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Indigenous practices used by women in the conservation of natural resources

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Abstract

The conservation of natural resources, particularly soil and water, is essential for sustaining agricultural productivity, especially in a country like India, which has long been recognized for promoting traditional conservation methods. However, due to India's vast geographical area and diverse climatic conditions, these traditional practices cannot be universally applied, making it necessary to evaluate them carefully and validate them scientifically. Rural women in India play a pivotal role in farming and other agricultural activities, contributing significantly to natural resource conservation. The study was conducted in nine villages within three talukas—Dantiwada, Danta, and Vav—in the Banaskantha district of Gujarat. Data were collected from 180 randomly selected respondents (20 rural women from each village) through detailed questionnaires and personal interviews. The findings highlighted that the majority of women used indigenous soil and water conservation practices at a medium to high level. Out of the ten identified indigenous practices, seven—farm pond construction, vegetative barriers, crop rotation, intercropping, windbreaks, cover crops, and strip cropping—were found to be scientifically valid for the region. Therefore, it is recommended that these practices be actively promoted and efforts be made to increase the use of indigenous methods by women through additional training and exposure.

Keywords: Indigenous knowledge, rural women, soil conservation, water conservation, natural resource management, sustainable agriculture

Introduction

Agriculture holds a significant place in the Indian economy, with over 70% of rural households relying on it for their livelihoods. However, despite its critical role, the sector's contribution to the total Gross Value Added (GVA) has decreased from 35% in 1990-91 to 18.4% in 2022-23 ^[1]. One of the key factors behind this decline is the improper use of natural resources, particularly soil and water. Soil and water are most important natural resources but limited in nature. Soil is considered as the most basic of all resources and primary substrate for growing crops as it is non-renewable over the human timescales ^[2]. India's agricultural soils are under increasing pressure due to factors such as deforestation, improper irrigation practices, overuse of chemical fertilizers, and poor land management. It is estimated that about 30% of India's total land area—around 96.4 million hectares—is affected by soil degradation ^[3]. This includes soil erosion, nutrient depletion, and salinity, which reduce the productivity of agricultural land. The problem is particularly acute in arid and semi-arid regions, where wind and water erosion cause the loss of fertile topsoil, further exacerbating the risk of desertification ^[4]. Water resources in India are also under severe stress.

Groundwater, which accounts for around 62% of the country's irrigation needs, is rapidly depleting, with over 50% of wells in major parts of north-western and western states, already facing critical water levels ^[5]. Additionally, India's annual per capita water availability has decreased from about 5,177 cubic meters in 1951 to just 1,368 cubic meters in 2021, categorizing the country as water-stressed ^[6]. This decline is due to a combination of factors, including population growth, inefficient irrigation systems, and climate change-induced variability in monsoon patterns. Therefore, availability of water, both in terms of soil moisture and for irrigation and soil productivity remains the crucial factor in deciding the overall agricultural production. Recognizing these challenges, the Indian government has introduced several initiatives to conserve soil and water resources. Programs like the Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) aims to improve irrigation efficiency, while the National Mission for Sustainable Agriculture (NMSA) emphasizes sustainable farming through improved soil health, water conservation, and climate-resilient agricultural practices. Additionally, The Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) has also played an important role by

generating rural employment while supporting the creation of water harvesting and soil conservation structures, including check dams, farm ponds, and contour trenches. Although these initiatives have strengthened resource conservation in many regions, the agricultural sector continues to face challenges such as declining groundwater levels, land degradation, and the need for more efficient management of natural resources. The long-term success of watershed development programmes depends largely on the active involvement of local communities in planning, implementation, and management. It made policy makers to realize that conservation initiatives are more effective when indigenous knowledge and practices are integrated with scientific approaches and supported by community participation^[7].

