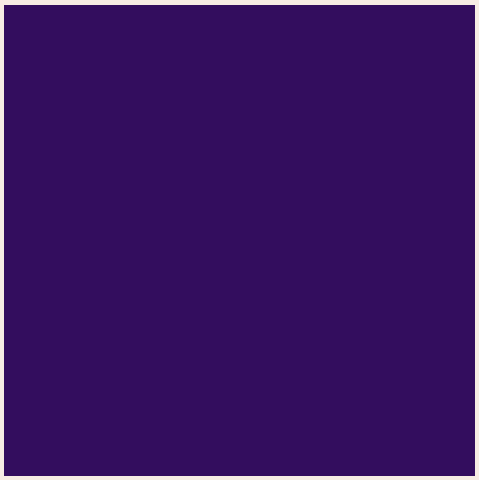
Message



Secretary

Sindh Irrigation Department

Message

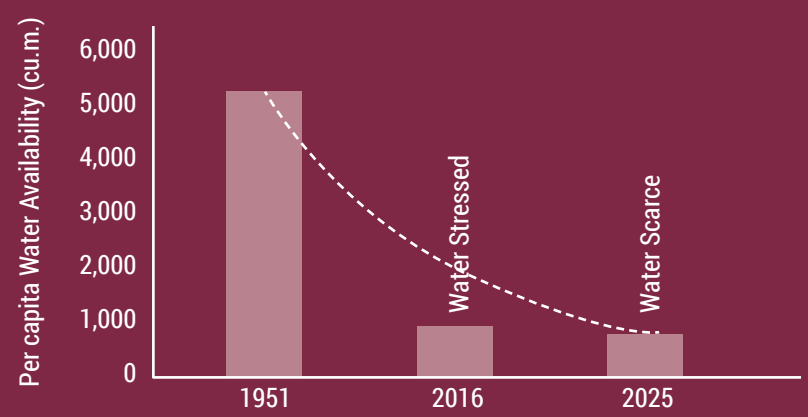


Secretary

Sindh Agriculture Department

Introduction

Pakistan, home to one of the world's largest contiguous irrigation systems, is grappling with significant challenges to sustain its agrarian economy due to a severe shortage of water resources. Per capita surface water availability has been rapidly declining due to an ever-increasing population, inefficient water management practices—including outdated irrigation methods—and rapid urban expansion. Additionally, while laws and regulations exist, they are not effectively implemented, and data collection on water resources is neither comprehensive nor adequately shared among government agencies or with the public. Climate change is exacerbating these issues, and manifesting itself through unpredictable precipitation patterns, flash floods in the north, and prolonged droughts in the south.



(Data Source: Census of Pakistan, and Daily Tribune 2019)

Sindh, situated in the southeastern region of Pakistan and the country's third-largest province by land area, faces significant water-related challenges. These include declining water quality, increasing waterlogging and salinity, tail-end canal command areas drying up, and wetlands disappearing. These issues contribute to the economic insecurity of the province and its people. There is a strong perception among stakeholders that both the conventional water use methods and current management practices need to be revised. On-farm water management approaches must expand to encompass overall water resources management, including surface water, groundwater, rainwater, wastewater reuse, and floodwater. User demands and water usage practices

Khisana Mori, Hyderabad Regulator on Rohri Canai, Sindh

also need harmonization.

In response to these challenges, the Government of Sindh approved its first-ever water policy, the Sindh Water Policy 2023. This policy aims to secure the comprehensive development and management of water resources to ensure the well-being of citizens and boost the province's economy. The policy highlights water governance challenges, including rising water demands due to a growing population and climate-induced challenges like increasing frequency of floods and droughts. The policy emphasizes managing canal water supply, distribution, and water use practices to enhance water productivity. Specific practices advocated in the policy to enhance water supplies are conjunctive use or reuse of drainage effluents (the choice depending on water quality), and discouraging water-intensive crops.

'Water conservation' has been prioritized as a tool to serve tail-end areas, maintain environmental flows, and support the expansion of irrigated agriculture. It also encourages adaptive water resource management practices to secure water availability for diverse demands across the province. Adaptive management implies strengthened monitoring of water systems and water use.

As part of the overall management and development of water resources in line with Sindh Water Policy 2023, the CARE for South Asia project, in collaboration with the Government of Sindh's Irrigation and Agriculture departments, has co-developed this compendium of best adaptive water resource management practices. The compendium focuses on sustainable water supply (drought not flood) management, and agricultural production. It includes water-saving or water conservation interventions practiced in various districts of the province that have been selected for their potential to be scaled up and implemented across Sindh, Pakistan.

The compendium aims to sensitise policymakers, water resource managers, agricultural extension workers, and farmers on these interventions and the judicious use of water, ultimately conserving water to serve tail-end areas, meet environmental flow requirements, and support agricultural expansion for food security and economic upliftment of the province. It may also serve as a reference for researchers and academia to extend their studies for the efficacy of the adaptive water management practices in different agro-ecological zones of the province.

The Context

In mid-2021, the Government of Sindh's Irrigation Department organised a consultation meeting to discuss priority interventions in Sindh to be included in the Climate Adaptation and Resilience for South Asia Project funded by the World Bank. The meeting was attended by representatives from provincial and federal government departments, academia, and international organisations, including:

- Sindh Irrigation Department, Government of Sindh
- Sindh Irrigation and Drainage Authority (SIDA), Government of Sindh
- Sindh Agriculture University, Tando Jam, Sindh.
- Food and Agriculture Organization (FAO) of the United Nations represented by the consultant from the Sindh Barrage Improvement Project (SBIP).
- Pakistan Council of Research in Water Resources (PCRWR), Ministry of Water Resources, Government of Pakistan.

In mid-2022, the Ministry of Planning, Development, and Special Initiatives (MoPDSI) and Irrigation Departments of Sindh and Balochistan as part of the national planning meeting of the Climate Adaptation and Resilience for South Asia Project endorsed the proposed study to identify the best practices to adapt and build the resilience of the farming community of the province to changing climate. The study was directed to include indigenous and local adaptive water resources management practices.

Water Resources of Sindh Province

Water plays an essential role in the livelihoods of the population in Sindh, driving both agricultural productivity and socioeconomic development. Since ancient times the Indus River has been the focus of society, culture and economy.

From 950 – 1250 AD "the world witnessed climatic changes in form of rise in temperatures in most of the world. This is called the 'Climatic Optimum' which resulted in more rainfall and consequently swelling of the Indus waters. The phenomenon brought much prosperity to the land of Indus." In these early times and until the present, people have fished and based their livelihood around the river.

The fertile, cultivable alluvial plain of the Indus River highlights the region's reliance on water resources for agricultural activities, which form the backbone of its economy. Originally the floodplain was covered in jungle which graded into the desert of the higher ground. This land was cleared, first for agriculture (using traditional water management) and grazing from very early but with greater intensity from the 8th century, and later systematic large-scale irrigation started in the mid-19th century. Traditional water management relied on the annual rise and fall of the river, which also maintained the soil health.

Sukker Barrage

Kotri Barrage

Even now, Sindh's prosperity in terms of food production, industry, and rural livelihoods is intricately tied to the management and use of its water, particularly through the extensive irrigation systems fed by the Indus River. However, some of the past benefits of the river system to fishermen, small-scale farmers and the environment have been lost through the development focus on intensive irrigation. Effective water governance is therefore critical to restoring and sustaining the various water resource-depende livelihoods and ensuring long-term development.

Due to the province's average yearly rainfall of only 100 to 200 mm, Sindh's residents have restricted access to water resources. The Indus River is Sindh's main source of water. Water from the river is diverted at the three main barrages, Guddu, Sukkur, and Kotri into a network of canals that branch out to carry water from the Indus River to irrigation farmers. This Lower Indus Basin Irrigation System (IBIS), was built over the previous century, and in addition to these barrages comprises 14 main canals, 117 branch canals, 1,400 distributaries and minors, and 44,000 watercourses.

Outside the coverage of the IBIS, surface water resources are even more scarce. They primarily depend on runoff generated in the local catchment areas during rainfall. However, groundwater aquifers underly much of Sindh

and where its quality permits is another significant and more frequently used source of water within both dryland and canal regions. A significant concern for Sindh is its status as the lower riparian region within Pakistan. This brings multiple challenges, including worries about reduced surface water inflows, the risk of uncontrolled flood releases during periods of flooding, and the deteriorating water quality in the main Indus River.

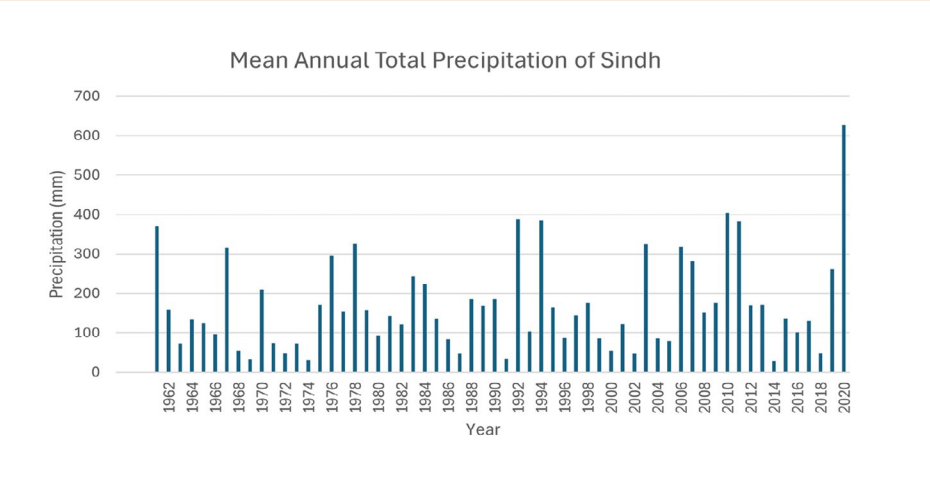
The largest water use in Sindh is agriculture, accounting for around 95% of total consumption, with evapotranspiration ranging from 26.6 to 41.7 MAF.

Annual water demand for domestic use is 1.2 MAF, for industry 0.5 MAF, and livestock use is minimal[11]. Maintaining the Indus Delta's ecosystem is also crucial, and the Indus River Accord specifies an annual flow of 10 MAF for this purpose, but actual flows often fall short of environmental needs. Sindh has a responsibility to sustainably manage its significant Ramsar-listed wetlands, such as Keenjhar Lake and Haleji Lake, as well as the Indus River Delta, to protect their ecological and cultural values, as these are vital for fish stocks and the livelihoods of local fishermen.

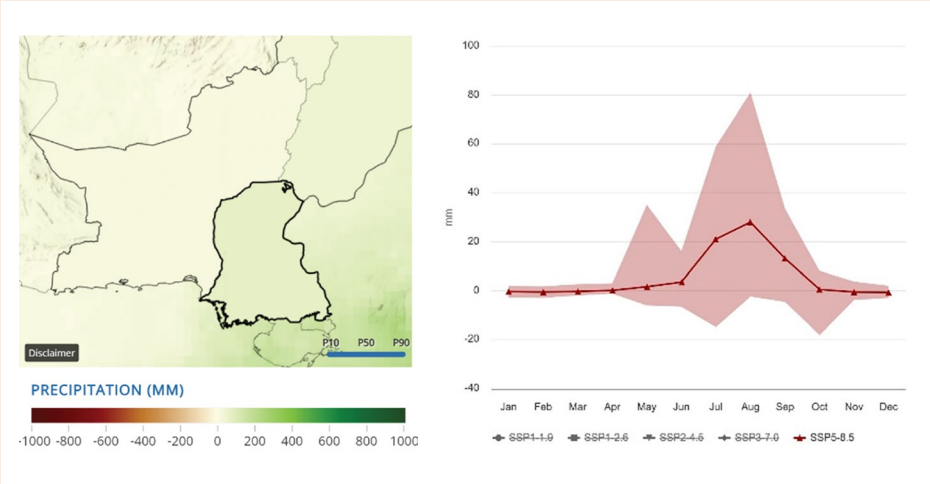
1 *Sindh Water Policy 2023*

Climate Dynamics and its Impact

The Sindh Water Policy emphasises the interconnected nature of water-related challenges and underscores the need for international cooperation. It calls for collective action to address the water and climate change crises, recognising water as a fundamental human right and advocating for equitable access and distribution (Sindh Water Policy, 2023). The climate change impact in Sindh has been significant. Among all these risks, the most devastating has been the increased frequency and intensity of droughts and floods. Sindh has experienced six major floods over the past fourteen years, including two catastrophic floods in 2010 and 2022 that devastated nearly the entire province. These events resulted in loss of life, destroyed crops and livestock, and caused extensive damage to people's assets. The frequency of drought occurrences was notably high in Sindh, with years like 1871, 1881, 1899, 1931, 1947, and 1998 marked as the worst drought years. The drought event from 1998 to 2000, declared the worst in Pakistan's history, resulted in dire consequences, including 127 casualties due to water scarcity and dehydration, predominantly in the Tharparkar district of Sindh. Studies carried out by Provincial Disaster Management Authority (PDMA), Sindh show the province's decadal annual average temperatures have risen markedly since 1990. The most significant recorded temperature increases have been in Central and Upper Sindh. Significant change in total precipitation was observed over the period starting from 1981. The impacts of climate change, population growth, and migration from rural to urban areas of Sindh, are the three primary areas of concern for water and food security in the province. Increasing crop production with a reduced volume of water and achieving that with equity among a large and mostly poor farming community is the challenge addressed by this compendium.



Total annual Precipitation of Sindh from 1961 through 2020.
(Data Source: Pakistan Meteorological Department, 2020)



Projected Precipitation Anomaly for 2040-2059 (Annual) Sindh, Pakistan;
(Ref. Period: 1995-2014), SSP5-8.5, Multi-Model Ensemble

(Data Source: https://climateknowledgeportal.worldbank.org/

Identification of the Practices

THE INITIAL PROCESS

01 Opportunity

Recent Water policies created an opportunity

Initiated the idea for the compendium and defined its objectives

02 TWG Setup

Sindh Irrigation Department establishes a Technical Working Group

03 Agree on Criteria

TWG confirms selection criteria

04 Long Listing Practices

31 practices across the province identified by members of the Technical Working Group and ADPC Experts

05 Evaluation

31 practices evaluated using the criteria

06 Shortlisting

18 practices selected for assessment in the field

EVALUATION CRITERIA

Criteria 01

Climate Change Resilience: water saving and livelihood improvement

Criteria 02

Scope for scaling-up

Criteria 03

Successful trails by government agencies of the water management solutions

Criteria 04

Endorsed in peer-reviewed paper and piloted in Sindh province with scaling-up potential

THE CONFIRMATION PROCESS

07 Field Visit

Field visit to 18 identified practices with representatives from Provincial Agriculture and Irrigation Department and CBOs

08 Capturing Farmer's Experience

FGDs with farmer groups, officials of government research stations and KIIs with progressive farmers carried out at each location along with photography and videography

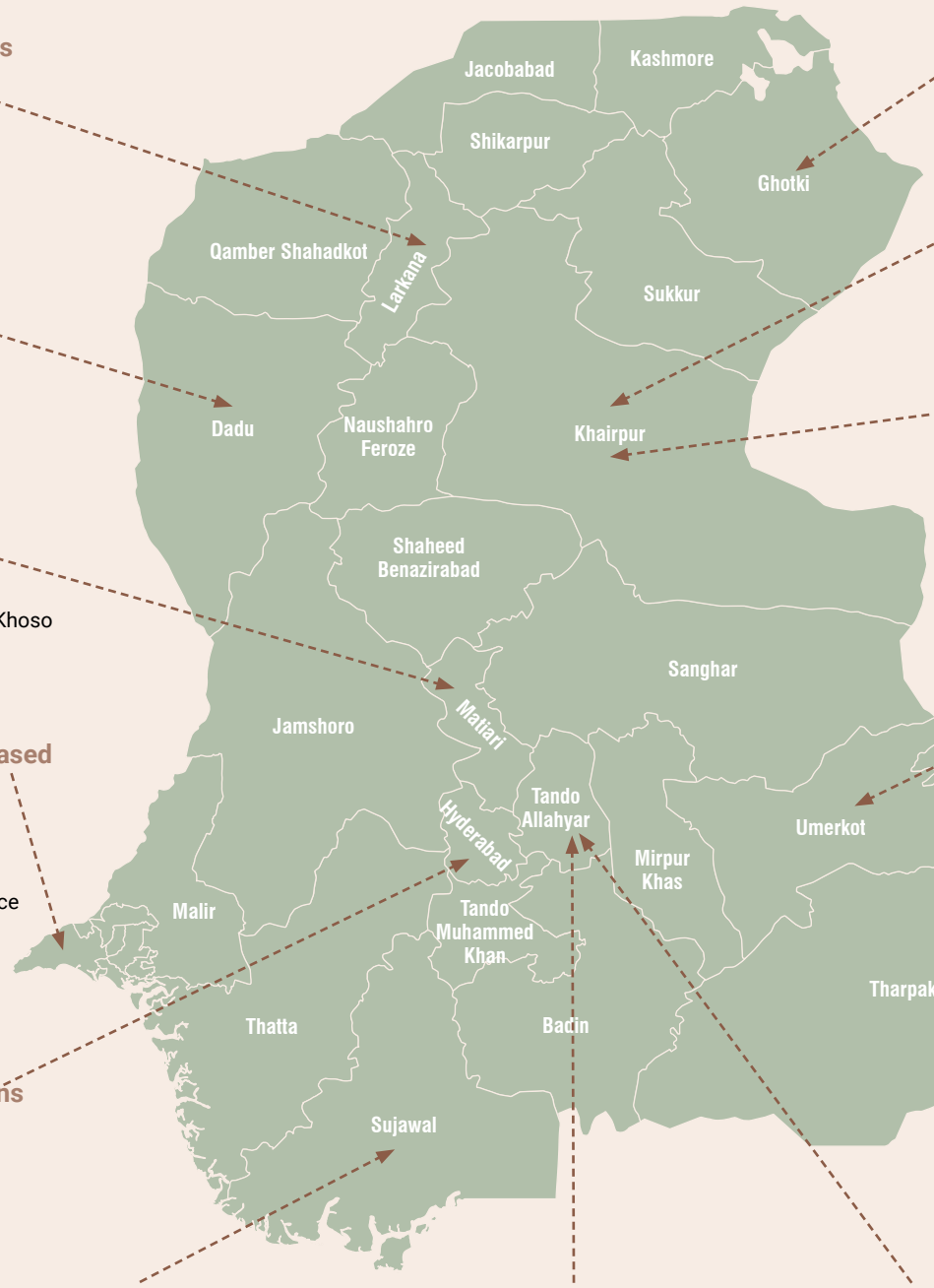
09 Analysis Of Data

FGD and KII information were analysed and 14 out of 18 practice were documented based on a rationale, benefits and challenges, scaling potential and discussion with farmers

10 Final Documentation

Designing of the compendium, necessary approval from the World Bank and Technical Working Group and Launch of the Compendium

Evaluation Location of the Practices



Zero Tillage Practices
District: Larkana
Tehsil: Rato Dero
Village: Kubro

Beneficial Use of Hill Torrents
District: Dadu
Tehsil: Johi
Village: Drigh Bala

Intercropping
District: Matiari
Tehsil: Matiari
Village: Haji Fazal Khan Khoso

Mobile Application Based Remote Water Tank Monitoring
District: Karachi
Tehsil: Shahrah-e- Faisal
Village: National Aerospace Technology Park

Orchard in Ring Basins
District: Hyderabad
Tehsil: Hyderabad
Village: Tando Jam

Bed and Furrow Irrigation for Bananas
District: Sujawal
Tehsil: Sujawal
Village: Belo

