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THEMATIC PAPER

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# Indigenous Knowledge Pathways to Climate Resilient Agriculture and Water Management in Bundelkhand





# Abstract

Bundelkhand, renowned for its rich natural heritage, faces persistent natural stress, particularly in relation to Water Resources. Bundelkhand categorized as a semi-arid region, is experiencing an increasing risk of drought due to prevailing climatic conditions. In recent years, the region has also begun to face other climate change induced disasters, such as flash floods.

In responding to these challenges, the centuries old Indigenous Knowledge of local communities has proven to be highly effective. Practices such as the construction and maintenance of stepwells (bawris) and ponds, conservation and promotion of indigenous seed varieties, soil conservation through field bunding, and the use of organic manure represent Indigenous Knowledge Systems that are well suited to the region's unique geographical and ecological context. These practices can significantly contribute to addressing climate change induced risks. For instance, climate projections indicate that Bundelkhand is likely to experience rising temperatures, prolonged drought periods, and an increase in high intensity rainfall events over shorter durations in the coming years. In such a scenario, water bodies like stepwells and ponds can serve as buffer zones during periods of heavy rainfall, helping to mitigate risks such as flash floods and soil erosion. Conversely, during drought conditions, the water stored in these structures can be utilized for agriculture, livestock, and domestic purposes. Moreover, the year-round presence of water in these sources enhances the potential for groundwater recharge.

Under these circumstances, there is a clear need to revisit and revive Indigenous/Traditional Knowledge and Practices that have been integral to the lives of Bundelkhand's farmers for centuries. In a water-sensitive region such as Bundelkhand, the indigenous knowledge of local farmers represents a vital resource for modern agriculture and allied sectors, supporting efforts to reduce the impacts of climate change and improve the management of natural resources.

As part of state level efforts to address climate change induced impacts, the Government of Uttar Pradesh has developed the Uttar Pradesh State Action Plan on Climate Change (UP-SAPCC) 2.0, aimed at analysing the impacts of climate change and associated risks across different agro-climatic zones of the State and formulating robust, zone-specific strategies. Under the Climate Adaptation, Resilience, and Climate Finance Programme in Rural India, the GIZ is providing technical support to the Directorate of Environment, Government of Uttar Pradesh, for the implementation of Agriculture and Water related Missions under the UP-SAPCC (2021–2030). This technical assistance is intended to facilitate the execution of selected activities under the Agriculture and Water Missions, particularly in the Bundelkhand region.

In this context, and with the objective of enhancing Bundelkhand's resilience to climate change induced risks, this paper has been developed to reconnect Traditional Knowledge and Practices prevalent in the Agriculture and Water sectors with mainstream development processes. By documenting and scaling these practices, the paper seeks to strengthen the climate adaptation capacity of local communities and contribute to sustainable and resilient development in the region.

# Geographical and Agro-Climatic Profile of the Region

Bundelkhand spans seven districts of Uttar Pradesh—Chitrakoot, Banda, Mahoba, Hamirpur, Jalaun, Jhansi, and Lalitpur—with parts extending into Madhya Pradesh. Situated in the Vindhya plateau, the region is semi-arid and drained by rivers such as the Ken, Betwa, Dhasaan, and Tons, all tributaries of the Yamuna. Despite this, groundwater levels are low and water availability is largely limited to the monsoon, leading to frequent water scarcity and recurring droughts. The region is dominated by black soils, suitable for crops like wheat and gram, and less fertile red soils. Agriculture is predominantly rainfed, with only about 25 percent of land irrigated, making it highly vulnerable to climate variability. Erratic rainfall, extreme heat—often exceeding 45°C—and recurring droughts and flash floods have significantly affected agricultural productivity and livelihoods. Agriculture and livestock remain the main livelihood sources, supporting over 80 percent of small, marginal, and women farmers.