The indigenous or local knowledge (IK) refers to the understandings and skills developed by individuals and populations, specific to the places where they live [8,9]. ITKs have a sound base as they have been tested and practiced over several years and are suited to the regional climate and agro-ecological conditions^[10]. The indigenous knowledge by local people especially women have great value in conservation. Their role is crucial as their daily responsibilities often involve managing and using natural resources to ensure their family's well-being. Studies have shown that indigenous methods such as farm pond construction, vegetative barriers, crop rotation, intercropping, and the use of cover crops have been instrumental in maintaining soil health and optimizing water use in agriculture^[11, 12, 13]. These methods are not only sustainable but are also tailored to the local environment and agro-ecological conditions. As such, they complement modern scientific approaches to resource management and contribute to the resilience of farming systems amid environmental changes. However, despite their importance, indigenous practices, and the women who apply them, are often overlooked in formal agricultural policies.

Therefore, there is an urgent need to not only document but also scientifically validate and refine these time-tested indigenous practices so that their applicability, sustainability, and effectiveness can be demonstrated on a wider scale^[14]. Against this backdrop, the present study has been undertaken with the dual objectives of systematically identifying and documenting the prevalent soil and water conservation practices rooted in indigenous technological knowledge within the study area, and scientific validation of indigenous practices on the basis of opinion of experts, academicians, researchers, and field practitioners.

Materials and Methods

This study employed an ex-post facto research design to assess rural women's indigenous knowledge of soil and water conservation practices in Banaskantha district, a semi-arid region in northern Gujarat known for its extreme temperatures and erratic rainfall^[15]. The district's dry climate, coupled with low rainfall and limited water resources, highlights the importance of effective soil and water conservation practices to sustain agriculture. Banaskantha district comprises 14 talukas, of which three—Dantiwada, Danta, and Vav—were randomly selected using a multistage random sampling method. From each taluka, three villages were randomly selected, resulting in a total of

nine villages being included in the study. In each village, 20 respondents were randomly selected, thus, a total of 180 rural women constituted the study sample.

A quantitative approach was employed to systematically analyze indigenous practices, supplemented by expert validation for scientific applicability. Data were collected through structured questionnaires, administered via face-to-face interviews in the local dialect. Responses were recorded on a three-point continuum scale (Always, Sometimes, and Never). To enhance depth and triangulate findings, Focus Group Discussions (FGDs) were conducted in each of the nine selected villages. Each FGD consisted of 8–10 participants, allowing researchers to gather contextual insights into the origin, transmission, and perceived effectiveness of various indigenous practices. The FGDs facilitated the identification of lesser-known practices and cross-verification of information collected through questionnaires.

To assess the scientific soundness of the identified indigenous soil and water conservation practices, a Delphi method was employed. A panel of 20 experts from relevant institutions—including the District Forest Department, the College of Renewable Energy (SDAU), Krishi Vigyan Kendra, and local NGOs—participated in two iterative rounds of evaluation using structured questionnaires. Experts categorized each of the ten selected practices as Scientific (S), Non-Scientific (NS), or Uncertain (UC). Practices receiving at least 75% consensus in the "Scientific" category were deemed scientifically validated. Data were analyzed using Microsoft Excel and SPSS to compute frequencies, percentages, and mean scores.

Ethical Consideration

Prior informed consent was obtained from all respondents before conducting interviews, and participation in the study was voluntary.

Results and Discussion

Distribution of the respondents based on indigenous practices used by women with regard to soil and water conservation

To categorize respondents based on their use of indigenous practices, they were divided into three strata: low, medium, and high levels of indigenous practice adoption. These categories were determined using the calculated mean and standard deviation of their indigenous practice scores.

Table 1: Distribution of the respondents based on indigenous practices used by women for soil and water conservation

S.no.	Indigenous practices	f	%
1.	Low level (< 9.9 score)	027	15.0
2.	Medium level (9.9 – 15.71 score)	117	65.0
3.	High level (> 15.71 score)	036	20.0
	Total	180	100.0

F= Frequency, % = Percentage n = Sample size

Majority of the respondents (65.0%) had been using indigenous practices at a medium level, while only 20% of women used them at a high level. In contrast, just 15% of respondents utilized indigenous practices at a low level for soil and water conservation. (Table 1) In conclusion, the data reveals that 85% of the women possessed indigenous

practices at medium to high levels for soil and water conservation. This is likely because these practices have been passed down through generations and are well integrated into their daily lives, making them both familiar and practical. The finding of this study with earlier report indicated a high level of perception among farmers towards soil conservation ^[16].