Tunnel Farming
District: Tando Allahyar
Tehsil: Tando Allahyar
Village: Piyaro Lund

Vegetables on Raised Beds
District: Tando Allahyar
Tehsil: Jhando Marrir
Village: Piyaro Lund

Laser Land Levelling
District: Ghotki
Tehsil: Khangarah
Village: Jan Muhammad Society

Banana Residue Management
District: Khairpur
Tehsil: Kingri
Village: Pir Jo Goth

Drainage Effluent for Raising Crops
District: Khairpur
Tehsil: Thari Mirwah
Village: Soofai Sahata

Rainfed Agriculture
District: Umar Kot
Tehsil: Umar Kot
Village: Lakhee Bali

Tankaa
District: Tharparkar
Tehsil: Mithi
Village: Khario Nara

Saline Aquaculture
District: Tharparkar
Tehsil: Chachro
Village: Madhjee Dhani

Categorisation of the Practices

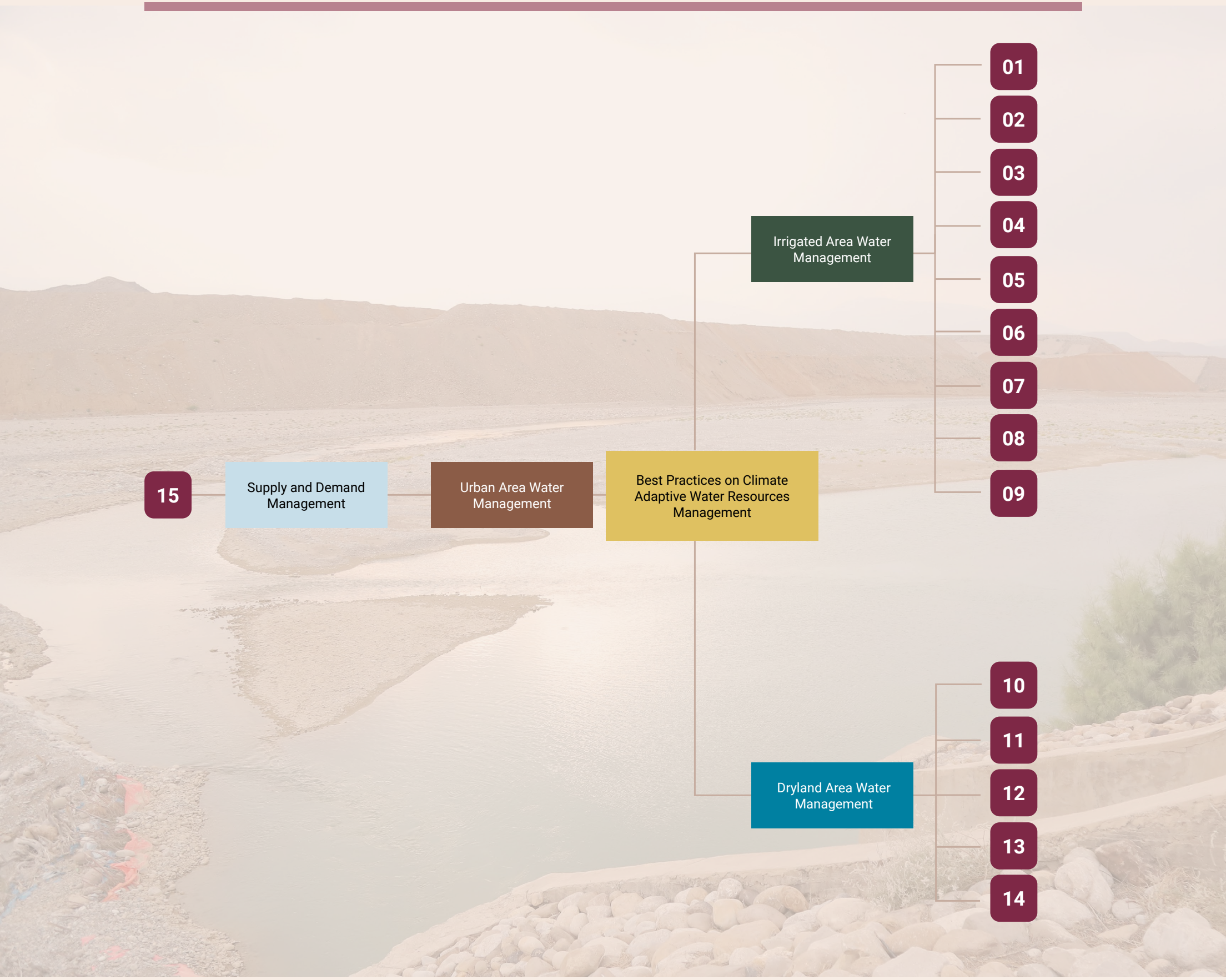


Photo Credit: Tanveer Darwesh

Irrigated Area
Water Management

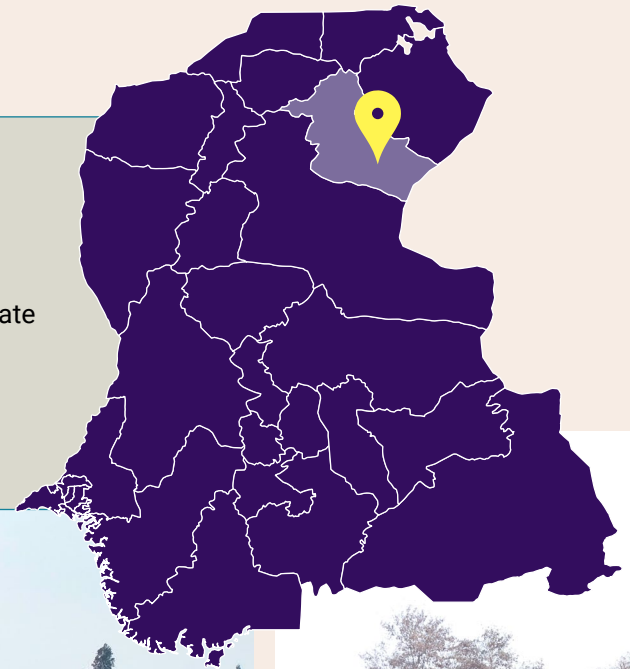
01

Laser Land Levelling

Rationale

Laser leveling promotes water conservation, and increases crop yields through even water distribution. It is a valuable intervention for dryland and irrigation farming including paddy-fields. Laser levelling was introduced in the Punjab province of Pakistan in 1985. The government supported 11,500 farmers in the Sindh province to adopt laser leveling, but the uptake of this technology remains low despite its clear advantages.

District .....**GHOTKI**
Province.....Sindh
Population .....1.772 Million
Climate.....Subtropical Desert Climate
Altitude .....71 m above sea level
Average annual rainfall .....203 mm
Temperature range.....23.4^0 C to 34^0 C

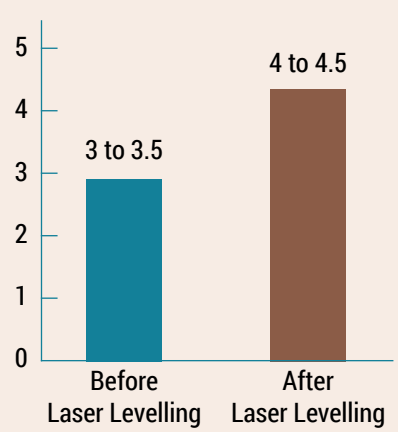


Farmer's Experience

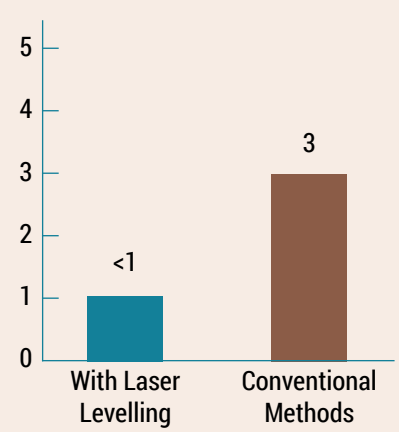
(**Village:** Jan Muhammad Society, **Tehsil:** Khangarah)

Historically farmers used bullock-drawn levelers. Later these were replaced by tractor-mounted blades, which improved crop yields. The technique of laser land levelling was introduced in Sukkur 10 – 12 years ago and demonstrated superior results. Farmers noted 50% water savings and a 20-25% increase in crop yield. Farmers also noted that the fields leveled under conventional levelling system required 5 – 6 hours to irrigate one-acre (0.4 ha) whereas, the laser leveled fields are irrigated within 1.5 hours with the same discharge in the watercourse. Laser levelled lands are used to grow wheat and sugarcane, with vegetables and orchards as additional cultivation.

Wheat Yield Output (tonnes /ha)



Irrigation of One Acre (hours)



Support and Implementation

The Government of Sindh introduced laser land levelling technology to local farmers through demonstration events. Many farmers were impressed and were eager to adopt this innovative technology. Initially, a lack of skilled labor and financial constraints prevented its widespread use. Later, a few progressive farmers in the region, taking advantage of government subsidies, purchased 1-2 laser units and brought in skilled operators from Punjab. Fields levelled using the rented laser levelling services showed significant improvements in crop yields and water efficiency.

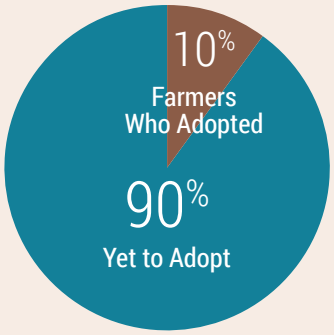
Benefits

- Uniform soil moisture distribution
- Uniform irrigation reducing under irrigation and over-irrigation issues
- Improved irrigation efficiency
- Better crop germination
- Reduced water and nutrient losses

Challenges

- High input cost
- Lack of awareness amongst farmers
- Training of Operators

LASER Land levelling (top). Ridge plantation of sugarcane followed by laser levelling (right).



Adoption Rate of Laser Levelling[2]

Success Story

Laser levelling of land has become popular in surrounding villages and the Jan Muhammad Society as progressive farmers bought the equipment. Five to six laser levellers are available for rent. Technical operators are also available. Although the initial cost is high, the farmers see the benefits including water savings, increased crop yields, reduction in seeds and fertilisers, and saving on labour costs, far outweighs the initial investment.

Scaling Potential

Laser land levelling is an effective technique to increase agricultural production and water use efficiency. Scaling up can be achieved with increased awareness, offering financial support to reduce input costs, and fostering community-based models for shared equipment and training of operators.

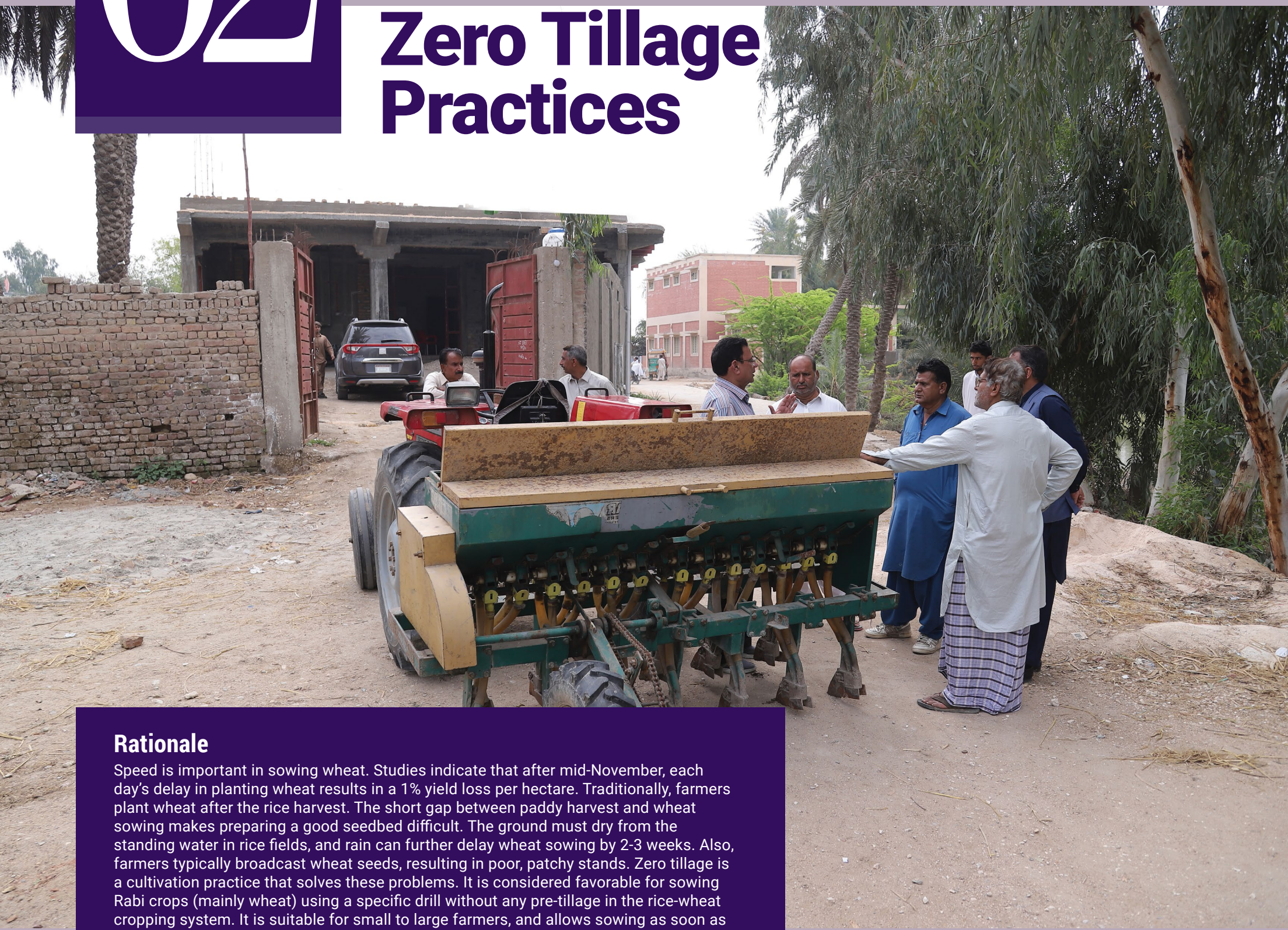
Message for Farmers

The benefits far outweight the high input cost, and technology should ideally be used every 2-3 years.

KNOW MORE

Please scan for more details

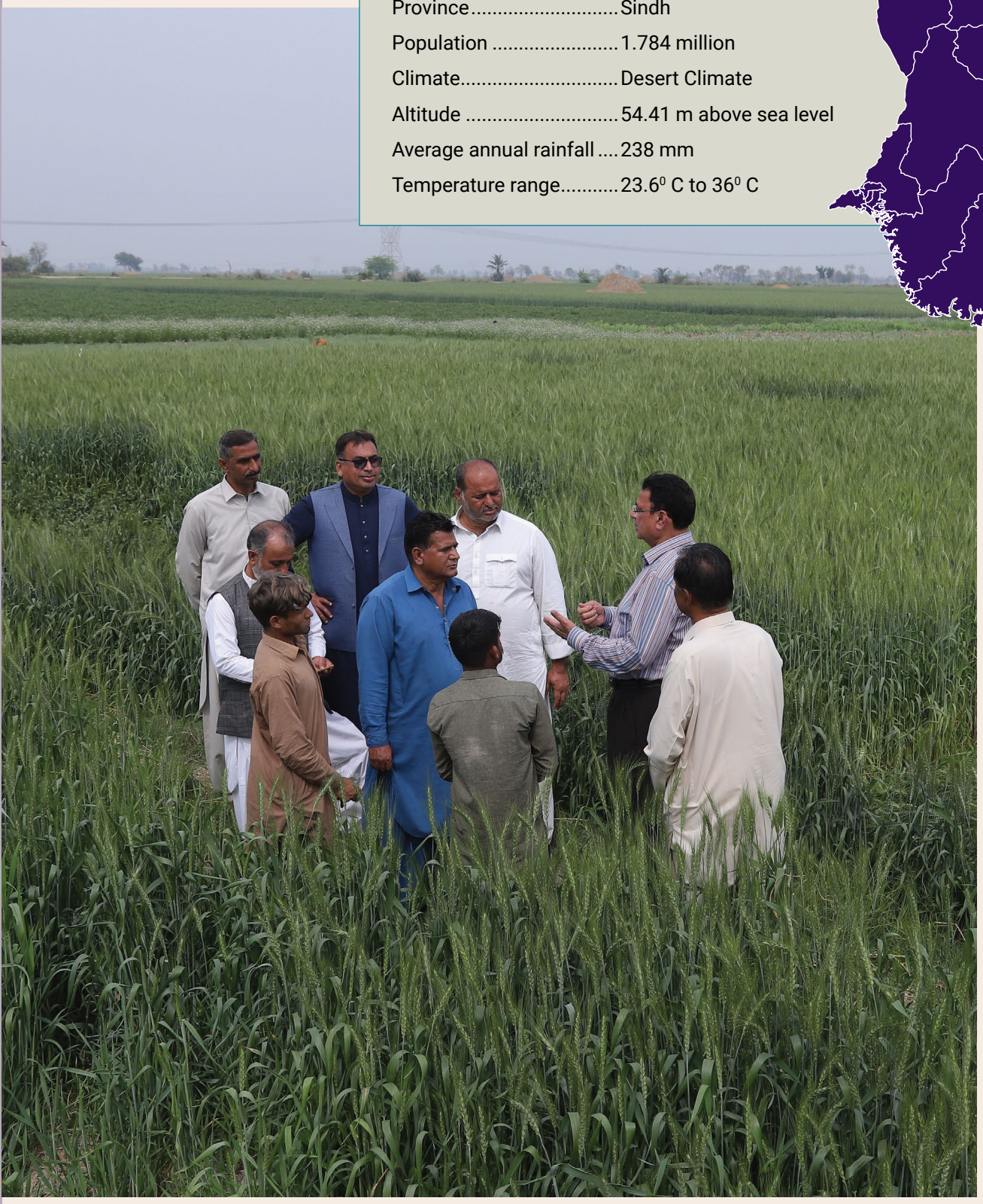
02 Zero Tillage Practices



Rationale

Speed is important in sowing wheat. Studies indicate that after mid-November, each day's delay in planting wheat results in a 1% yield loss per hectare. Traditionally, farmers plant wheat after the rice harvest. The short gap between paddy harvest and wheat sowing makes preparing a good seedbed difficult. The ground must dry from the standing water in rice fields, and rain can further delay wheat sowing by 2-3 weeks. Also, farmers typically broadcast wheat seeds, resulting in poor, patchy stands. Zero tillage is a cultivation practice that solves these problems. It is considered favorable for sowing Rabi crops (mainly wheat) using a specific drill without any pre-tillage in the rice-wheat cropping system. It is suitable for small to large farmers, and allows sowing as soon as the field is sufficiently dry with minimal soil surface disturbance.