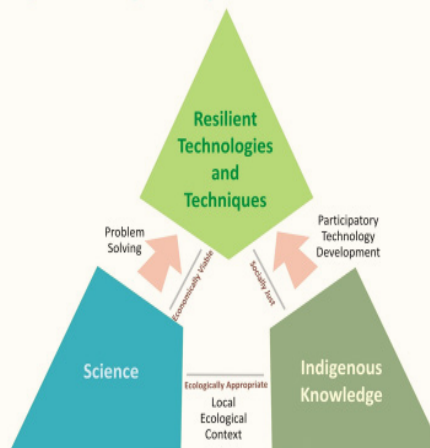


# Synergising Science and Indigenous Knowledge for Climate Resilience in Bundelkhand

The Bundelkhand region’s experience clearly demonstrates that climate-resilient agriculture and water management emerge most effectively from the synergy of science and indigenous traditional knowledge, rather than from either system working in isolation. As illustrated in the diagram, indigenous knowledge—rooted in generations of local experience—offers deep understanding of soils, water flows, cropping patterns, and climate variability, while science contributes analytical tools, improved techniques, and systematic problem-solving approaches.

When these two knowledge systems interact through participatory processes, they give rise to resilient technologies and techniques that are ecologically appropriate, locally adapted, and socially acceptable. In Bundelkhand’s semi-arid and climate-stressed context, this synergy enables solutions such as improved water harvesting structures, drought-resilient cropping systems, and soil conservation practices that are technically sound yet grounded in local realities. By integrating scientific validation with community wisdom and participatory technology development, Bundelkhand can strengthen its capacity to adapt to climate risks while ensuring sustainability, ownership, and long-term resilience of Agriculture and Water systems.

## Evolving Participatory Resilient Technologies



## Agriculture and Water Sectors: Indigenous Knowledge and Modern Approaches



### Agriculture:

Indigenous knowledge of farming practices adapted to local climatic conditions not only connected communities with their environment, society, and culture, but also ensured the sustainability of agriculture. This traditional knowledge, often referred to as *Indigenous Knowledge* was based on traditional farming wisdom, the use of local seed varieties, natural inputs such as farmyard manure, and reliance on human and animal labor.

In contrast, Modern Agricultural Practices emphasize high yield, market oriented seed varieties, chemical fertilizers and pesticides, and increased mechanization. While these approaches often result in higher short-term productivity, they also lead to increased input costs, accelerated environmental degradation, and adverse impacts on the health of crops, humans, and livestock.



## **Water:**

Traditional water conservation practices ensured the availability of water even during periods of scarcity, thereby meeting agricultural and daily domestic needs. On the other hand, many modern technology driven interventions have been reduced to just activities. Instead of conserving water, they often contribute to wastage, further exacerbating water stress and making the region increasingly water-deficient.

It can be concluded that both indigenous/traditional knowledge and scientific approaches have their own strengths and limitations. The present need is to integrate indigenous wisdom with scientific methods and adopt resilience & sustainable practices. Such integration can help ensure food and nutrition security while also enhancing adaptive capacity to climate change. Striking a balance between the two is therefore crucial for a sustainable future.

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## **Need to Revisit Indigenous Knowledge:**

While agricultural yields have improved and living standards have risen with modernization, it is essential to question the cost at which this progress has been achieved. Mining in hilly areas, deforestation, encroachment on water bodies, shrinking wetlands, and the rapid pace of climate change and climate-induced disasters have significantly increased the vulnerability of Bundelkhand's Agriculture and Water sectors.

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## **Agriculture Sector:**

Increased temperatures and unpredictable rainfall patterns are disrupting cropping cycles, reducing yields, and degrading soil health. Rising temperatures during critical crop growth stages are particularly affecting major crops such as Wheat, Paddy, and Pulses. Water scarcity and excessive extraction of groundwater are leading to soil salinization, while warmer conditions are increasing the incidence of pests and crop diseases.