Distribution of the respondents according to each indigenous practices used by women for soil and water conservation

As evident from Table 2, the majority of respondents prioritized "crop rotation" (MPS 96.94) as their primary indigenous practice, using it to grow different crops in various seasons, ranking it first in the hierarchy. A significant proportion also followed other indigenous practices such as "no-till farming" (MPS 94.72), "windbreaks/planting trees" (MPS 87.50), "strip cropping" (MPS 86.94), and "cover cropping" (MPS 80.00), which were ranked second, third, fourth, and fifth, respectively.

Table 2: Distribution of the respondents according to each indigenous practice used by women for soil and water

S.no.	Practices	MPS	Rank
1.	Crop rotation	96.94	1
2.	No-till farming	94.72	2
3.	Wind break/ Plant trees	87.50	3
4.	Strip cropping	86.94	4
5.	Cover cropping	80.00	5
6.	Vegetative barriers/ grass way	72.22	6
7.	Intercropping method to covering crops	70.83	7
8.	Construction of well	33.61	8
9.	Farm ponds construction	10.28	9
10.	Construction of traditional tank	07.78	10

MPS = Mean Percent Score n = sample size

Additionally, respondents utilized "vegetative barriers/grass way" (MPS 72.22) and the intercropping method (MPS 70.83) for covering crops, which were ranked sixth and seventh. However, the construction of wells (MPS 33.61), farm ponds (MPS 10.28), and traditional tanks (MPS 7.78) for rainwater conservation was rarely practiced, ranking eighth, ninth, and tenth, respectively. This is likely due to the low rainfall and sandy soil conditions in the Banaskantha district.

These results indicate that the majority of respondents preferred crop-related indigenous practices due to their economic benefits. While some women used construction-related indigenous methods, their lower participation may be due to their limited role in decision-making processes. These observations are consistent with Khandelwal *et al.* ^[17], highlighting women's active participation in crop rotation, cover cropping, vegetative barriers, as well as well and traditional tank construction.

Scientific validation of indigenous practices

Efforts were made to scientifically validate the identified indigenous practices, popular in the study area by seeking opinion of experts experienced in soil and water conservation. Following practices were identified and validated:

First practice: Construction of well

Indigenous well construction practices for water conservation involve traditional methods of building wells to access and store groundwater in regions where surface water is scarce ^[18].



Well construction

Data in Table 3 reveals that the "construction of wells" is considered scientific by all experts (100%), as its round shape aids in rainwater conservation by allowing water to be reached via steps descending to the water level. This stored water can be effectively used for irrigation, especially during water-scarce conditions. However, the respondents in the study area were not using this practice, likely due to the region's sandy soil, which may reduce its effectiveness.

Second practices: Farm pond

Farm ponds are traditional water conservation structures made by local materials commonly used in rural and agrarian communities to harvest and store rainwater for agricultural purposes ^[19]. The practice of "farm pond construction" is considered scientific by the majority of experts (85%), who argue that farm ponds are effective for conserving rainwater due to their square shape, which allows runoff to be captured. However, 10% of experts expressed uncertainty, citing concerns that farm ponds take up a significant portion of farmers' land. Additionally, 5% of experts deemed the practice unscientific, reasoning that it reduces water flow to other tanks and ponds in lower-lying areas. Despite these perspectives, farm ponds can store water for irrigation and help reduce soil erosion (Table 3). The majority of respondents in the study area were utilizing this practice, which aligns with the findings of Harikrishna & Naberia ^[20], who reported high adoption of farm ponds.

Third practice: Traditional tank

Traditional water tanks are man-made reservoirs designed to capture and store rainwater during monsoon seasons for use during dry periods. It is a cylindrical paved underground pit into which rainwater from rooftops, courtyards or artificially prepared catchments flows ^[21]. In a study, 70% of experts considered the construction of traditional tanks a scientific practice, supporting the idea that tanks are effective for conserving rainwater, storing water for irrigation, and recharging groundwater. However, 15% of experts considered the practice as unscientific, stating that these tanks are insufficient for rainwater storage due to poor

rainfall patterns in some regions. Another 15% of experts were uncertain, citing issues such as poor filtration, which leads to low water quality, and the high maintenance required to keep the tanks operational. Despite this, water stored in these tanks is still used for irrigation, although its quality may be compromised after heavy rainfall.