District ..... **LARKANA**
Province..... Sindh
Population ..... 1.784 million
Climate..... Desert Climate
Altitude ..... 54.41 m above sea level
Average annual rainfall .... 238 mm
Temperature range..... 23.6^0 C to 36^0 C

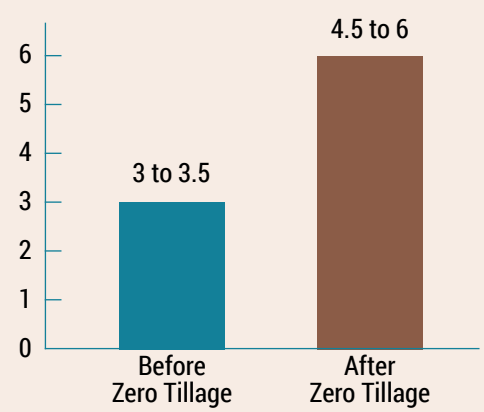


Farmer's Experience

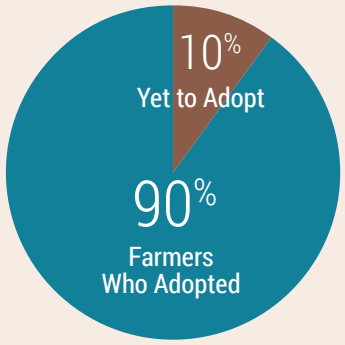
(Village: Kubro, Tehsil: Rato Dero)

The village and the surrounding areas grow rice followed by wheat, with pulses, rapeseed, gram, and vegetables. The village is under the command of the non-perennial Rice Canal, which supplies water only for the rice crop. After tubewells were introduced, rice was followed by wheat. Canal water is used for irrigation in the Kharif season (rice crop), while groundwater is used in the Rabi season. Farmers typically waited about a month after harvesting rice for the soil to dry before ploughing 3-4 times to prepare tilth for wheat sowing. This often resulted in a delay in wheat sowing by about four weeks resulting in a loss of yield. Zero tillage farming changed the farmer's experience in sowing wheat. Zero till sowing reduces fertiliser use and increases yield.

Wheat Yield Output (tonnes/ha)



Adoption Rate



Water Savings
30-40%

Support and Implementation

Zero tillage farming was introduced 5-6 years ago by some farmers in Larkana. After seeing the demonstration and understanding the benefits, the technique was adopted. Zero tillage equipment for wheat sowing was procured, allowing wheat to be sown and fertiliser simultaneously applied two weeks after the rice harvest. This saved 2-3 weeks compared to the previous method. Fertiliser application at sowing increased use efficiency, especially for DAP fertiliser. Two or three drill machines are available on a rental basis in each village. Local mechanical workshops easily handle machine repairs and maintenance. The technology is rapidly growing in popularity and has a high uptake rate by farmers.

Benefits

- Increased wheat yields
- Ploughing cost halved
- Reduced seed and fertilizer costs
- Water savings resulting in reduced tube well operation costs

Challenges

- Financial support for the procurement of machinery
- Awareness of benefits amongst farmers

Success Story

A farmer invited a demonstration of the technique after seeing a successful wheat crop using zero tillage at a relative's village. Observing the high yield and reduced input costs, zero tillage was adopted, resulting in increased grain yield and wheat straw, essential for livestock feed. The crop grows and mature uniformly.

Scaling Potential

Zero tillage farming has immense scaling potential, especially in regions practicing the rice-wheat cropping system. Zero tillage provides an efficient and sustainable alternative that can be adopted by small to large-scale farmers. It is a transformative practice in regions with rice-wheat systems, offering economic, environmental, and agronomic benefits. It suits diverse farming contexts, improves yield, water, and energy efficiency, and reduces cost. It is easy to implement and replicable through farmer networks.

Message for Farmers

Farmers in rice-wheat areas are encouraged to adopt zero tillage. Those with better resources can invest in a zero-tillage drill for personal use or rental.The Government of Sindh could support farmers through subsidies and promoting awareness about zero tillage as steps towards various sustainability targets including climate change mitigation and adaptation.

KNOW MORE

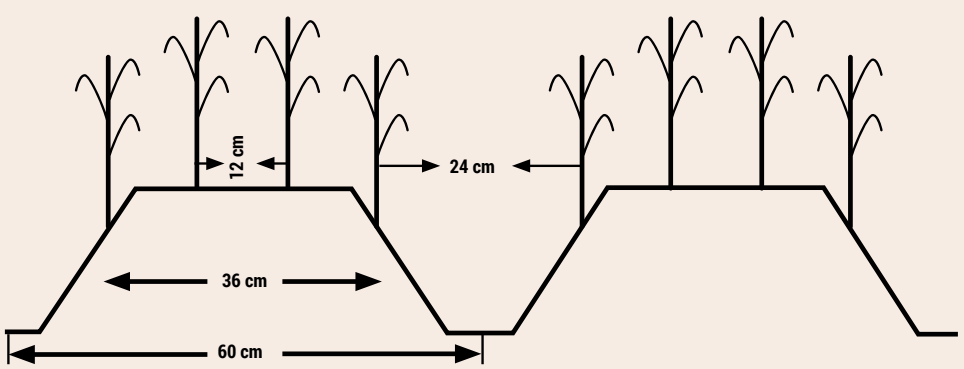
Please scan for more details

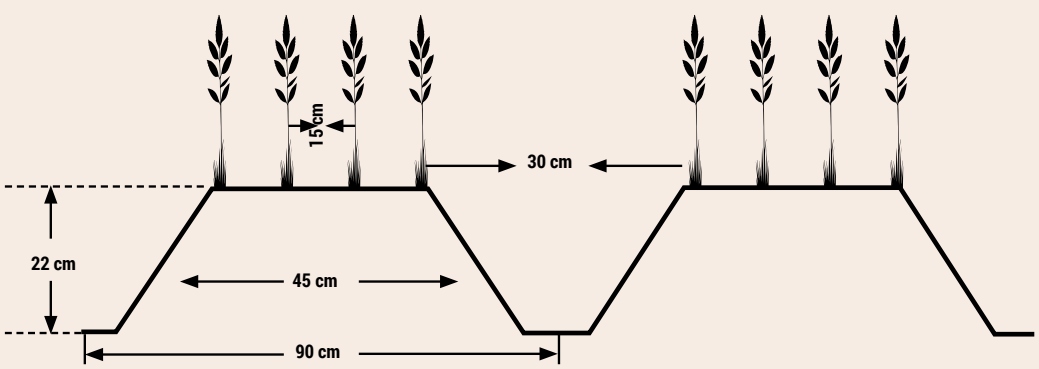
03 Vegetables on Raised Beds

Rationale

Soils that are low in nutrients, poorly drained, or compacted can negatively affect the health and productivity of vegetable gardens. To improve vegetable yields, raised beds provide an effective solution for better soil management, drainage, and accessibility, making them a popular choice among gardeners. Raised beds are constructed above the natural soil surface, typically 20 to 30 cm high. The mounds enhance seed germination, root growth, and nutrient availability, while also helping to manage runoff and erosion. The construction of raised beds is straightforward, often utilizing a tractor-mounted ridge maker to create flat-topped mounds.

District ..... **TANDO ALLAHYAR**
Province..... Sindh
Population ..... 0.922 Million
Climate..... Subtropical Desert Climate
Altitude ..... 22 m above sea level
Average annual rainfall .... 142 mm
Temperature range..... 21^0 C to 32^0 C





Farmer's Experience

(Village: Jalal Thebo, Tehsil: Jhando Mari)

Farmers traditionally used small ridges for vegetables, which resulted in plants overlapping and being vulnerable to pest attacks, impacting the yields. An expert team from the Drainage and Reclamation Institute (DRIP) introduced wider beds for better results. Wider beds for tomatoes resulted in fewer pest attacks and achieved 50% water savings. The water saving outcome is critical given the water scarcity in Tando Allahyar district. Additionally, wide bed planting allowed for better root growth and healthier plants. The trial resulted in a significant increase in productivity. When growing smaller standing vegetable plants, like chilies, farmers use narrow beds and intercrop with sugarcane in the furrows after chili plants are established.

Benefits

- Raised beds provide better drainage which helps avoid root rot and other water-related plant diseases.
- The soil in raised beds warms up faster in spring and stays warmer in the fall, compared to ground-level soil, thus extending the growing season.
- Raised beds help reduce soil erosion.
- Raised beds can be easily covered to protect from frost, and weeds can be removed more efficiently
- Furrows in raised beds not only facilitate irrigation, also make it easier to harvest vegetables without damaging the plants
- Furrows can be utilised for intercropping after establishment of vegetables.

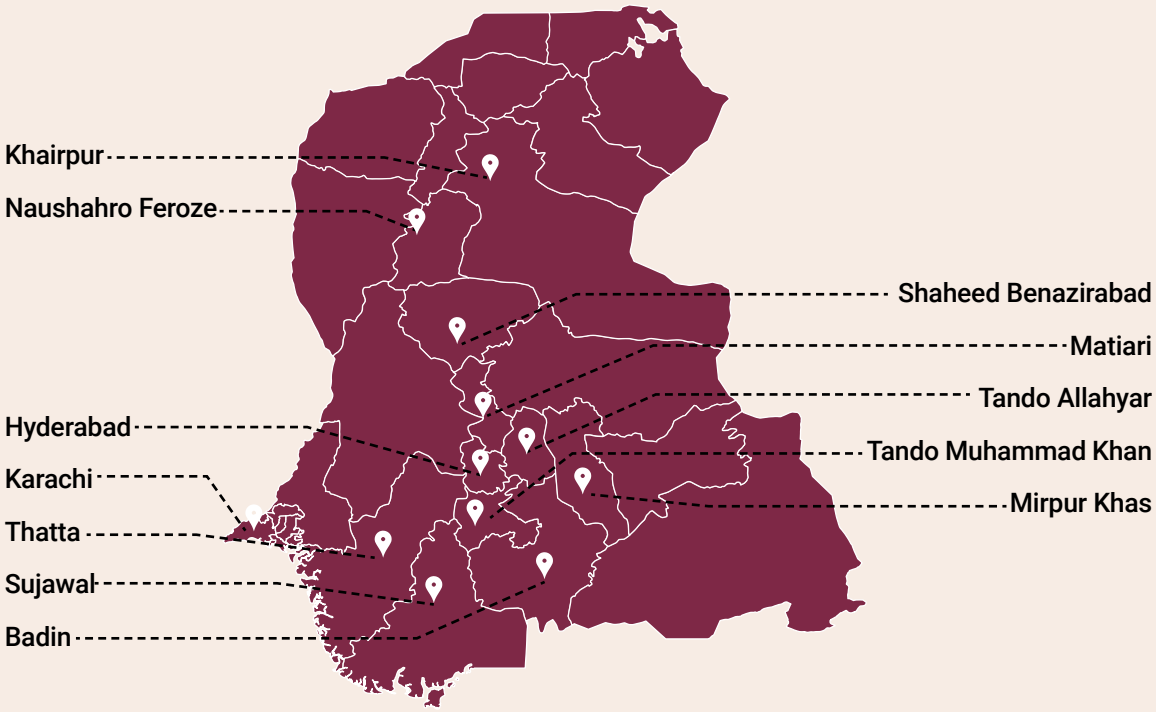
Challenges

- Preparing and maintaining raised beds involves extra cost and time.
- Raised beds dry out faster, necessitating more frequent irrigation compared to ground-level soil.

Scaling Potential

Raised bed farming is suitable for the entire command areas of the left-bank canals of the Guddu and Sukkur Barrages and the whole command of Kotri Barrage. This includes districts such as Sukkur, Khairpur, Naushahro Feroze, Shaheed Benazirabad, Sanghar, Matiari, Hyderabad, Tando Allahyar, Mirpurkhas, Tando Muhammad Khan, Thatta, Badin, Sujawal, and the periphery of Karachi.

Figure: Tomatoes and Chilies grown on narrow beds whereas sugarcane in the furrows



Message for Farmers

Bed plantation is a highly effective method for growing vegetables, saving over 50% water and increasing yields by 50-60%. Farmers are encouraged to adopt this method and visit the farms in Jalal Thebo for demonstrations. It's cost-effective, simple, and leads to healthier plants and higher productivity.

KNOW MORE

Please scan for more details

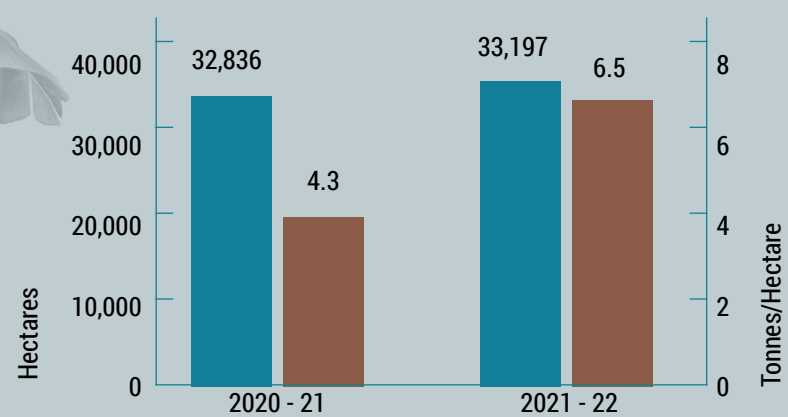
04

Bed and Furrow Irrigation for Bananas

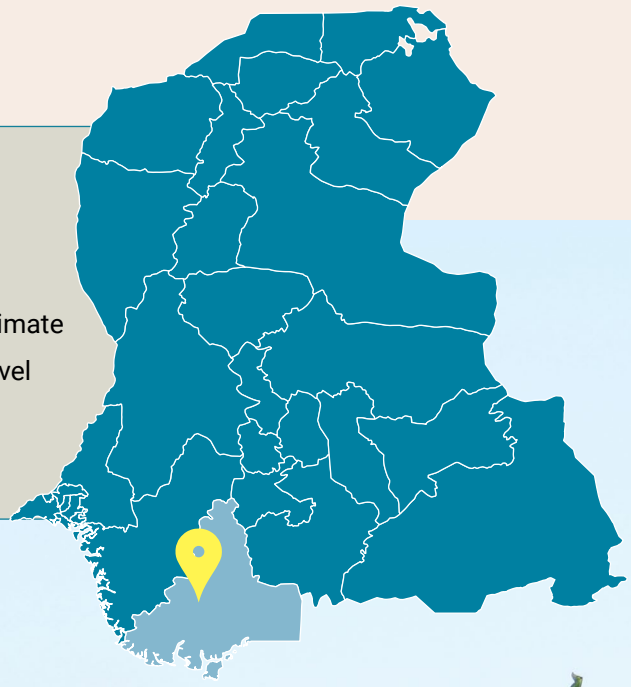
Rationale

Sindh province produces 96 percent of the country's bananas. Flood irrigation of a banana crop, which is the prevalent practice, uses more than twice the amount of water than the crop actually requires. Efficient irrigation, such as drip irrigation, although beneficial, has a higher capital and operational cost than most farmers in Sindh can't afford. Additionally, watering with drip irrigation systems must be done every few days, and this does not suit the *warabandi* canal water supply (a rotational irrigation system), where farmers receive water every 15 to 21 days. Alternative water supply for high-efficiency drip systems, such as from groundwater, is generally not available. Much of the groundwater in the region is saline and unusable.

Bed and furrow irrigation offers several benefits. When crops are grown on raised beds they have better root growth, water infiltration is improved, and water productivity is increased. It is a more affordable system than the efficient drip irrigation technology. Trials by the Pakistan Council of Research in Water Resources in Badin and Sujawal districts have shown promising results. Farmers have now started adopting bed and furrow irrigation in banana cultivation.



District ..... **SUJAWAL**
Province..... Sindh
Population ..... 0.839 Millions
Climate..... Subtropical Desert Climate
Altitude ..... 11.83 m above sea level
Average annual rainfall ..... 218 mm
Temperature range..... 24^0C to 31^0C



Farmer's Experience

(Village: Belo, Tehsil: Sujawal)

The district is recognized as a pioneer in banana cultivation due to its favorable climatic conditions and ranks among the top three banana-producing districts in Sindh. However, crop productivity has been declining, mainly due to the adverse impacts of climate change. The banana crop is particularly sensitive to drought, excessive rainfall, and temperature fluctuations. Significant crop losses were recorded during the floods of 2022, 2015, and 2010.

Farmers initiated bed and furrow irrigation three years ago resulting in about **50% water saving** than conventional method. Plant health also improved when using bed planting. Normally, row-row and plant-plant spacing is maintained @ 1.8 x 1.8 m, however in bed plantation a spacing of 1.5 x 3.0 m is used, which achieves the same plant density of 2,000 – 2,225 per hectare. The initial estimate of yield from bed and furrow irrigation of bananas is higher than the conventional cultivation practice. However, a comparison of the yield needs to be confirmed by another 2 years of production monitoring.

Research Outcome

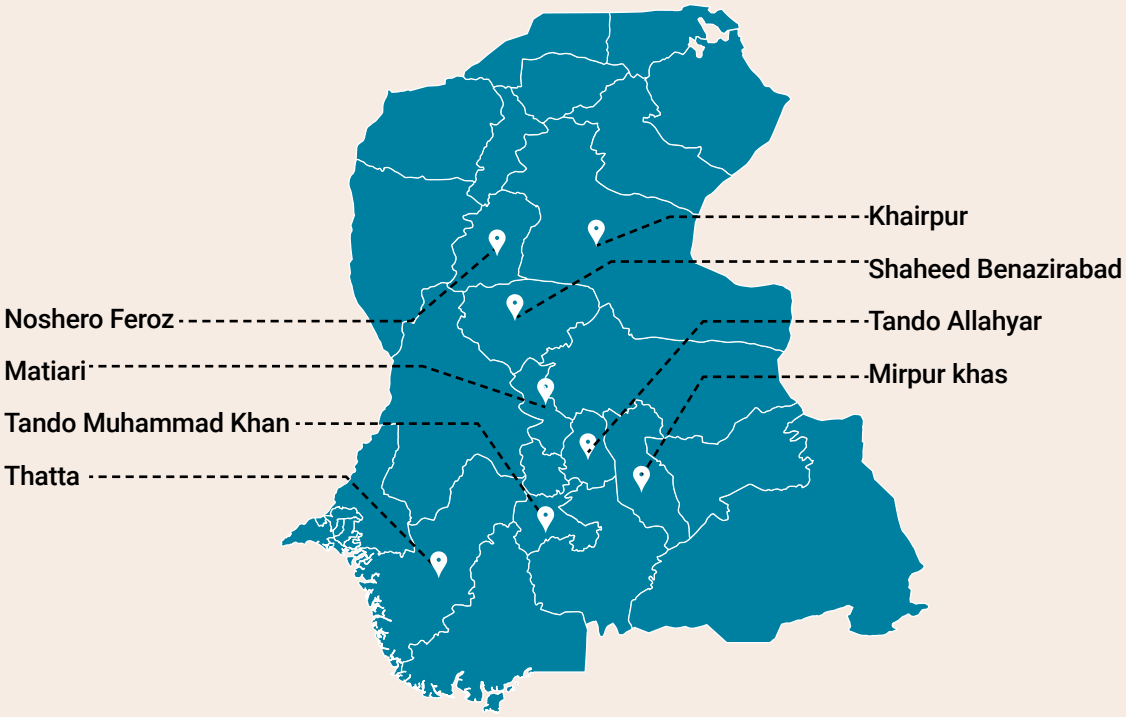
PCRWR Center in Tando Jam assessed bed and furrow irrigation of bananas, measuring crop yield, water use efficiency, production cost, net return, and soil salinity. Using 3.0-meter furrows and 1.5-meter beds, bananas were planted at a 1.5-meter spacing. This method reduces irrigated area by 30%. Findings of the study were encouraging.

Success Story: Combating Climate Change by Progressive Farmer

Farmers initiated bed and furrow irrigation achieving yields of 50 tonnes/ha, with progressive farmers reaching 60-65 tonnes/ha. To combat climate change, mulching (organic mulch, like banana leaves and crop residues) was used as to reduce evaporation, and retain soil moisture. Mulching also allowed an earlier crop sowing seasons (around one month).

Key Observations

- **Water consumption**
  1300-1500 mm in furrow planting vs. 2500-3000 mm in conventional methods.
- **Yield**
  35-40 tonnes/ha in furrows vs. 33-35 tonnes/ha in conventional farming.
- **Soil salinity**
  No adverse impact observed on beds.
- **Adoption**
  Reduces cost and requires little technical expertise.