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## **Water Sector:**

The Water sector is also being severely affected by irregular and extreme rainfall patterns, resulting in reduced groundwater recharge and the drying up of rivers, lakes, and ponds. Prolonged dry spells and increasing frequency of droughts are reducing water availability for irrigation, drinking, and livestock, while also deteriorating soil health. The decline in surface water sources has increased dependence on groundwater, leading to a deterioration in water quality. High evaporation rates, weak rainfall, and siltation are shrinking the area of water bodies. Additionally, sudden heavy rainfall events are causing flash floods, damaging crops and infrastructure and leading to the erosion of fertile topsoil.

The above clearly indicates that reviving Bundelkhand's Indigenous Practices and Knowledge Systems, while integrating them with scientific approaches is a vital solution for reducing the vulnerability of the Agriculture and Water sectors and for building long-term climate resilience in the region.



## Indigenous Knowledge in Agriculture:

Here, we briefly discuss some key traditional practices which, if revived and adopted, can help make Agriculture in the Bundelkhand region more sustainable. Importantly, this indigenous knowledge has been embedded in local traditions for generations but was gradually sidelined in the process of modernization.



### Region-Specific Indigenous Crops and Seeds:

- ➔ **Cereals:** Cultivation of nutritious, low-water-requiring crops that can grow on uneven and marginal lands, such as *Sorghum (Jowar)*, *Pearl Millet (Bajra)*, *Kodo Millet*, *Little Millet (Kutki)*, and *Finger Millet (Ragi)*. These crops are highly drought-tolerant.
- ➔ **Pulses and Oilseeds:** Growing crops such as *Gram (Chickpea)*, *Pigeon Pea (Arhar)*, *Black Gram (Urad)*, *Green Gram (Moong)*, and *Linseed (Alsi)*. These crops are rich sources of protein and help improve soil fertility by fixing nitrogen.



### Multiple Cropping Systems:

- ➔ **Intercropping/Mixed Cropping:** Cultivating different crops simultaneously in the same field to reduce risk and maintain soil fertility. For example, growing *Gram and Mustard* together.



### Farmyard Manure and Pest Management:

- ➔ **Organic Manure and Vermicompost:** Using organic inputs such as cow dung manure, NADEP compost, pit compost, and vermicompost instead of chemical fertilizers. These practices enhance soil nutrient content as well as the soil's moisture-retention capacity.
- ➔ **Organic/Natural Pest Control:** Using Neem leaves and other locally available herbs to manage pests instead of chemical pesticides.



### Agroforestry:

- ➔ Planting trees such as *Neem*, *Shisham*, and *Karonda* along farm boundaries and bunds. These trees provide additional income through timber, fruits, and fodder, and also protect crops during extreme weather conditions.



### Mulching:

- ➔ Covering the soil surface with crop residues or straw to retain soil moisture and suppress weed growth.



#### Soil and Water Conservation:

- ➔ **Farm Bunding:** Constructing small earthen bunds around Farm to retain rainwater, prevent soil erosion, and support groundwater recharge.
- ➔ **Floodplain (Kachhar) Farming:** Utilizing fertile riverbank lands and benefiting from nutrient-rich silt deposited by floodwaters.
- ➔ **Contour farming (Cultivation on Slopes):** Practicing contour or slope farming to slow down water runoff and prevent the loss of fertile topsoil.

These traditional agricultural practices, when combined with appropriate scientific inputs, can significantly enhance climate resilience, reduce risks, and promote Sustainable Agriculture in the Bundelkhand region.

## Harmonizing Traditional Knowledge and Science

By integrating centuries-old traditional knowledge with modern scientific approaches, long-term sustainability of the region's climate and soil can be achieved. The use of drought-resistant seed varieties suited to local geographical conditions, cultivation of coarse cereals, and adoption of organic and natural farming methods within mixed cropping systems can enhance soil fertility and reduce dependence on chemical fertilizers and pesticides. This not only lowers farmers' reliance on external markets but also significantly reduces input costs.

At the same time, the scientific analysis and validation of traditional knowledge provides a new perspective for farmers, markets, and consumers alike. On one hand, by strengthening resilience to locally emerging climate risks, farmers can achieve greater sustainability in their agricultural practices and improve their incomes. On the other hand, such analyses help create new markets and informed consumer demand. For example, scientific research and validation of the medicinal properties of locally available herbs and wild plants can open up new avenues for their use, expand market opportunities, and enhance farmers' incomes.

Thus, by harmonizing indigenous knowledge with modern scientific understanding, the region can make meaningful progress toward sustainable agricultural development, environmental conservation, and strengthened rural livelihoods.

## Traditional Knowledge and Practices in the Water Sector:

In Bundelkhand, traditional knowledge and practices related to water conservation include structures and systems such as *Stepwells (Bawdis), Kunds, Johads, and Farm Ponds*. A significant aspect of these practices is that local communities and government institutions are increasingly reviving and



implementing them through initiatives such as “Jal Sahelis”, using traditional wisdom as the foundation for various water-related projects.

### **Stepwells, Bandhis, and Kunds:**

- ➔ These are underground or semi-underground structures designed to harvest rainwater and release it gradually over time. *Stepwells, Bandhis, and Kunds* historically formed the backbone of Bundelkhand’s Water Management System. However, over the years, these systems have been steadily declining and many have fallen into disuse.

### **Johads or Earthen Check Dams:**

- ➔ These are small earthen embankments constructed to collect rainwater and enhance groundwater recharge. Johads help ensure water availability even during drought conditions by raising the groundwater level.

### **Ponds and Farm Ponds:**

- ➔ The construction of community ponds, restoration of traditional water bodies, and development of farm ponds by local communities enable effective rainwater harvesting and provide water for use during dry periods.

### **Farm Bunding and Tree Plantation:**

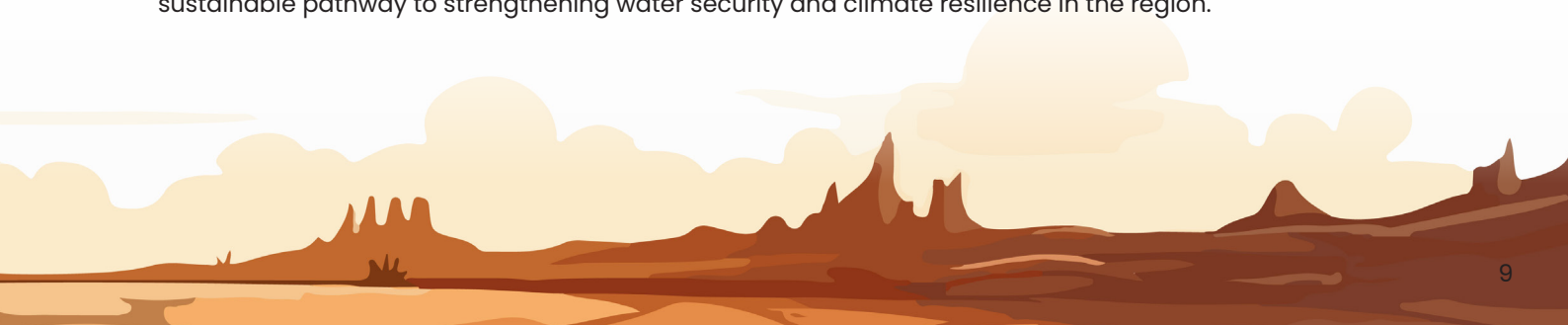
- ➔ Planting trees along Farm bunds and constructing earthen bunds help slow down surface runoff, reduce soil erosion, and improve in-situ water conservation.

Reviving and strengthening these traditional Water Management Practices supported by appropriate scientific planning and community participation can play a vital role in enhancing water security and building climate resilience in the Bundelkhand region.