Benefits

- Improved drainage and water conservation
- Better soil aeration, weed control,and easier harvesting
- Enhanced soil warmth and space efficiency
- Reduced soil erosion improved water use efficiency and optimised irrigation
- Mulch retention and carbon sequestration
- Opportunities for co-cropping with papaya

Challenges

- More research is needed on furrow and bed sizes to optimise yield and water consumption.
- Sucker growth requires some additional control compared to conventional banana cultivation

Scaling Potential

The practice has a scaling potential in the major banana growing districts of Sindh: Khairpur, Noshero Feroz, Shaheed Benazirabad, Matiari, Tando Allah Yar, Mirpur Khas, Tando Muhammad Khan, and Thatta.

Message for Farmers

Bed plantation of crops specially the banana crop is economically viable and easy. A normal ridge preparation machine for banana plantation can be used with slight adjustment of the dimensions. These machines are available in the market. Farmers can visit Belo village and learn the technique from progressive farmers.

KNOW MORE

Please scan for more details

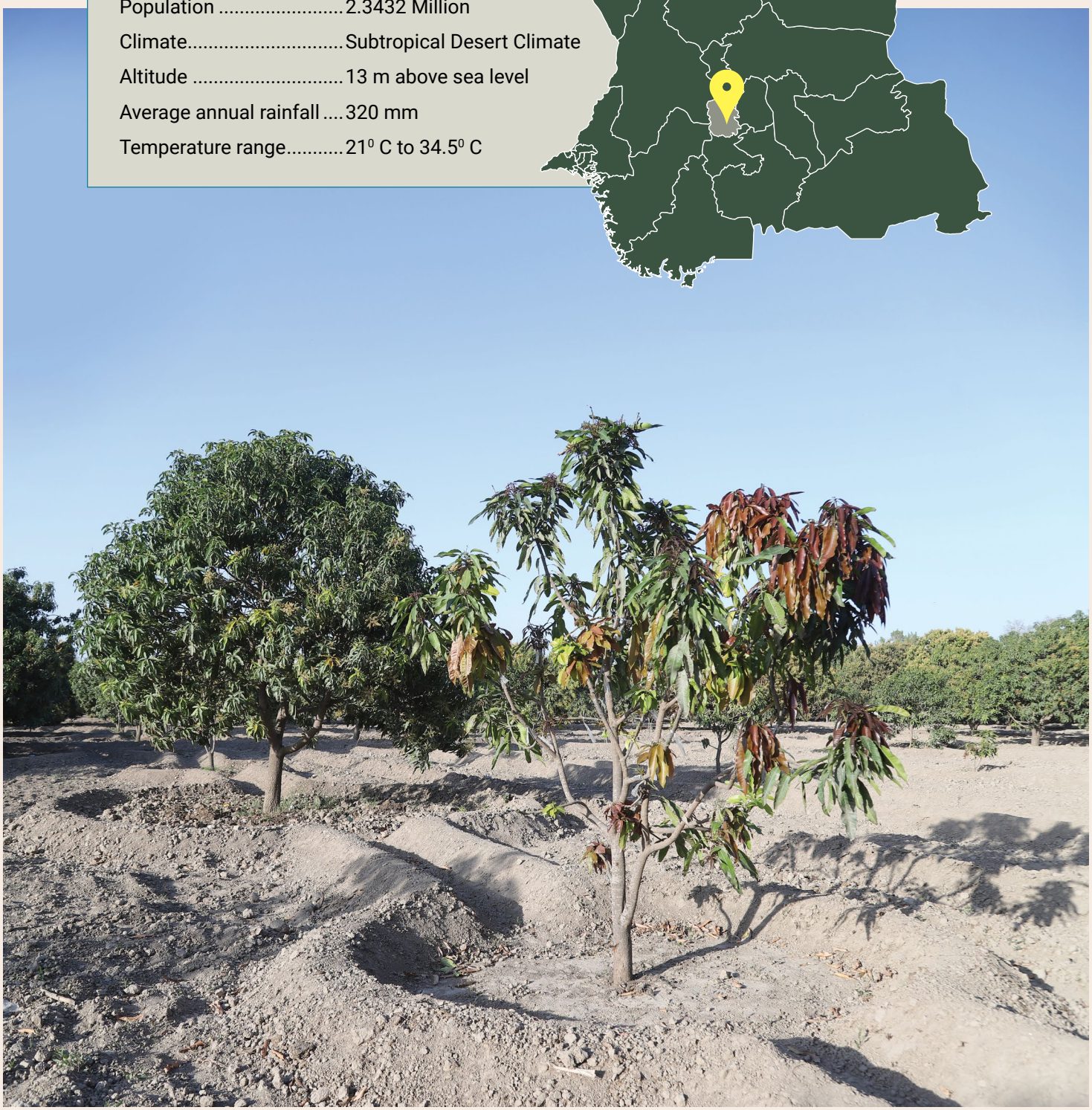
05 Orchard in Ring Basins

Rationale

Each plant species has specific water needs and insufficient irrigation causes crops to wilt. Excessive irrigation results in nutrient runoff and water waste, and lower yields. Optimal irrigation provides the right amount of water, aiding nutrient absorption and boosting food production while reducing water use, nutrient leaching and erosion.

Various irrigation methods are used worldwide to achieve optimum soil water conditions. The selection of an irrigation method is guided by factors such as water availability, financial capacity, and expected crop returns. In Pakistan, free flooding is a common, yet inefficient practice, particularly for orchards. A more efficient approach is basin irrigation. This method concentrates water and fertilizers at the root zone, and promotes better plant growth and higher yields.

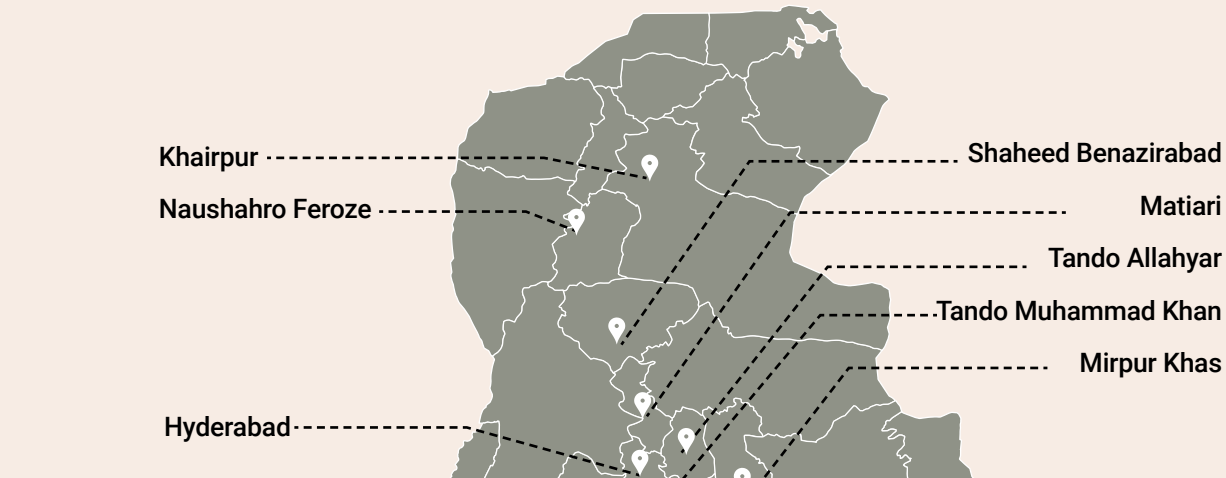
District ..... **HYDERABAD**
Province..... Sindh
Population ..... 2.3432 Million
Climate..... Subtropical Desert Climate
Altitude ..... 13 m above sea level
Average annual rainfall .... 320 mm
Temperature range..... 21^0 C to 34.5^0 C



Research Experience

(Research Station: Drainage and Reclamation Institute of Pakistan (DRIP), PCRWR, Tando Jam, Hyderabad)

Mango is the second-largest fruit crop in Pakistan, predominantly grown in Sindh and Punjab. Traditional flooding methods waste over 60% of applied water, exacerbating waterlogging and salinity issues. Sindh faces water shortages, waterlogging, and salinity due to its geography and irrigation practices. Over-irrigation and canal seepage raise groundwater levels, causing waterlogging and salinity. DRIP introduced the ring basin irrigation system for orchards at their research station, wherein the size of the basin was maintained according to the canopy of the plant. These basins start with a 0.5-meter radius at transplantation, expanding to 1.0 meter in the second year and growing larger as the plant matures. The method has shown enhanced efficiencies in water and nutrient used resulting in increased production.



Scaling Potential

Ring basin irrigation is suitable for all orchard plants, including date palm, guava, zizyphus, mango, and chikoo. This practice has the potential to be scaled up in districts like Larkana, Sukkur, Khairpur, Naushahro Feroze, Shaheed Benazirabad, Sanghar, Matiari, Hyderabad, Tando Allahyar, Mirpurkhas, Tando Muhammad Khan, Thatta, Badin, Sujawal, and Karachi's periphery.

Ring basin irrigation is suitable for all orchard plants, including date palm, guava, zizyphus, mango, and chikoo

Benefits

- DRIP's ring basin system applies water directly to the plant's root zone, improving water and nutrient efficiency and increases production
- The ring basin system saves 50% water compared to conventional flood irrigation.
- Free space around the rings can be used for vegetable cultivation
- The lower water use reduces fuel consumption for lift irrigation. Lift irrigation is required where the agricultural field is higher than the canal water supply level.

Challenges

- Preparing ring basins manually requires more labour
- Farmyard manure can float initially, requiring care to prevent it from washing into lower basins

Message for Farmers

DRIP organizes field days to demonstrate water conservation practices, inviting farmers to learn this technique. The research findings are published in local language magazines to raise awareness. DRIP also organize internship programs which benefit around 200 students annually. The students help to spread knowledge to their communities. Farmers are welcome to visit, discuss, and learn water management practices. DRIPs mission is: *"More Crop Per Drop"*.

KNOW MORE

Please scan for more details

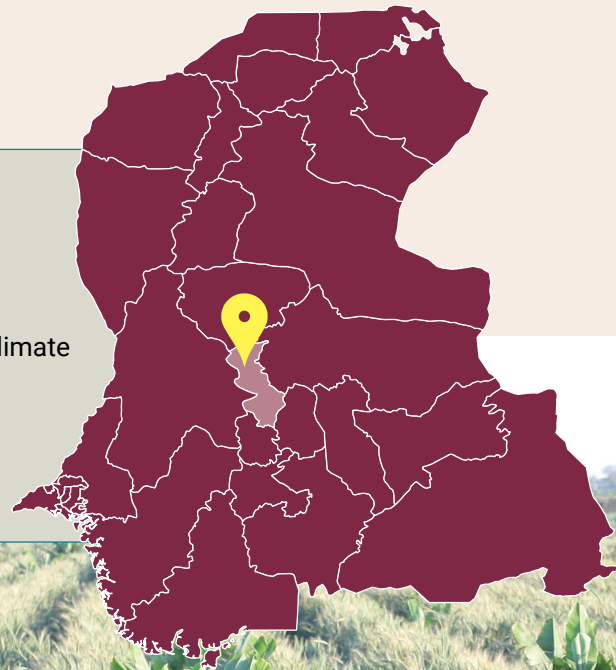
06 Intercropping

Intercropping of wheat with Sugarcane

Rationale

In Pakistan, water scarcity and climate change pose significant challenges, including in Sindh province, known for its agricultural productivity. Intercropping offers a viable solution to increase yields, enhance food security, and promote sustainable agricultural development. Intercropping, the practice of growing two or more crops simultaneously on the same field, enhances resource efficiency, including land, water, fertilisers, and pesticides.

District .....**MATIARI**
Province.....Sindh
Population .....0.849 Million
Climate.....Subtropical Desert Climate
Altitude .....25 m above sea level
Average annual rainfall ....232 mm
Temperature range.....23.5^0 C to 35^0 C



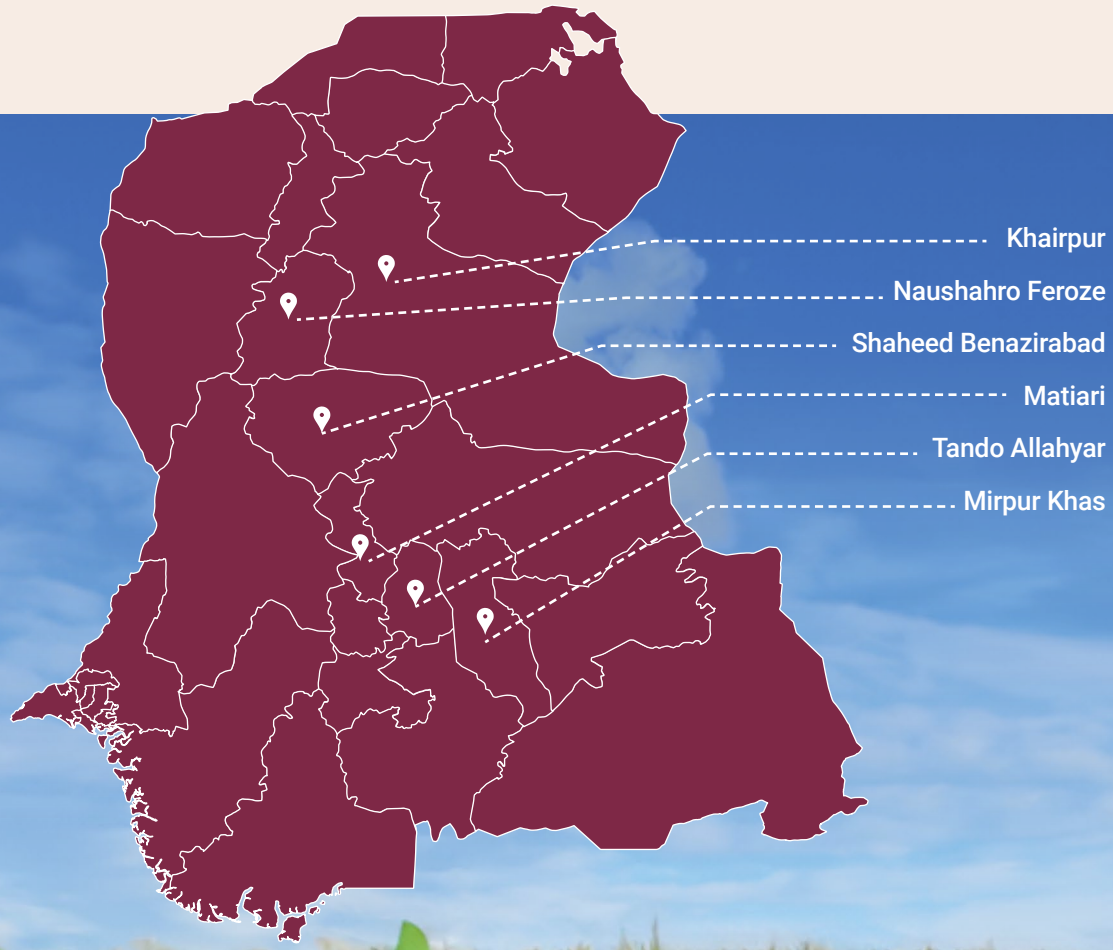
Intercropping of wheat with Banana

Farmer's Experience

(Village: Haji Fazal Khan Khoso, Tehsil: Matiari)

Farmers planning to cultivate sugarcane prepare the land 2-3 months in advance and plant onions on ridges in early July as soon as the land has been prepared. Sugarcane cuttings are planted in furrows about 2 weeks after the onions, sharing the same water and nutrients. After harvesting onions, farmers may plant wheat or mustard on the flattened ridges, which grow with sugarcane using the same resources.

Other farmers transplant banana plants into the furrows and manually sow wheat on beds, achieving high wheat yields using the same water and inputs applied to bananas.



Scaling Potential

Intercropping is a sustainable way to boost productivity and resilience in Pakistan's agricultural sector. Implementation is practical in all regions that face water scarcity, particularly in command areas of the left-bank canals of Guddu and Sukkur Barrages.

Benefits

- Ridge bed planting conserves water compared to flood irrigation.
- The yields of individual crops are maintained. Onion and wheat yields are nearly identical to when those crops are grown alone. Sugarcane yield may reduce, but only by 5-10%.
- Water and nutrient efficiency more than double compared to conventional farming.
- Intercropping reduces costs for fertilisers, land preparation, and labour.

Challenges

- There is a lack of awareness among the farmers of the benefits of intercropping in most of districts in Sindh
- Intercropping needs proper planning and commitment as farmers must follow a calendar for sowing, irrigation and fertigation, as delay in one activity will affect all the crops.

Water and nutrient efficiency have more doubled with Intercropping

Conserves more water compared to flood irrigation

Intercropping reduces costs for fertilisers, land preparation, and labor

Message for Farmers

In light of water scarcity and changing climate conditions, adopting intercropping practices can significantly benefit your farms. Although intercropping requires careful planning and timing, the rewards make it worthwhile, as it promotes a more sustainable and profitable future for your agricultural practices.

KNOW MORE

Please scan for more details

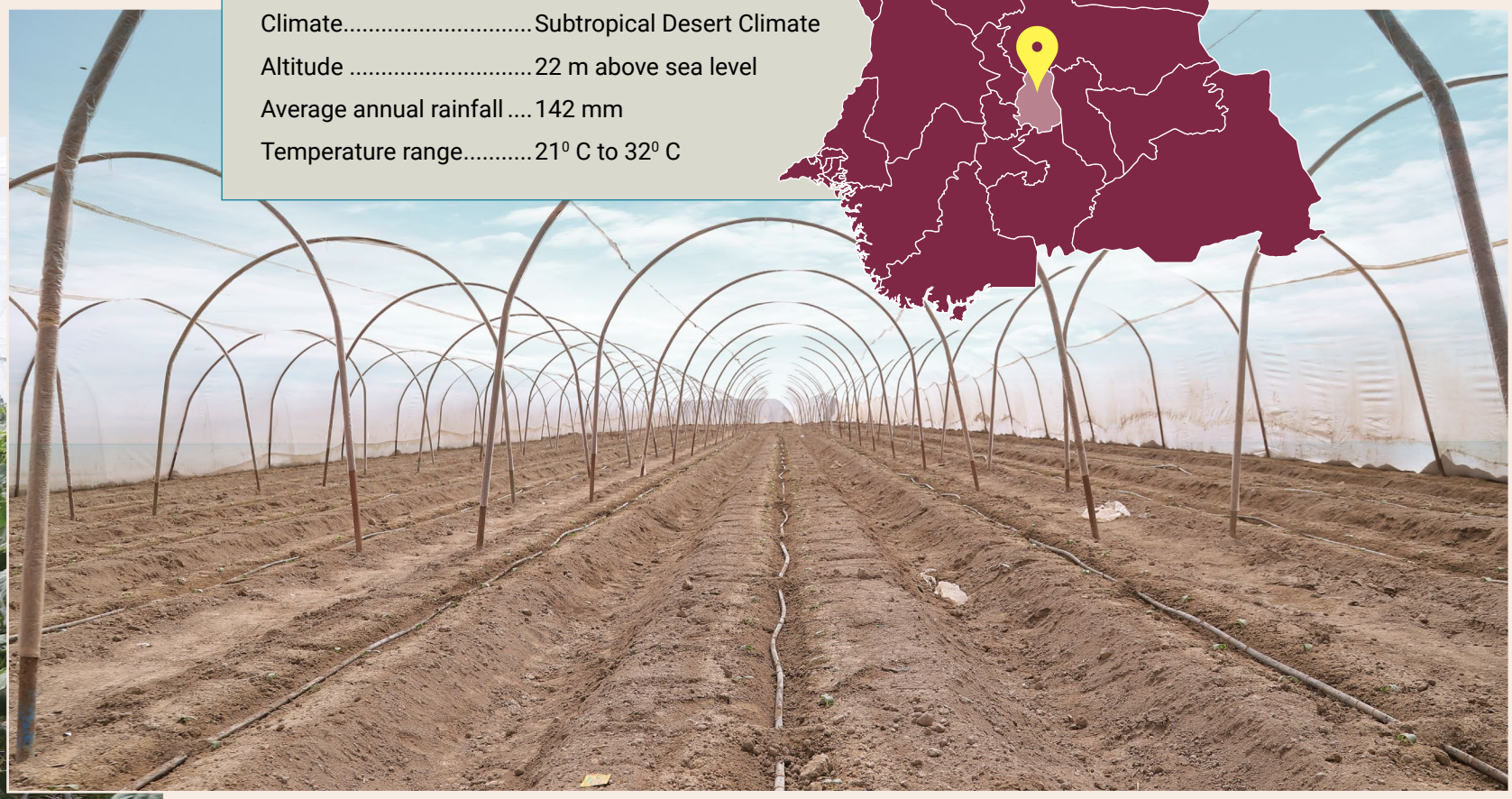
07

Tunnel Farming

Rationale

Tunnel farming is a highly water-efficient practice where crops are grown under covers, protecting them from rain, hail, wind, frost, and pests. It enables off-season cultivation of vegetables, ensuring maximum crop yield, better land fertility maintenance, controlled temperature and humidity, protection from animals and insects, and significant water conservation. Use of drip irrigation makes it a unique water saving technology for agriculture.

District ..... **TANDO ALLAHYAR**
Province..... Sindh
Population ..... 0.922 Million
Climate..... Subtropical Desert Climate
Altitude ..... 22 m above sea level
Average annual rainfall .... 142 mm
Temperature range..... 21^0 C to 32^0 C



Farmer's Experience

(Village: Piyaro Lund Road, Tehsil: Tando Allahyar)

Farmers shared that this practice, although requiring full-time commitment, yields good profits. It includes drip irrigation, which **saves up to 75% water compared to conventional methods.** Fertilisers mixed with water and applied through the drip system have shown excellent results, providing returns five times higher than conventional farming. Tunnel farming also generates significant employment, especially for women, who handle tasks like inter-culturing, picking, and processing crops like cucumber, ladies' finger, bitter gourd, ridged gourd, and tomato. Initially practiced on 2-3 hectares, it has now expanded to almost 80 hectares. The farm generated job opportunities for 500 field workers (male/female).

Conserves more water
compared to flood irrigation

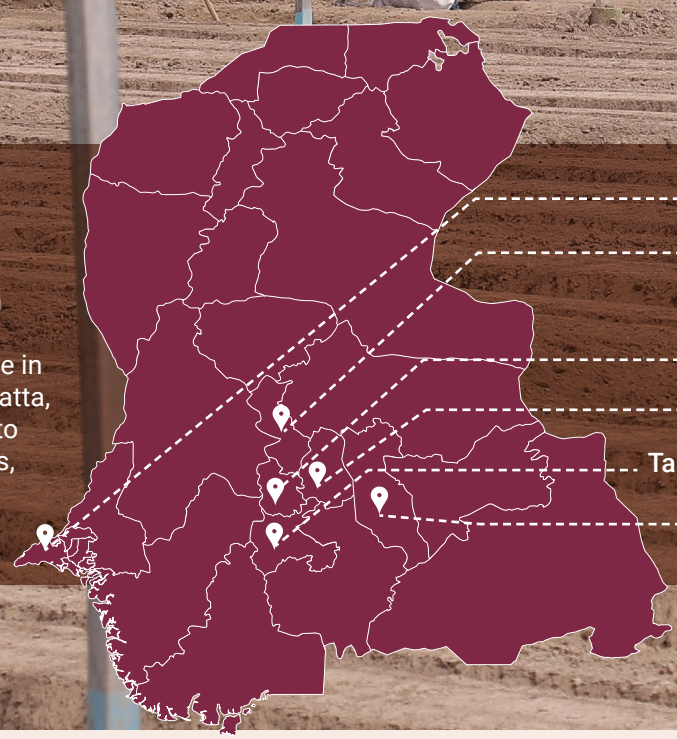
Support and Implementation

Tunnels vary in structure and height (low, medium, and high). Low to medium tunnels are dismantled after each crop, while high tunnels are permanent, allowing tractors to cultivate the land.

Steel pipes and a special plastic net are essential, with the net being the costlier component (PKR 1.70 – 2.0 million per hectare) and lasts 6-7 years. Steel pipes are long-lasting with anti-rust maintenance. Tunnel farming recovers capital costs within two years, after which farmers profit from only running and input costs.

Scaling Potential

The practice is suitable for cucumber farming and can be scaled up in southern districts though not feasible in coastal districts (Badin, Thatta, Sujawal, and Karachi) due to high wind velocity, cyclones, and saline dust particles.



Benefits

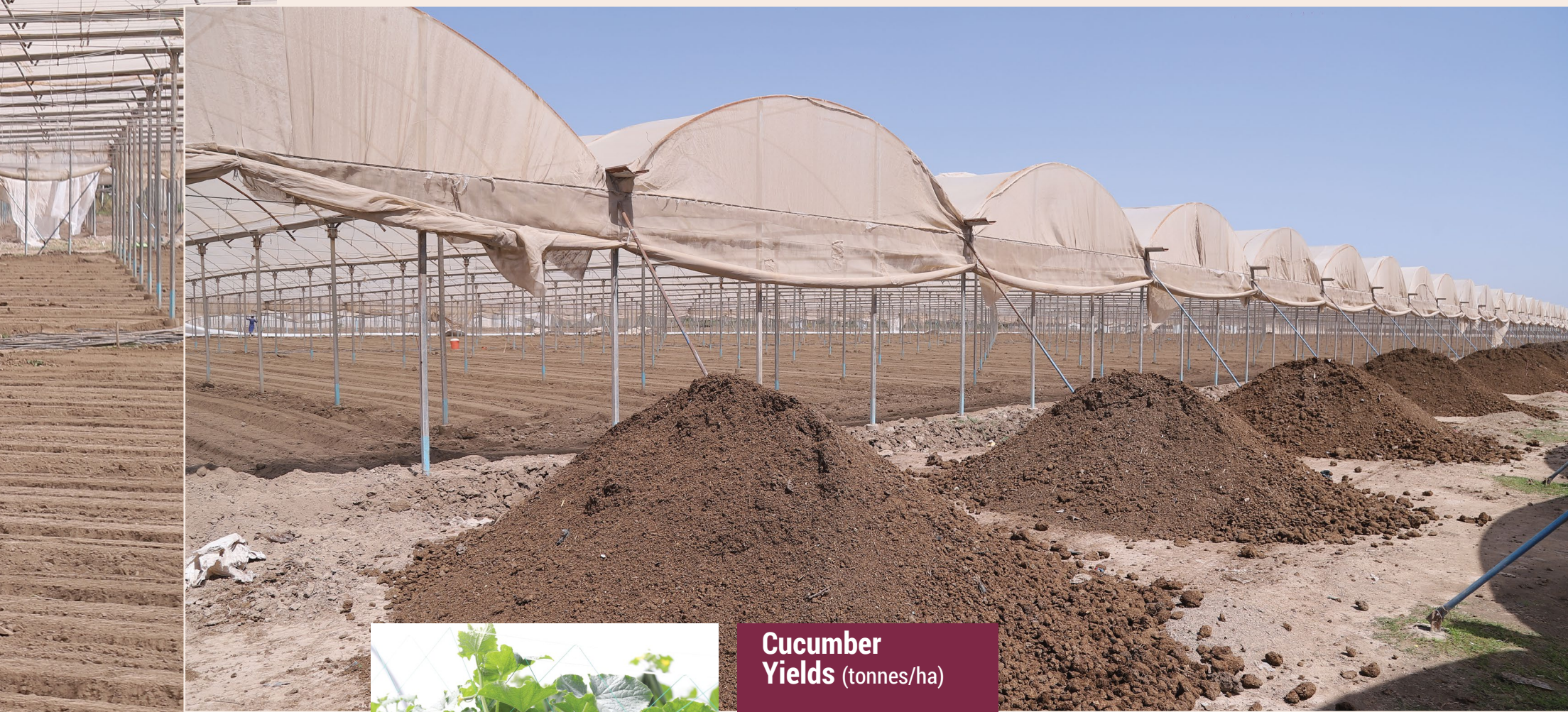
- Extended growing season
- Tunnels contribute to water conservation by minimising the amount of water required for crop irrigation.
- Protection from pests and diseases
- Better quality produce

Challenges

- High initial investment (PKR 12 million/ha for high tunnels, PKR 5 million/ha for walk-in tunnels).
- Requires full-time commitment.
- Lack of locally trained technical and managerial workforce.

Recommendation

Government of Sindh should promote the construction of on-farm reservoirs to store surplus water, enabling efficient use through drip irrigation systems.



Cucumber Yields (tonnes/ha)

Conventional Method
(One crop/year)
2.5-3

Tunnel Farming
(Two-Three crops/year)
20-25

KNOW MORE

Please scan for more details

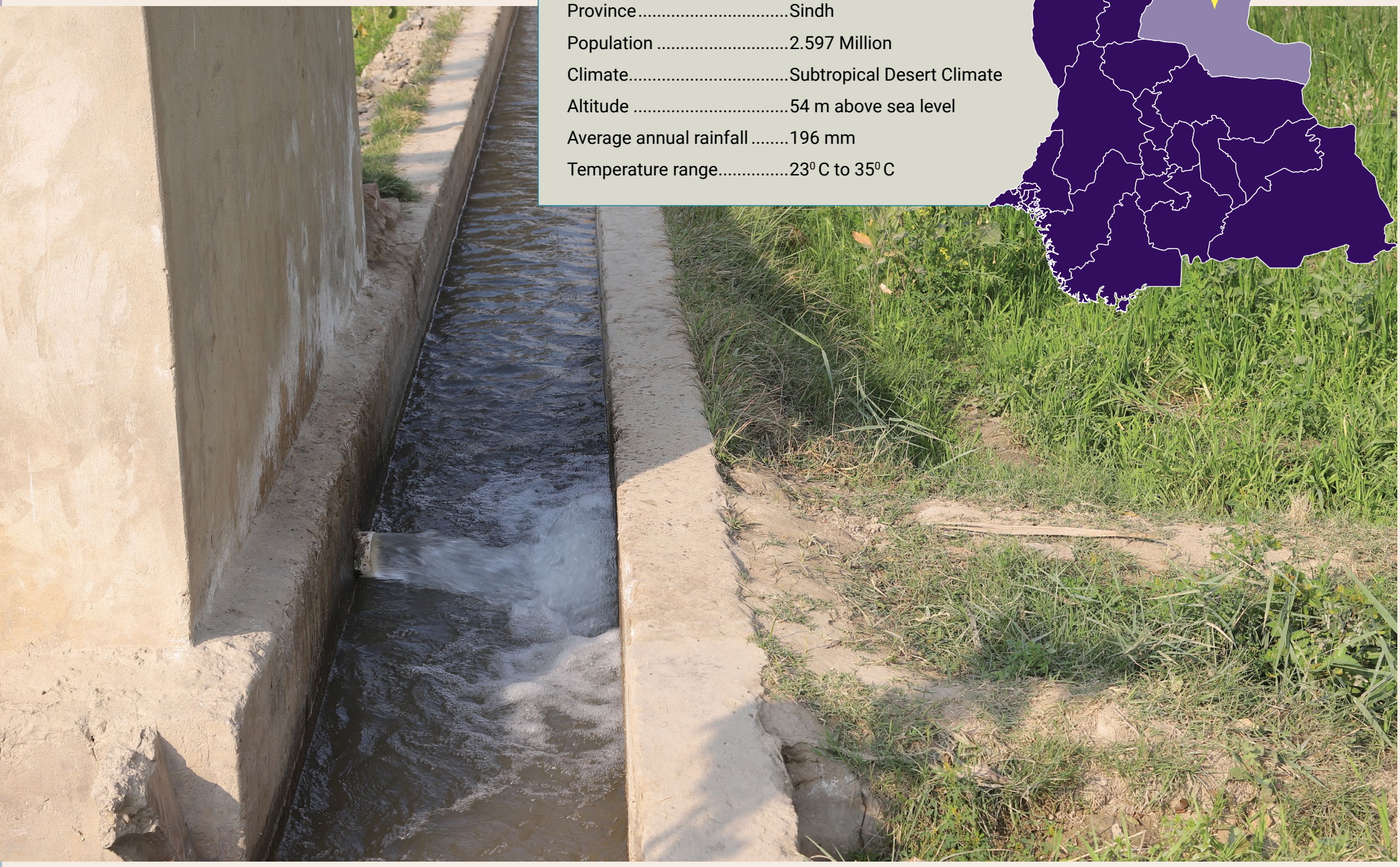
08 Drainage Effluent for Raising Crops

Rationale

The irrigation system in Sindh province, is supplied from the three major barrages in the Indus River basin —Gudu, Sukkur, and Kotri— through fourteen main canals. It irrigates around 5 million hectares of land but the system faces significant challenges due to socio-economic pressures, rapid population growth, land distribution, uneven water distribution, and drainage management. These factors have resulted in excessive water usage, leading to widespread salinity and waterlogging in nearly one-third of the canal-irrigated areas.

This technology highlights the use of drainage effluent and shallow groundwater in SCARP tube well areas during surface water shortages, either in conjunction with or instead of surface water, to sustain crops and support long-term agricultural resilience, enhance water efficiency, and mitigate the negative impacts of waterlogging and salinity.

District .....**KHAIRPUR**
Province.....Sindh
Population .....2.597 Million
Climate.....Subtropical Desert Climate
Altitude .....54 m above sea level
Average annual rainfall .....196 mm
Temperature range.....23^0 C to 35^0 C



Salinity Control and Reclamation Project (SCARPs)

In the mid-70s, the Federal Government of Pakistan, through the Water and Power Development Authority (WAPDA), initiated SCARPs to control waterlogging and reclaim salt-affected lands in Sindh. These projects focused on installing tube wells, constructing surface drains, and building pumping stations. Effluent from SCARP tube wells, ranging from fresh to marginal quality groundwater, is conveyed through surface drainage network and disposed of into irrigation canals. Due to poor groundwater quality, private tube wells in waterlogged areas are restricted to balance groundwater discharge and recharge.

Farmer's Experience

(Village: Soofai Sahita, Tehsil: Thari Mirwa)

Farmers located in the irrigated areas face salinity, waterlogging, and seasonal droughtsDuring the months from March to June due to canal water shortages, the canal tail-end farmers near the surface drains use the effluent from SCARP tube wells, either in conjunction with or to replace surface water, to sustain their crops. Farmers prefer canal water for agriculture, but it meets only 40% of crop water requirements. Drainage effluent from the Deparja drain meets 30-40% of the demand, and groundwater (tube wells) is used when neither source is available.

Support and Implementation

Water Management

Deparja Drain, passing through village Soofai Sahita, originates from Ranipur and carries effluent from approximately 70-75 SCARP tube wells, some in saline and others in fresh groundwater zones. The drain also receives wastewater from the Ranipur Sugar Mill and surrounding towns, which contains chemicals and acids that lower soil pH and enhance crop production. The mixed SCARP tube well effluent, considered marginal in quality, is pumped into the Rohri Canal 2-3 km from the village. A shallow layer of fresh groundwater lies over deeper saline groundwater aquifer and is used if neither canal nor drain water is available.

Benefits

- Supplementary water to counter seasonal droughts
- Crop yield is not compromised by using Deparja drainage effluent if it is applied in small quantities (depth) and not allowed to stand in the field for more than 24 hours

Challenges

- Laboratory testing of the water quality of the SCARP tube well and industrial and town drainage effluent is required before replication to avoid soil damage and ensure safe agricultural products.
- Risk of salt crust formation if the irrigation water is not drained out on time (< 24hours).
- It is not practical to pump drainage water to farms far from a canal.

Success Story:

The village falls under the Khairpur East Feeder canal command and is at the tail end of the Ali Bahar Wah distributary. Since the early 2000s, canal water shortages led some farmers to use drainage effluent for irrigation. The technique quickly spread, and now many farmers use it. Those without their own pumping units are assisted by others with such facilities, paying only for fuel costs. Farmers predominantly grow wheat followed by cotton, as well as sugarcane, mustard, sorghum, vegetables, fodder crops, and date palms. Cotton is grown on ridges, while other crops use flood irrigation.

Scaling Potential

The practice has significant scaling potential to leverage SCARP tube well drainage effluent, particularly in addressing water shortages and improving agricultural resilience in waterlogged and salinity-affected areas. The approach can be adopted by farmers facing seasonal droughts, especially those at the tail end of canals. With proper management and community collaboration, the practice can be expanded across similar regions, supporting water efficiency, reducing waterlogging and salinity impacts, and enhancing food security in the face of climate challenges.