## **Synergy between Traditional Knowledge and Science:**

In the Water sector, Bundelkhand has, for centuries, relied on traditional water harvesting systems such as *Ponds, Stepwells (Bawdis), Wells, and Bandhis*. Modern science recognizes the effectiveness of these Traditional Water Management Systems and emphasizes the need to revive and restore them. Scientific analysis of these Traditional Knowledge-based practices reveals that they are grounded in sound *geological and hydrological principles*, making them highly effective in preventing soil erosion and enhancing water retention.

Furthermore, by integrating these small-scale water bodies with improved irrigation systems and scientifically designed rainwater-harvesting techniques, local-level water scarcity can be significantly reduced. Such a convergence of traditional wisdom and scientific innovation offers a practical and sustainable pathway to strengthening water security and climate resilience in the region.



# Challenges

In Bundelkhand, Traditional Knowledge and Practices face multiple challenges arising from the dominance of Modern Agricultural methods, less convergence within policy frameworks, and limited community participation. These factors are weakening Traditional Agricultural and Water Management Systems as well as the social fabric of the region. On one hand, the value of local knowledge is diminishing, and on the other, achieving sustainable development has become increasingly difficult. The key challenges can be summarized as follows:

- ➔ **Shift toward water-intensive crops:** In the process of modernization, interest in local crops and indigenous varieties has declined. Farmers are increasingly shifting from traditional seeds to water-intensive crops such as paddy.
- ➔ **Economic and demographic pressures:** Rising family sizes, shrinking landholdings, and increasing economic pressures are pushing communities to prioritize activities that offer immediate financial returns over traditional practices.
- ➔ **Declining inter-generational knowledge transfer:** As younger generations are drawn toward modern lifestyles, the transmission of Traditional Agricultural and Water-related Knowledge such as Indigenous crops and varieties, Medicinal plants, and Water conservation techniques from one generation to the next has weakened.
- ➔ **Lack of platforms, Motivation, and support mechanisms:** Communities lack adequate platforms, institutional support, motivation, and support mechanisms to conserve and promote their traditional knowledge systems.
- ➔ **Migration and livelihood stress:** Limited local livelihood and employment opportunities, coupled with economic stress, have led to migration, distancing communities from traditional practices and weakening social cohesion.

In summary, limited awareness, inadequate access to government schemes and programmes, weak inter-departmental coordination, and insufficient community participation have posed serious challenges to the preservation and promotion of Traditional Knowledge in Bundelkhand. These challenges constitute a major barrier to sustainable development in the region.

## Efforts toward Water Conservation in Jakhni Village:

In Jakhni village of Banda district, residents addressed water scarcity by independently reviving traditional knowledge and practices, without any external support. The community restored village Ponds, constructed check Dams, and adopted measures such as Farm bunding and Tree plantation to overcome the water crisis. This initiative stands as a powerful example of community-led action and has come to be widely recognized as the “**Jakhni Model.**”

## Traditional Water Sources

Ancient water structures such as Chandel tanks and Charakhari lakes, which have managed water resources for centuries, require concerted efforts at both the community and government levels for their rejuvenation.

*According to Dr. Mustafa Ahmed, Head of the Krishi Vigyan Kendra, Orai, paddy cultivation in the region covered approximately 1,800–2,000 acres in 2018. At present, this area has expanded significantly to around 5,000–6,000 acres.*

## Conclusion:

It can be stated that Bundelkhand is rich in Traditional Knowledge, which can be effectively utilized to build resilience in the region. Traditional Knowledge and Practices prevalent in the Agriculture and Water sectors, such as soil and water conservation, use of local seeds and crop varieties, and agro-forestry based systems not only make agriculture more drought-resilient but also play a significant role in improving nutrition, income, and environmental conservation.

There is a strong need to transfer this Indigenous Knowledge from one generation to the next and to make young people aware of its importance while actively engaging them. Practices such as field bunding and Traditional Water Management, combined with the cultivation of low water requiring crops, help enhance soil fertility, build the capacity to withstand drought conditions, and secure livelihoods. These practices are therefore highly relevant and valuable even in the context of modern agriculture.