Message from Farmers

Drainage effluent can be a valuable resource against drought, but proper water quality analysis and advisory support are essential to safeguard soil quality and ensure sustainable crop production

KNOW MORE

Please scan for more details

09

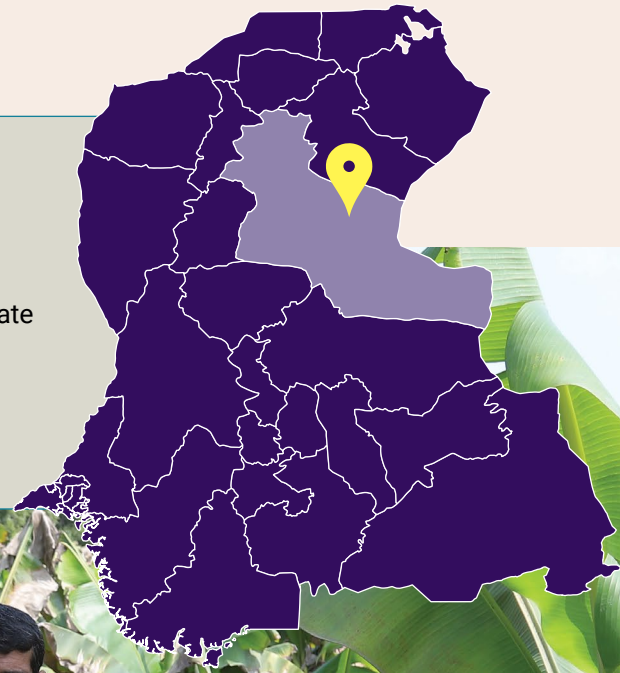
Banana Residue Management

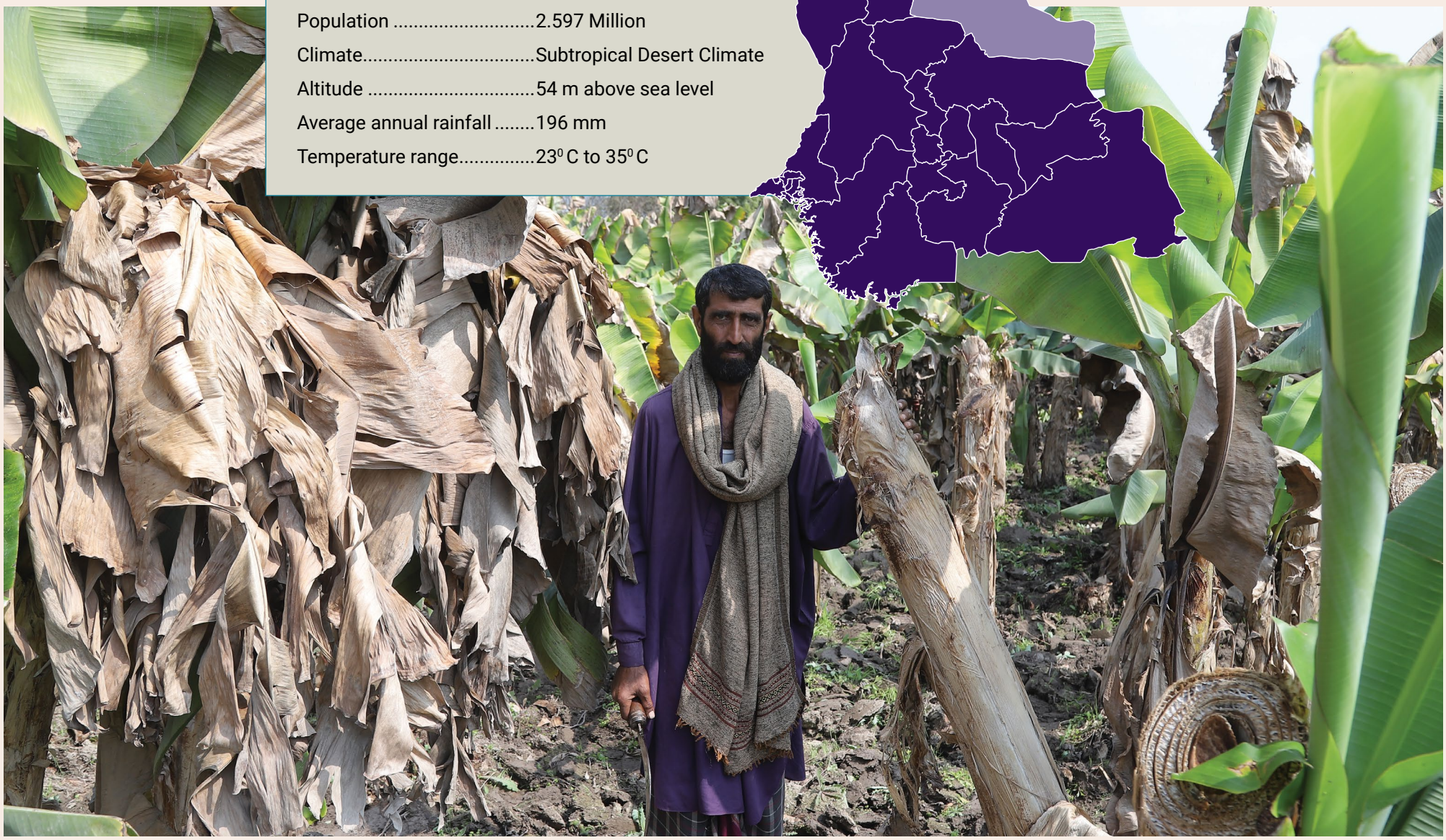
Rationale

In Pakistan, banana cultivation spans over 33,000 hectares, with the Sindh province accounting for 96% of the total production. The average fruit yield in Sindh is around 35-40 tonnes per hectare, generating 70-80 tonnes of residue per hectare, annually. In total, there is approximately 2.31 million tonnes of residue each year, much of which is burned, contributing to environmental and social challenges. However, banana plants are abundant in water and polymers, making them ideal for fibre production,

a practice that dates back to the 13th century. With a growing focus on eco-friendly textiles, banana residue is gaining attention as a sustainable material for fibre production.

District .....**KHAIRPUR**
Province.....Sindh
Population .....2.597 Million
Climate.....Subtropical Desert Climate
Altitude .....54 m above sea level
Average annual rainfall .....196 mm
Temperature range.....23^0 C to 35^0 C





Farmer's Experience

Inspired by online instructional videos, subsequent visits to farmers in Hyderabad, Pakistan, and supported by an NGO, some farmers have started extracting fibre from banana trunks, realising the advantages of banana fibre, such as its durability and biodegradability. They also recognised the potential of using fibre bags as an eco-friendly alternative to plastic bags, which can naturally decompose, offering agriculture and waste management benefits.

Benefits

- Banana fiber can be sold in the local market for coarse textile manufacture (shipping bags)
- Produces bi-products (liquid and solid) that are useful as mulch and biotech-fertilizer, conserving water and reducing the need for inorganic fertilizers
- Provides an easy-to-handle business opportunity, accessible to female farmers working from home
- Utilises land previously used for dumping residues
- Reduces the carbon footprint, thus mitigates climate change
- Enhances livelihood opportunities for local labourers
- Reduces social conflicts over residue disposal

Challenges

- The technique is new, and adoption in the absence of a comprehensive feasibility study, is slow.
- Cost-benefit analysis and marketing of the practice is needed.
- Banana stems must be collected from the fields as many farmers are reluctant to deliver stems to collection points, even when compensated.

Support and Implementation

The NGO, *Goth Sudhar Sangat Sindh*, financed the required machinery. The farmers bought a locally-made fiber extraction machine, purchased banana trunks from neighboring farmers, and employed workers to delaminate the stems. A machine can process residues from 2 hectares of banana cultivation and produce around 250 kg of fiber per month. Fiber is sold in the local market, and local farmers purchase the liquid and solid by-products.

Scaling Potential

The practice holds significant scaling potential with development of a wide range of further end uses including clothing, paper, and building materials[1]. With market development, adoption is possible throughout Sindh, Pakistan. By turning waste into a valuable resource, such as eco-friendly fibres, this practice addresses environmental concerns while opening new economic opportunities for farmers, particularly women. To realise its full potential, further support is needed regarding farmer education, infrastructure, and innovative financing mechanisms like low interest loans and market access to finished products.

Success Story: A Female Farmer's Success in Banana Fibre Extraction

Inspired by neighboring farmers and YouTube videos, a female banana grower began extracting fibre from banana stems. Facilitated by a low interest loan, after one year, she is earning a significant income from her home-based business. Along with selling fibre, she uses the process's liquid and solid byproducts in her fields, leading to noticeable improvements in plant growth and water conservation. Her story highlights the dual benefits of fibre extraction—not only as a source of sustainable income but also as a means to enhance agricultural productivity and resource efficiency.

1 https://textiletuts.com/banana-fiber/

KNOW MORE

Please scan for more details

Photo Credit: Asian Development Bank

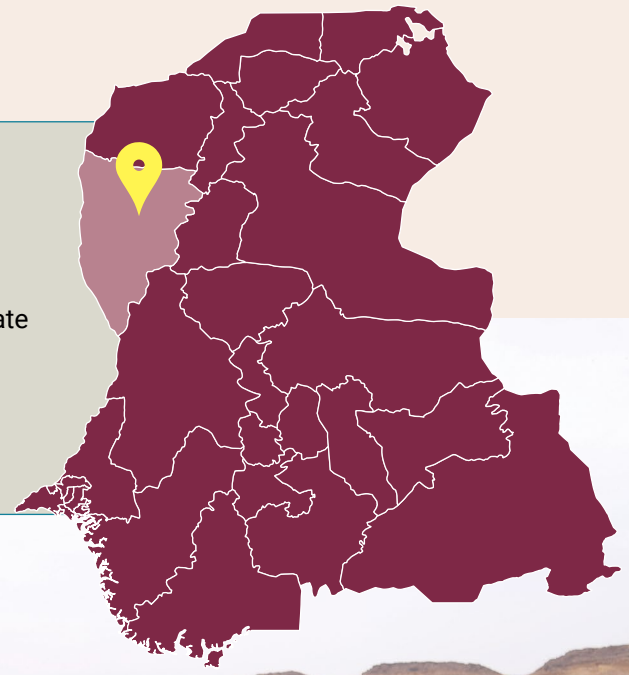
Dryland Area
Water Management

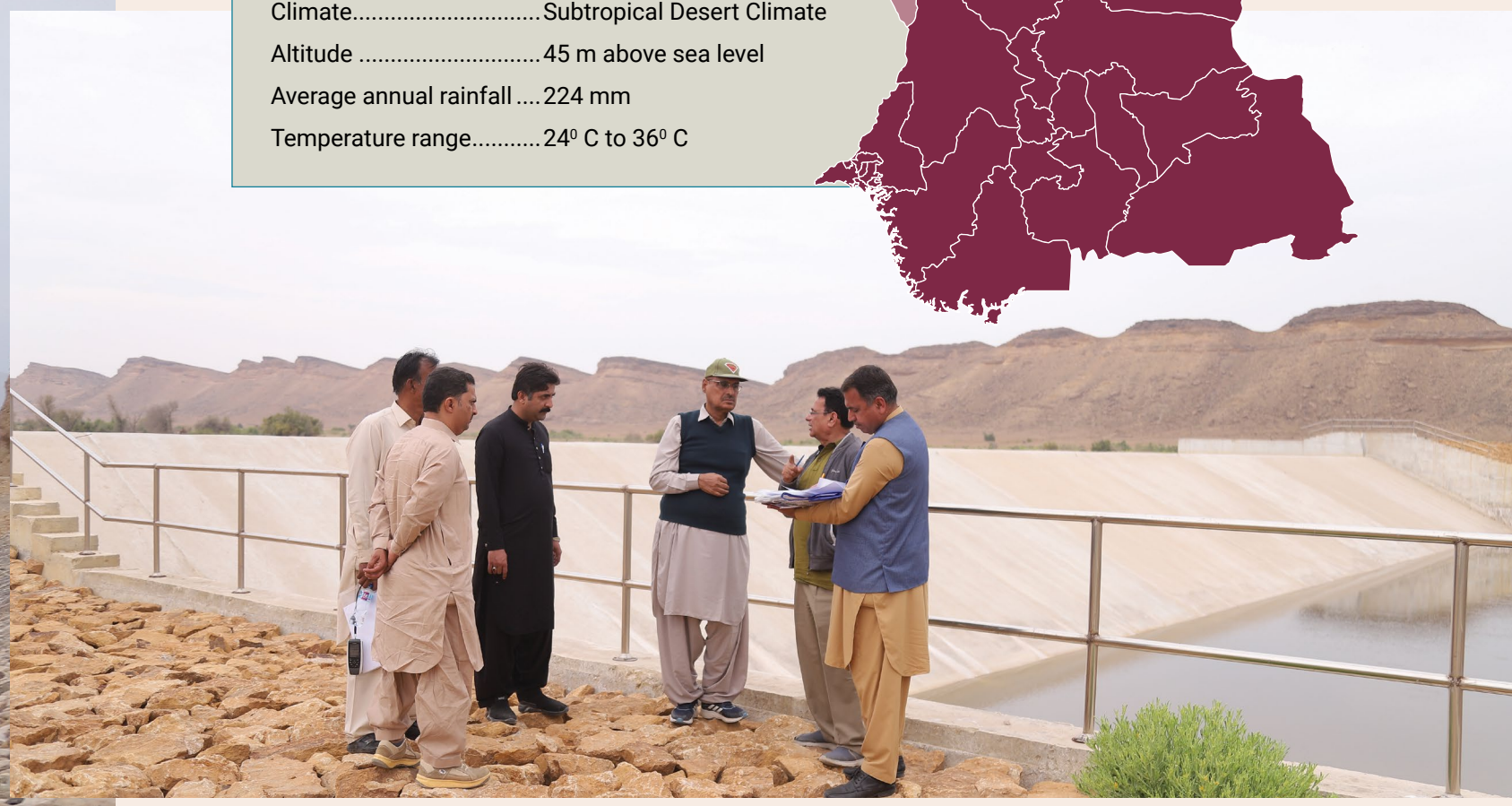
10 Beneficial Use of Hill Torrents (Nai)

Rationale

Hill torrents (called *Nai* in Sindh, *Rodh Kohi* in Punjab, and *Sailaba* in Balochistan) carry flash flood flows from mountains, causing significant damage to human habitation, infrastructure, wetlands, and crops. The arid regions outside the Indus Basin Irrigation System (IBIS) in Sindh are particularly affected by torrents. These areas include Khirthar Range (Jamshoro, Dadu, Shahdad Kot, Malir, and Thatta), Shadi Shaheed Range (Khairpur Mirs), and Karoonjhar Range (Nagarparkar in Tharparkar). Here livelihood depends on rainfall and groundwater, climate change poses a significant threat to water resources and ecosystems, and due to high elevation, canal irrigation is not feasible. Thus, the potential use of these torrents needs special attention and management.

District ..... **DADU**
Province ..... Sindh
Population ..... 1.742 Millions
Climate ..... Subtropical Desert Climate
Altitude ..... 45 m above sea level
Average annual rainfall .... 224 mm
Temperature range ..... 24^0 C to 36^0 C





Farmer's Experience

(Village: Drigh Bala, Tehsil: Johi)

Kachho area (lying between the Khirthar Mountains Range and Flood Protection bund) depends on 13 hill torrents for spate irrigation of around 38,000 hectares. Nai Gaj, the primary torrent, originates from Balochistan and drains into Manchar Lake. The catchment area experiences a significant drop in elevation, causing high-velocity water flow and erosion. An irrigation system with off-shoot inundation channels diverting water from the Nai to fields for agriculture in both the kharif and rabi seasons was established during the British era. The system has no headworks or structures as these would be washed away during flash floods. Nai Gaj is ephemeral, with short intervals of huge torrential flows, mainly in monsoon season, and a very low discharge in the non-monsoon period. The farmers' water rights on the distributaries of Nai Gaj are determined by rotation in the same order as their land holdings.

Government Initiatives

The Government of Sindh constructs small dams on torrent streams to recharge groundwater using various financial packages. Unless carefully sited and designed these small dams can negatively impact hill torrent irrigation systems, such as the Nai Gaj. Low flows in the Nai Gaj, previously used for rabi season irrigation, are now impounded by a dam, affecting the rabi crop. However, if well planned, small dams can be combined with hill torrent irrigation systems to more sustainably divert torrents for irrigation production.

Additional considerations

- Well-designed dams, weirs and diversion off-takes can replace traditional rock-spur diversion banks which are subject to washout
- Temporary storage can be provided off the main channel to give a regulated release extending the potential irrigation time
- Diverting high flows reduces the erosion and damage potential of the torrent
- The torrential flow from hill catchment areas has a high silt load which can fill a dam within 1-2 years
- Silted dams have a reduced water holding capacity and overflow during high discharge
- Recharge from a small dam may be limited because of unfavorable strata and silt deposits, and most of the water impounded evaporates
- Proper design, community training, and support are essential for long-term success. reduces their water holding capacity resulting in overflows during high discharge.

Figure: Field watercourses and crops grown on hill torrent irrigation

Success Story: Sindh Resilience Project funded by the World Bank

The Sindh Irrigation Department and Sindh Disaster Management Authority with the technical and financial support of the World Bank is currently implementing a USD 200 million Sindh Resilience Project to mitigate flood and drought risks in selected areas and strengthen Sindh's capacity to manage natural disasters and public health emergencies. As part of the drought subcomponent 72 small rainwater-fed recharge dams were constructed, less than 10 meters in height, in the Kohistan and Nangarparkar regions (Tharparkar district) to contribute significantly to the provision of water to communities during dry periods, recharging of underground aquifers in adjacent drought prone areas, and protection of communities against seasonal hill torrents and flash floods originating in the Kirthar Range (Dadu, Jamshoro and Malir districts).

The project is expected to add 26,163-acre feet into fresh groundwater aquifers, thereby raising the water table from the current depth of around 200 feet up to 25-50 feet. In addition to recharging of fresh groundwater aquifers, these investments will provide safe drinking water to local communities and livestock as well as irrigate more than 7,000 hectares of arable lands. Further benefits include protection of around 11,000 households having a population of more than 65,000 persons from hill torrents and flash flooding. Around 48% of the beneficiaries were women. A field visit to a groundwater recharge dam in Village Bandha Khan, Tehsil Sehwan, District Jamshoro, highlighted the project's early-stage impacts.

Scaling Potential

Communities dependent on hill torrents are highly vulnerable to climate change since the future will bring more violent torrents that are likely to destroy existing irrigation structures. These regions need projects that leverage local wisdom for sustainable development and regulate torrential flows for beneficial use. The natural irrigation system in Kachho and the small rainwater-fed recharge dams is a scalable model for management of other hill torrent regions in Sindh and beyond.

Recommendation

Hill torrent management requires government intervention to develop distribution systems that dissipate torrent velocity. A well-distributed system can harness the potential of hill torrents, while narrowing tracks can cause disasters. Provincial governments should facilitate inter-region farmer coordination to share best practices. Additionally, adding escape channels beside spillways of small dams would help manage silt and extend dam life.

Figure: Groundwater recharge dam, Sindh Resilience Project

KNOW MORE

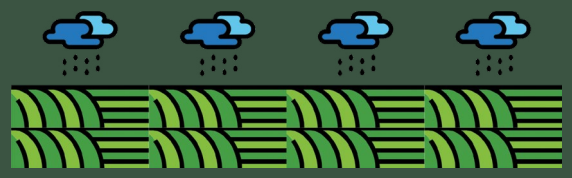
Please scan for more details

11

Dryland Agriculture

Rationale

Dryland agriculture relies on natural rainfall to satisfy the evapotranspiration needs of crops and plays a crucial role in the socio-economic systems of many impoverished communities in Pakistan. Locally referred to as 'Barshat,' 'Khushkhaba,' and 'Barani' in Sindh, Balochistan, and Punjab, respectively, this form of agriculture faces several interconnected challenges. Climate change exacerbates issues such as soil degradation, desertification, and a decline in vegetation quality, all of which lead to lower crop yields and diminished economic returns in dryland agriculture. Although dryland agriculture is practiced on one-fourth of Pakistan's cultivated area, there is a lack of proper farm management and extension services. Implementing science-based interventions, such as rainwater harvesting, soil conservation, and raising community awareness of climate change adaptation strategies, can help sustainably increase production in dryland agriculture.



Farmer's Experience

(Village: Lakhee Bali, Tehsil: Umar Kot)

The village is located in Thar desert where the key livelihood of the farmers is dryland agriculture and livestock rearing. The cultivation of crops like pearl millet, cluster bean, sesame, and moth beans relies on monsoon rainfall. The crops are grown in sandy soil, where farmers typically check soil moisture at depths of about 30 to 45 cm (1 to 1½ feet) before sowing seeds. Crop growth depends on subsequent rainfall within 15-20 days of sowing. Earlier decades had regular monsoon rainfall, yielding reasonable crops. Recently, irregular rainfall patterns, either too early, late, or insufficient rainfall, have hindered crop sowing and growth. Frequent rains post-sowing have also led to diseases and pest attacks, reducing yields. Farmers in this village have been trained in seed selection and cultivation methods. Sowing the improved varieties and better cultivation has resulted in disease-resistant crops, and yields have nearly doubled.

Implementation Support

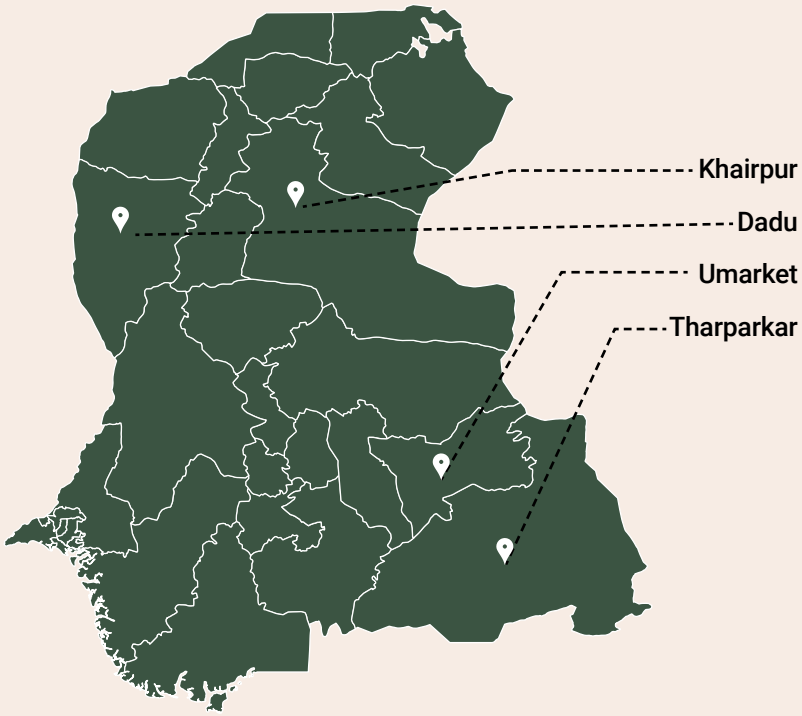
Community World Service (CWS), a non-governmental organization, offered agricultural training that resulted in the widespread adoption of new practices within the community. The Pakistan Council of Research in Water Resources (PCRWR) established a research station near Mithi to focus on dryland agriculture, rainwater harvesting, and saline agriculture. PCRWR introduced a tractor-mounted drill that facilitated optimal row spacing of approximately 40 cm for planting cluster beans. This optimal row spacing significantly improved crop yields.

Benefits

- Proper seed selection doubles yield
- Optimal row spacing using drill improves yield

Challenges

- Use of tractors compacts native soil, leading to reduced nutrient availability and lower crop yield
- Traditional intercropping can cause damage during early harvesting
- One of the precious medicinal plants *Commmiphora Wightii* locally called, '*Gughar*' which was widespread in the Thar desert has vanished now due to tractor ploughing which reduces the local biodiversity.



Scaling Potential

Rainfed agriculture can be improved with proper techniques and support from civil society organizations and federal research stations like PCRWR. This practice can be adopted in areas outside of the IBIS, particularly in districts such as Tharparkar, Umarkot, Dadu, and Khairpur.

KNOW MORE

Please scan for more details

12

Tankaa

Rationale

In drylands, inhabitants often rely on rainwater runoff for drinking water, agriculture, and livestock water needs. Agricultural practices are typically rainfed, while rainwater is harvested and stored in ponds or cisterns for human and livestock use. The people of these areas understand the need for separate storage for human and livestock uses.

In the traditional rainwater harvesting technique, *Taanka*, is used for drinking water purposes for humans. A *taanka* is a covered, underground, impermeable cistern built in low-lying areas to collect rainwater. It is constructed with brick masonry plastered with cement or lime mortar, and has a catchment area that is prepared to ensure erosion-free runoff. *Taankas* are built near settlements to reduce the distance people need to walk to fetch water. They are commonly used in the Thar desert, which spans Pakistan and India.

Cholistan is second largest desert of Pakistan bounded by Bahawalnagar, Bahawalpur and Rahim-Yar-Khan districts of the Punjab province. It extends to Indo-Pak International border. Livestock rearing is major livelihood option for this desert population. There is no canal water supply and the groundwater is saline. Rainwater harvesting is major source of drinking water for both the human population and their livestock. The desert comprises mainly sandy soils but 17 percent of the desert area is occupied by flat clayey soils. The slow infiltration rate of these clay soils makes the area suitable for harvesting rainwater.

The rainwater is either harvested and collected in the storage ponds locally called '*Toba*' and covered reservoirs, like *taanka*, locally called '*Kunds*'. The *Kunds* are a better water storage arrangement as water quality is superior since it is subject to less evaporation than water stored in *tobas*.

Rainwater harvesting taankas

Salient Features

- The use of *taankas* in the area dates back generations. Originally, deep pits were excavated and plastered with mud, but these were not durable and often collapsed. In the recent past, with support from local NGOs, cement plaster has replaced mud plaster, and *taankas* last longer.
- Construction is started by excavating an oval-shaped underground pit about 3 meters deep, with a larger diameter at mid-depth. The pit is plastered with cement. A ring wall about 6 meters in diameter and 15-20 cm in height is constructed around the mouth of the *taanka*. The surface area within the ring is compacted with clayey mud and plastered with cement to act as a catchment for rainwater. The top of the *taanka* is covered and a windlass with a bucket, or some other arrangement, is used to withdraw water. Typically, two *taankas* are constructed in a single catchment.
- *Kunds* are constructed underground using bricks and mortar in the shape of well, plastered inside with cement. The bottom is sealed with concrete and top covered with reinforcement cement concrete (RCC) block. A 0.75 m diameter hole is created in the RCC block at the top of the kund to withdraw water with a bucket on a rope. The walls of the *Kund* are raised about 0.6 – 1.0 m above the ground surface and 2-3 inlets are provided on the base of the sidewalls to facilitate rainwater collection from the catchment. The *kunds* are 6 – 10 m in diameter and 5-6 m in depth and circular in shape. However, recently some triangular shape *kunds* have also been constructed.
- The main difference between a *kund* and a *taanka* is the use of bricks which allows them to be constructed in less stableground.

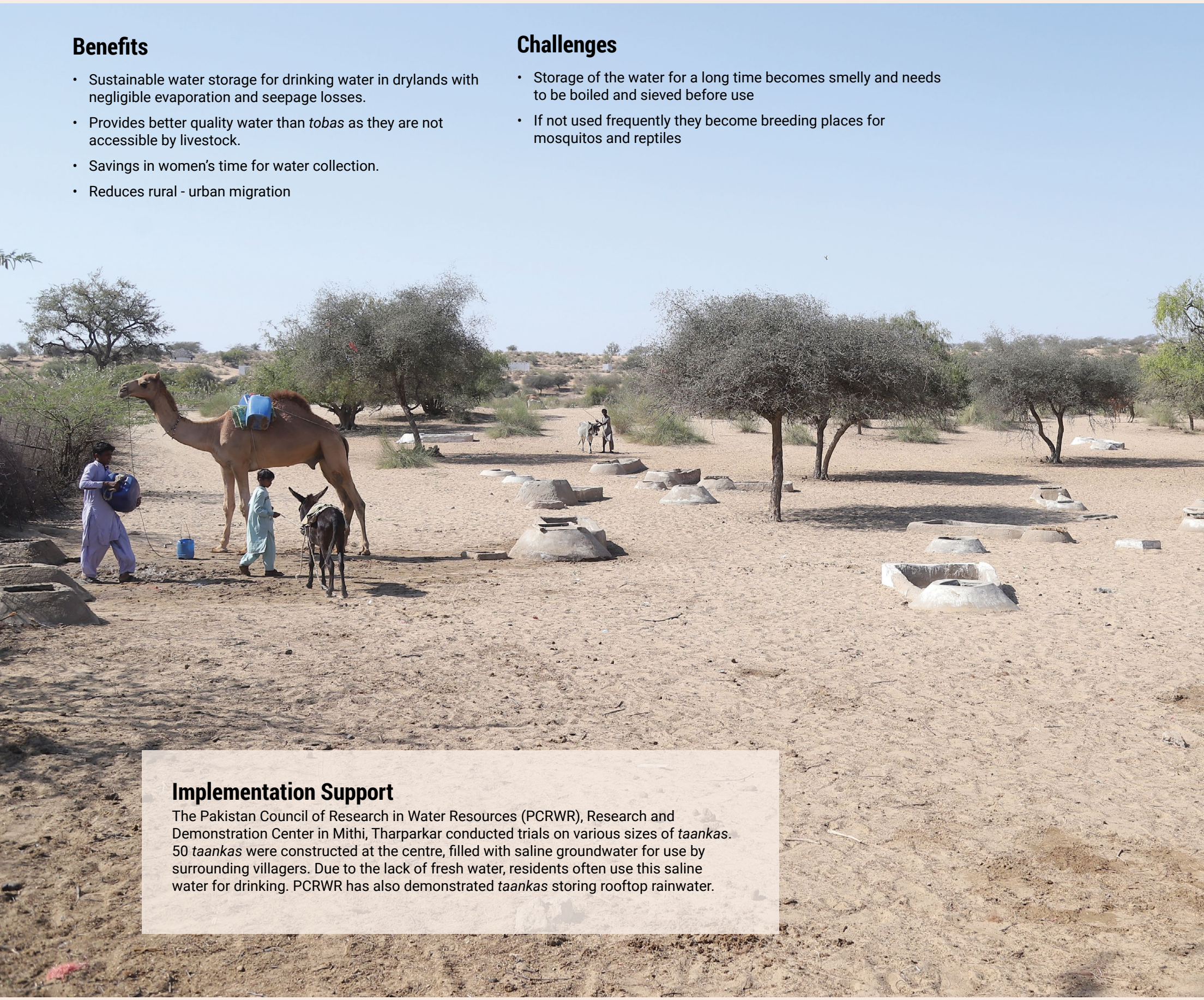
District ..... **THARPARKAR**
Province..... Sindh
Population ..... 1.778 Million
Climate..... Hot and Dry Desert Climate
Altitude ..... 13 m above sea level
Average annual rainfall .... 271 mm
Temperature range..... 23^0 C to 35^0 C

Benefits

- Sustainable water storage for drinking water in drylands with negligible evaporation and seepage losses.
- Provides better quality water than *tobas* as they are not accessible by livestock.
- Savings in women's time for water collection.
- Reduces rural - urban migration

Challenges

- Storage of the water for a long time becomes smelly and needs to be boiled and sieved before use
- If not used frequently they become breeding places for mosquitos and reptiles



Implementation Support

The Pakistan Council of Research in Water Resources (PCRWR), Research and Demonstration Center in Mithi, Tharparkar conducted trials on various sizes of *taankas*. 50 *taankas* were constructed at the centre, filled with saline groundwater for use by surrounding villagers. Due to the lack of fresh water, residents often use this saline water for drinking. PCRWR has also demonstrated *taankas* storing rooftop rainwater.

Farmer's Experience

(Village: Khario Nara, Tehsil: Mithi)

Taankas fill with rainwater and can provide drinking water for a family of 6-7 members for 3-4 months. The *tankaas* are refilled by follow-up rain or by water transported by donkey or camel-drawn tankers from surrounding ponds.

Kund, Punjab

Recommendation

Rainwater harvesting through *taankas* offers a sustainable solution for drinking water in drylands. With more support for construction and maintenance, *taankas* can significantly improve water availability and quality for residents. During the drought period, *Tankaas* may be supplied with freshwater through existing pipelines spread over the Thar. Though similar to *tankaas* in Sindh, *kunds* have a larger storage capacity. The *kund* technology has potential to be replicated in Thar desert districts of Sindh. If *kunds* are constructed in Thar desert reeds should be planted, or small ponds constructed, to trap silt in the harvested rainwater before it enters the *Kund*, due to the soil characteristics.

KNOW MORE

Please scan for more details

13 The Great Wall of Surajpura[4]

Rationale

The villagers of Surajpura, Rajasthan, India have implemented an innovative water conservation strategy to combat the impacts of climate change in their drought-prone region. Using funds from the Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGA), they built a 15-foot mud wall stretching nearly a mile across barren land, accompanied by a trench to capture rainwater runoff, and hold it long enough to infiltrate into the ground. This wall has revived local farms, recharged wells, and restored vitality to the area for the first time in over two decades. It is not just a physical structure but a symbol of climate resilience powered by a social welfare policy.

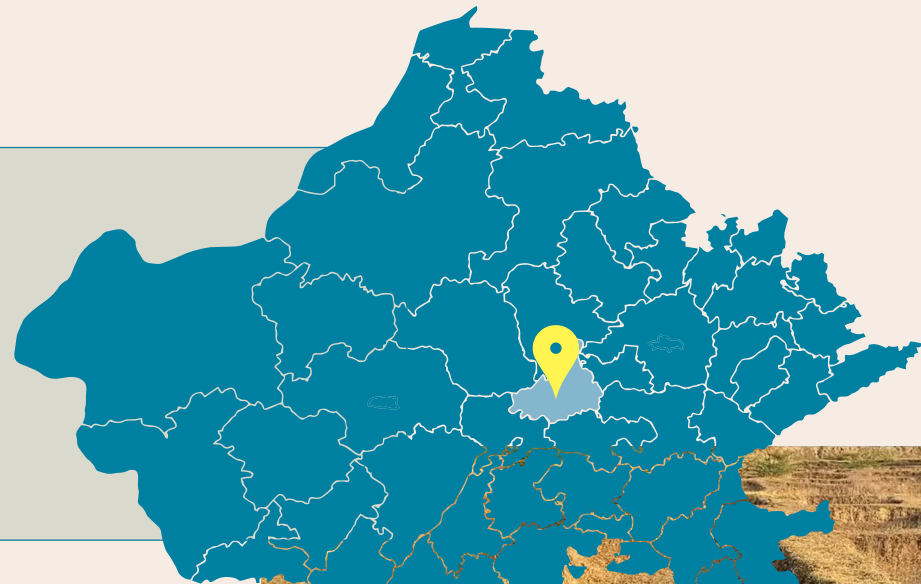
Farmer's Experience

(Village: Surajpura, Tehsil: Kekri)

In February 2024, the residents of Surajpura proudly stood atop the wall they had built in 2022, marveling at its ability to transform their village. Over 650 residents, many of whom relied on MGNREGA for work, toiled for six months to construct the wall. Their efforts have not only revived 40 of the village's 100 wells but also brought back migratory birds and rejuvenated agricultural activities. The wall passed its first major test when it successfully captured rainwater during a drought year, filling wells that had long run dry and rejuvenating farmlands that had lain barren for years.

[3]*Srivastava, Roli. 2024. The Great Wall of Surajpura. The Migration Story blog. Shabdpayanam Pvt Ltd. https://www.themigrationstory.com/post/the-great-wall-of-surajpura*

District ..... **AJMER**
Province ..... Rajasthan
Population ..... 2.583 Million
Climate ..... Subtropical Steppe climate
Altitude ..... 370 m above sea level
Average annual rainfall ..... 525 mm
Temperature range ..... 27^0 C to 39^0 C



Benefits

- Rural Employment Guarantee Scheme, initially designed as a job creation program, has proven to be a powerful instrument in addressing climate challenges.
- Nearly 75% of the work under MGNREGA is related to natural resource management, an essential intervention as India faces growing climate risks.
- By building water conservation structures like wells, trenches, and check dams, rural communities are safeguarding their future against droughts and water scarcity.
- The scheme can be leveraged as a tool for climate adaptation, particularly in water-scarce regions like Rajasthan, India where groundwater levels have plummeted and rainfall is erratic.

Conclusion

The wall of Surajpura is more than just a structure—it is a testament to the power of community-driven climate action. By tapping into MGNREGA funds, the villagers have not only secured their water supply but also revitalised agriculture and local livelihoods, proving that with determination and the right support, even the harshest climates can be made more livable.

Scaling Potential

The potential to scale up such initiatives through MGNREGA is immense, especially when combined with other government programs focused on groundwater security. As climate risks worsen, including more erratic rainfall and depleting groundwater, it becomes critical to monitor the impact of these interventions and strengthen their design through scientific guidance. Programs like MGNREGA offer hope for water-scarce regions, providing both jobs and climate.

Message from Farmers

For farmer Hemraj Sharma, the wall meant water in his well for the first time in years, allowing him to grow a healthy wheat crop instead of watching his fields lay fallow.

KNOW MORE

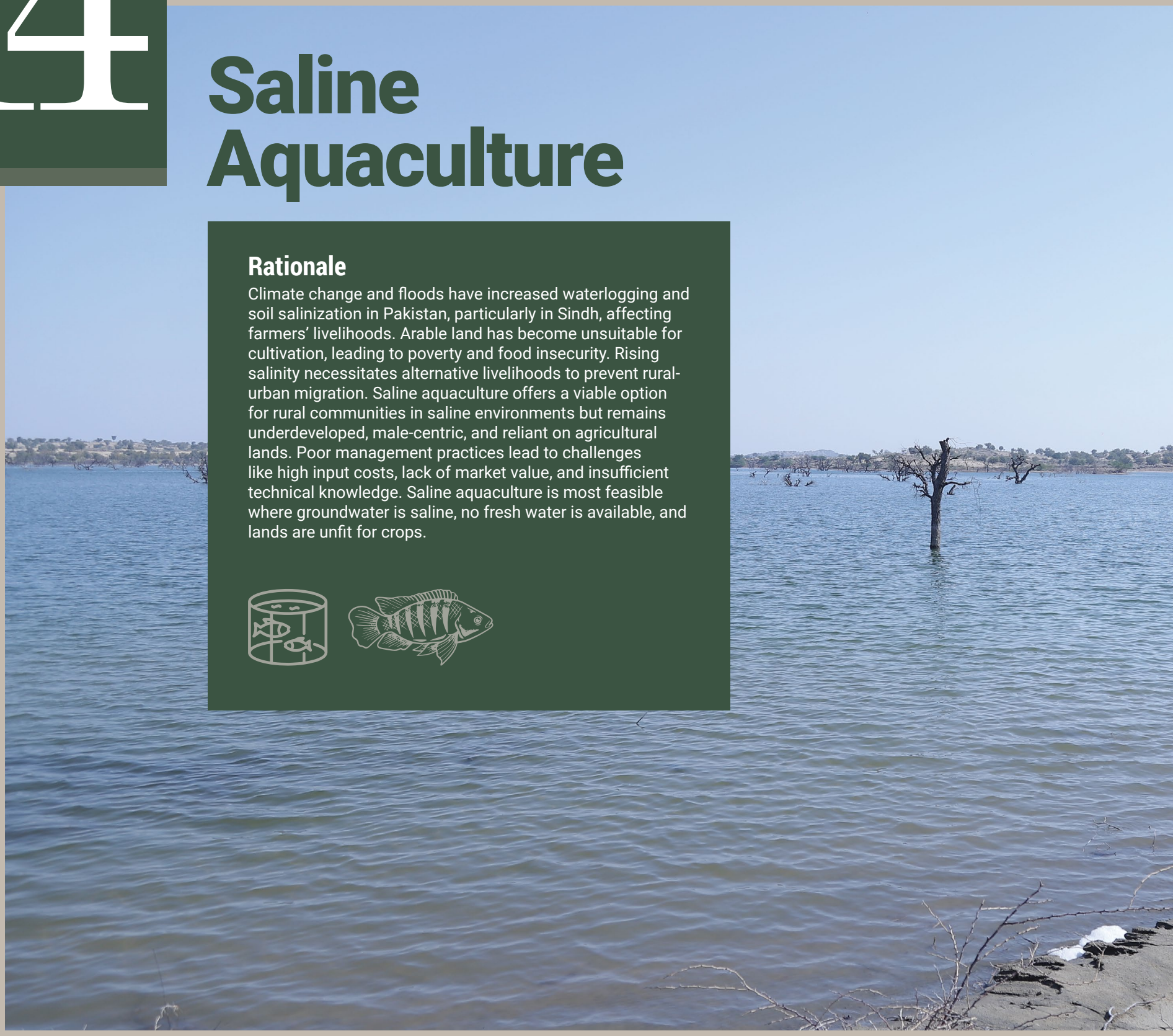
Please scan for more details

14

Saline Aquaculture

Rationale

Climate change and floods have increased waterlogging and soil salinization in Pakistan, particularly in Sindh, affecting farmers' livelihoods. Arable land has become unsuitable for cultivation, leading to poverty and food insecurity. Rising salinity necessitates alternative livelihoods to prevent rural-urban migration. Saline aquaculture offers a viable option for rural communities in saline environments but remains underdeveloped, male-centric, and reliant on agricultural lands. Poor management practices lead to challenges like high input costs, lack of market value, and insufficient technical knowledge. Saline aquaculture is most feasible where groundwater is saline, no fresh water is available, and lands are unfit for crops.



Farmer's Experience

(Village: Madhi Ji Dhani, Tehsil: Chachro)

Farmers, primarily are dependent on livestock and rainfed agriculture for livelihood. They observed changes in rainfall patterns over the last 20 years (either too less or too much water), leading to crop damage. Post 2022 floods, selected NGOs introduced alternative livelihoods, such as saline fish farming by providing matching grant to develop a small cage and install a solar based small motor pump for Tilapia fish farming, resulting in good yields and sales. The setup is currently a demonstration point for farmers residing in the area with some adopting the livelihood option.

District ..... **THARPARKAR**
Province..... Sindh
Population ..... 1.778 Million
Climate..... Hot and Dry Desert Climate
Altitude ..... 13 m above sea level
Average annual rainfall .... 271 mm
Temperature range..... 23^0 C to 35^0 C

Implementation Support

Farmers requested government and NGO support for technical skills, hatcheries, breeding stations, and short-term financing for saline aquaculture. Fisheries department has advised that the month of March is best period for putting hatchery of fish in the ponds/cages.

Saline aquaculture has vast potential in the Thar desert due to available land and saline groundwater. PCRWR trials at their Mithi center showed successful results with four fish species in a controlled pond using saline groundwater. The trials encourage promoting saline aquaculture in the Thar desert.

Benefits

- Alternate livelihood during inconsistent rainfall patterns which affect crop sowing and growth, and often results in economic loss.
- Allows beneficial use of saline water which is predominant in the area.
- Partially reduces reliance on traditional agriculture.
- The practice is a proactive climate adaptation measure.

Challenges

- High temperatures and sandy soils increase evaporation and seepage rates
- Cage aquaculture suits small-scale fish farming, however, it requires a capital cost.
- The Gorano Reservoir (area of 25 hectares) has potential for fish farming. Gorano Dam was constructed by Sindh Coal Authority to store dewatering effluent. Initial fish farming showed promise, but developing this potential is challenging as catching fish is difficult in the deep water (5-7 m).

Scaling Potential

The practice has potential for scaling up in the Thar region of Sindh where farmers are dependent on rainfed agriculture. Future agriculture production in Thar is uncertain due to climate change, which is changing rainfall patterns. There is a public-private partnership opportunity for saline aquaculture in Gorano Reservoir, and in other reservoirs planned or under construction by the Sindh Coal Authority.

Message for Farmers

Saline aquaculture offers a sustainable alternative livelihood where groundwater is saline. It can reduce the reliance on traditional rainfed agriculture. With proper support and management, it can make a significant contribution to local and national economies.

KNOW MORE

Please scan for more details

Photo Credit: Muhammad Jawaid Shamshad

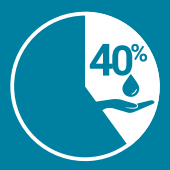
Urban Area
Water Management

15

Mobile Application Based Remote Water Tank Monitoring

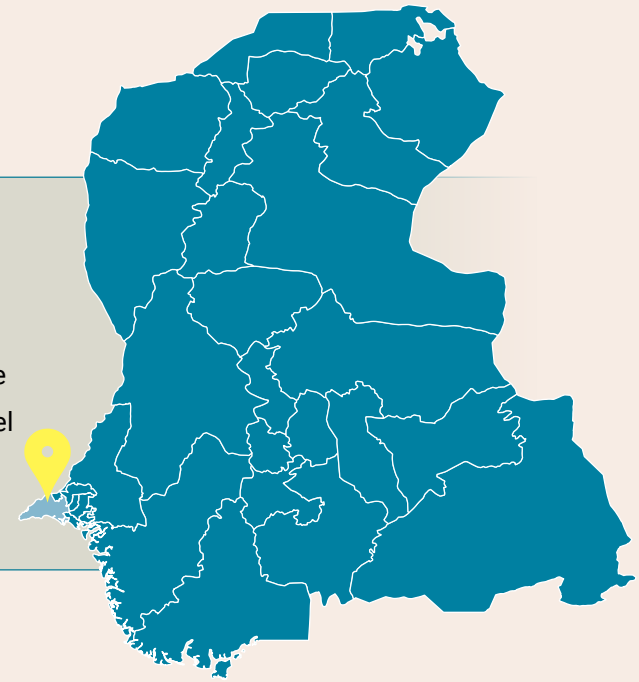
Rationale

Urban water supply service delivery in Pakistan is managed by local governments and overseen by provincial governments. Water and Sanitation Agencies (WASAs) in major cities handle domestic water supply. Karachi, the largest city in Pakistan, relies on the Karachi Water and Sewerage Board (KW&SB) for its water supply. According to the KW&SB website, the board faces a 40% water shortage, making it challenging to meet the basic per capita water needs of the metropolitan city without better management of available water resources.



According to the Karachi Water and Sewerage Board (KW&SB), the city faces a 40% water shortage

District ..... **KARACHI**
Province..... Sindh
Population ..... 3.822 Millions
Climate..... Hot Desert Climate
Altitude ..... 8 m above sea level
Average annual rainfall .... 205 mm
Temperature range..... 22^0 C to 32^0 C



Service Providers Technology Demonstration

(Location: National Aerospace Science and Technology Park, Karachi)

asani.io is a water management service provider delivering solutions for monitoring water storage tanks, optimising pump operation times in residential and commercial properties, and preventing water loss from tank overflow. The water supply in Karachi is intermittent, with no exact schedule. The city receives a water supply around 600-650 million gallons per day (MGD) compared to a requirement of approximately 1100 MGD. The intermittent supply causes residents to constantly monitor their pipelines to start their pumps, often resulting in water overflow, especially during the night. To address these issues, asani.io designed a device that allows residents to auto-fill their tanks without interrupting their regular routine. It automatically switches off the motor when the tank is full, preventing overflow.

An internet-supported app has been developed to help consumers monitor their water storage tanks remotely. Consumers receive alerts when their water levels are low or when the tank is full. In commercial units, sensors in the tanks provide remote information about available water. All installations are cloud-connected, allowing experts to monitor and address any issues from a control room. This system has resulted in considerable saving of water and energy.

Requirement: 1100 million gallons per day Supply: 600-650 million gallons per day

Benefits

- Monitoring water level in tanks and optimizing water and energy usage.
- Alerts to book a water tanker at the right time during low supply
- Remote control of water pump motors through the mobile application.

Challenges

- Awareness raising amongst citizen
- Initial cost of installation

Demonstration of the Dashboard for Monitoring Water Storage Tanks

Scaling-up Potential

There is potential to scale up these services in both public and private sectors in urban areas and industrial zones of the country, which would save water and energy.

Recommendation

Implementing advanced water management solutions in urban areas can significantly address water shortages and enhance resource efficiency. By adopting these technologies, cities can ensure a more reliable and sustainable water supply system. A third-party evaluation of the technology's water and energy saving audit is also recommended.

KNOW MORE

Please scan for more details

Acknowledging the Champions of Water Resilience (Technical Working Group)

Mr. Muhammad Ayoub Soomro

Additional Secretary, Sindh Irrigation Department / Sector Focal Point, Climate Adaptation and Resilience for South Asia Project

Mr. Gulam Mustafa Ujjan

General Manager (Transition) Sindh Irrigation and Drainage Authority

Mr. Allahwarayo Rind

Additional Director General, Agriculture Extension, Lower Sindh

Mr. Hafiz Abdul Salam

Regional Director, Drainage and Reclamation Institute of Pakistan, Pakistan Council of Research in Water Resources

Prof. Dr. Altaf Ali Sial

Dean, Faculty of Agriculture Engineering, Sindh Agriculture University, Tando Jam

Mr. Muhammad Yousif Channa

Vice President, Society of Facilitators and Trainers, Sakrand, Nawab Shah

Recognising the Collective Effort

CONCEPT

Lt. Gen. Nadeem Ahmed
Regional Advisor, Asian Disaster Preparedness Center

Irfan Maqbool
Director, Asian Disaster Preparedness Center

Senaka Basnayake
Director, Asian Disaster Preparedness Center

Niladri Gupta
Sr. Water Resources Management Specialist,
Asian Disaster Preparedness Center

RESEARCH AND COMPILATION

Zamir Ahmed Soomro
Water Resources Management Specialist,
Asian Disaster Preparedness Center

Niladri Gupta
Sr. Water Resources Management Specialist, Asian
Disaster Preparedness Center

COLLABORATION

Ashraf Muhammad
Ex-Chairman, Pakistan Cpuncil Of Research In Water Resources

Bilal Khalid
Disaster Risk Management Analyst,
The World Bank Group

Carina Fonseca Ferreira
Disaster Risk Management Specialist,
The World Bank Group

We would also like to thank all who supported and contributed to the work in ADPC Bangkok and Pakistan Country Office.

Know More (References)

PRACTICE 01

A review of global precision land-leveling technologies and implements: Current status, challenges and future trends.

Laser guided land levelling: A precision technique for enhancing water productivity

Laser Land Leveler: A Technology for Resource Conservation in India

Laser guided land levelling: A precision technique for enhancing water productivity

PRACTICE 02

Zero Tillage Agricultural Technology

A study on wheat cultivation under zero tillage and conventional tillage practices

Case Study on Zero Tillage Technique

PRACTICE 03

The potential of raised-bed planting in Central Asia

Commercial Raised Bed Farming a Full Guide

Crop Production Guide Horticulture Crops

PRACTICE 04

Soil And Water Conservation For Banana

Strategies to Improve the Irrigation Efficiency of Raised Beds on Small Farms

PRACTICE 05

Mango Production And Fruit Quality Under Properly Managed Drip Irrigation System

Irrigation management in mango, Irrigation in mango

PRACTICE 06

Successful Sugarcane Crop with Intercropping

Maximizing Sugarcane Yields and Sustainability with Intercropping

PRACTICE 07

Poly Tunnels: Advantages, Present Status and Future Prospects

Kryzen For Rural Farmers

PRACTICE08

Making the case for reusing saline water and restoring salt-affected agricultural lands

Drainage water reuse 01

Drainage water reuse 02

Shallow skimming well water reuse

Drainage scavenger tube wells can sustain rural livelihoods: Evidence from Sindh Pakistan

Conjunctive use of surface and groundwater in IBIS

Know More (References)

PRACTICE 09

How banana waste upcycling is kick-starting Uganda's circular economy.

Sustainable Management of Banana Waste in Sindh

Banana Waste to Wealth.

Management of banana crop waste biomass using vermicomposting technology.

PRACTICE 10

Hill Torrents' Management and Social Relations of Farmers: A Study of Arid Land in Tehsil D.G. Khan

Management of Hill Torrents: Opportunities and Challenges

Untapped Potential of Spate Irrigation in Pakistan

Managing Hill Torrents In Pakistan

How Pakistan Can Better Manage and Benefit from Hill Torrent Flooding

PRACTICE 11

Rainfed Agriculture and Use of Groundwater

Challenges and Strategies for Dryland Agriculture in Pakistan

A critique of successful elements of existing on-farm irrigation water management initiatives in Pakistan

PRACTICE 12

Kundi — timeless sanctuaries of rainwater in the heart of desert

Water Harvesting Systems: Traditional Systems

Indigenous Knowledge and Traditional Practices for Water Resource Management in Rajasthan, India

Traditions of Rainwater Harvesting in South Asia

Pakistan's Deserts: Land and Water Resources Development

Traditional Water Harvesting Techniques and Practices in Pakistan

Native and Traditional Rainwater Harvesting Systems in Balochistan of Iran

PRACTICE 13

The Water Warriors of Surajpura

Mahatma Gandhi National Rural Employment Guarantee Scheme 01

Mahatma Gandhi National Rural Employment Gurantee Scheme 02

Towards Landscape-Based Groundwater Recharge for Arid Regions

Enhancing Groundwater Recharge Through Nature-Based Solutions: Benefits and Barriers

PRACTICE 14

Opportunities for brackish and saline aquaculture in Pakistan

Using saline groundwater for culture of Marine Fish

Living with Salinity in the Southern Indus Basin through Aquaculture

PRACTICE15

WaterO: A Smart Water Device

Smart Irrigation Monitoring & Controlling System With Android App Based on IoT

Remote Monitoring, Control and Data Visualization for a Solar Water Pumping System

Glossary of Terms

ADAPTIVE WATER MANAGEMENT

A dynamic approach to managing water resources that involves continuous learning, flexibility, and adaptation to changing environmental and socio-economic conditions.

ALLUVIAL PLAIN

A flat landform created by the deposition of sediment over time from rivers, especially the Indus River, making it highly fertile and suitable for agriculture.

BED AND FURROW IRRIGATION

A flat landform created by the deposition of sediment over time from rivers, especially the Indus River, making it highly fertile and suitable for agriculture.

CANAL COMMAND AREA

An area served by an irrigation canal network, receiving controlled water flows for agricultural use.

CLIMATE RESILIENCE

The ability of a system, community, or region to cope with and recover from the impacts of climate change, including floods and droughts.

CONJUNCTIVE USE

The coordinated use of surface and groundwater resources to optimize water availability and improve agricultural productivity.

DRAINAGE EFFLUENT

Water discharged from fields or drains, often reused for irrigation where quality permits, especially during surface water shortages.

EVAPOTRANSPIRATION

The combined process of evaporation from soil and transpiration from plants, used to estimate crop water needs.

HILL TORRENTS (NAI)

Flash flood flows originating from hills and mountains, used traditionally for spate irrigation in arid regions of Sindh.

IBIS(INDUSBASINIRRIGATIONSYSTEM)

One of the world's largest contiguous irrigation systems, supplying water to millions of hectares in Pakistan through canals and barrages.

INTERCROPPING

An agricultural practice of growing two or more crops in proximity to maximize land use, conserve water, and improve resilience.

KHARIF/RABI SEASONS

Kharif refers to the monsoon cropping season (summer), and Rabi refers to the post-monsoon season (winter) in South Asia.

LASER LAND LEVELLING

A technique using laser-guided equipment to level agricultural land, enhancing water distribution, irrigation efficiency, and crop yields.

MARGINAL QUALITY WATER

Water with moderate salinity or contaminants that may be suitable for irrigation under certain conditions with proper management.

Glossary of Terms

NUTRIENT LEACHING

Loss of essential soil nutrients due to excess irrigation or rainfall, often addressed by efficient irrigation practices like basin or ring irrigation.

RAINFED AGRICULTURE (BARANI)

Farming systems that rely solely on natural rainfall without supplemental irrigation.

RING BASIN IRRIGATION

An irrigation method where a circular basin is constructed around individual trees in orchards, concentrating water and nutrients at the root zone.

SALINE AQUACULTURE

The practice of farming fish in saline or brackish water environments, offering livelihood alternatives in areas with high soil salinity.

SCARP(SALINITYCONTROLANDRECLAMATIONPROJECT)

An area served by an irrigation canal network, receiving controlled water flows for agricultural use.

SMALL RECHARGE DAMS

Low-height dams constructed in hill torrent areas to recharge groundwater and support agriculture and drinking water supply.

SPATE IRRIGATION

A traditional method using seasonal flash floods (torrents) to irrigate land, particularly in arid and semi-arid regions.

SURFACE WATER

Water collected on the surface of the ground, such as in rivers, canals, and lakes, used for irrigation and other purposes.

TAIL-END FARMERS

Farmers located at the end of irrigation canals who often receive less or inconsistent water supply compared to those at the head.

TAANKA / KUNDS

Traditional underground rainwater harvesting structures used for drinking water storage in arid regions like Tharparkar and Cholistan.

TUNNEL FARMING

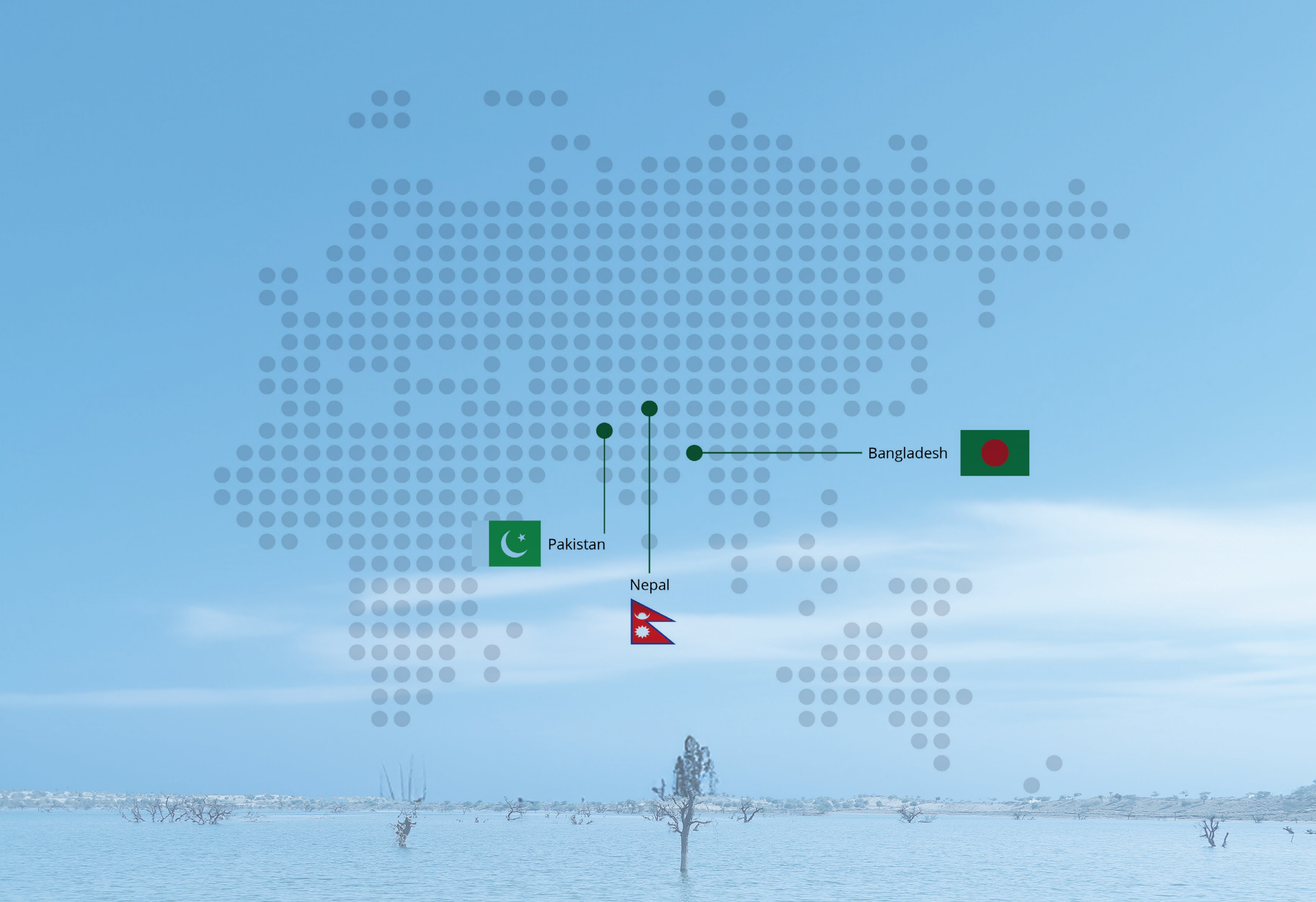
A protected cultivation method using low to high plastic tunnels, allowing off-season vegetable production and water-efficient irrigation.

WARABANDI

A rotational system of water distribution in irrigation canals that allocates water equitably among farmers.

ZERO TILLAGE

A conservation agriculture practice where crops are sown without prior ploughing, reducing soil disturbance, input costs, and conserving water.



Asian Disaster Preparedness Center

SM Tower, 24th Floor, 979/66-70 Paholyothin Road,
Phayathai, Bangkok 10400 Thailand
Tel: +66 2 298 0681-92
Fax: +66 2 298 0012
Email: adpc@adpc.net

www.adpc.net
@ADPCnet
Asian Disaster Preparedness Center - ADPC
Asian Disaster Preparedness Center (ADPC)
Asian Disaster Preparedness Center (ADPC)
Asian Disaster Preparedness Center (ADPC)