There remains little consensus on whether the practice can be fully deemed scientific, and further research is needed to explore improvements in water quality and filtration systems. In addition, respondents in the study area reported that they do not use this practice due to economic constraints, which highlights the need for cost-effective solutions to improve the sustainability of traditional tanks. (Table 3).

Table 3: Scientific validation of indigenous practices used by women for the conservation of natural resources (n = 20)

No.	Indigenous practices	Degree of importance (%)		
		S (%)	US (%)	UC (%)
1.	Construction of well	100	00	00
2.	Farm ponds construction	085	05	10
3.	Construction of traditional tank	070	15	15
4.	Vegetative barriers/ grass way	080	05	15
5.	Crop rotation	085	05	10
6.	Intercropping method of covering crops	085	05	10
7.	No-till farming	050	25	25
8.	Wind break/ Plant trees	095	05	00
9.	Cover cropping	080	05	15
10.	Strip cropping	095	05	00

%= percentage, n = sample size

Fourth practice: Vegetative barrier/ grass way

A vegetative barrier is a natural soil conservation technique that involves planting strips of dense vegetation, such as grasses or shrubs, along contours or at intervals on sloped land. These barriers slow down surface water runoff, which helps prevent soil erosion and promotes water infiltration into the ground [22].



Grass way

The majority of experts (80%) regard vegetative barriers as a scientifically sound method, highlighting their ability to minimize surface soil erosion during rainfall. These barriers are also helpful in diverting runoff to stable outlets, trapping sediment-borne and soluble contaminants, and aiding in their transformation. In contrast, 5% of experts view this practice as unscientific, believing that vegetative barriers do not effectively prevent or mitigate slope failures. Meanwhile, 15% of experts were uncertain about the practice. Respondents reported using various plants and grasses, such as brinjal, tomato, pigeon pea, cow grass, and lawn grass, as vegetative barriers. (Table 3).

Fifth practice: Crop rotation

Crop rotation is the practice of growing a sequence of different crops in the same area over a series of growing seasons. This practice reduces soil health, pest control, and overall crop yields [23]. The practice of crop rotation is viewed as scientific by the majority of experts (85%), who believe it enhances soil nutrient levels. However, 10% of experts expressed uncertainty, citing the additional costs associated with planting different crops.



Crop rotation

Meanwhile, 5% of experts considered it unscientific, arguing that rotating crops seasonally based on environmental factors is more challenging. Despite this, crop rotation is recognized for maintaining soil nutrients, which improves both the quality and quantity of yields. In the study area, respondents practiced crop rotation by growing wheat and potatoes during the winter season and peanuts during the monsoon season. (Table 3).

Sixth practice: An intercropping method for covering crop

Intercropping is an agricultural practice where two or more crops are grown simultaneously on the same field, following specific spatial patterns and arrangements to maximize resource use. The main goal is to improve productivity by utilizing light, water, and nutrients more efficiently than in monocropping system. As a covering crop, intercropping provides soil protection by offering ground cover, reducing erosion, improving soil fertility, and boosting biodiversity [24].



Intercropping

Data in Table 3 indicates that 85% of experts consider the "intercropping method for covering crops" to be scientifically valid, mentioning its ability to optimize soil use on the same plot of land. However, 10% of experts expressed uncertainty, citing the risk of crop disease, and 5% considered the method unscientific, claiming that mixed cropping could negatively impact soil fertilization. Despite these concerns, intercropping provides flexibility, allowing one crop to be harvested while another matures, offering both income and insurance against crop failure.

Seventh practice: No-till farming

No-till farming is a soil conservation practice where the soil is left undisturbed during planting, and seeds are directly sown into the soil without tillage. In indigenous soil conservation, no-till farming has been practiced for centuries as a way to sustainably manage the land and protect the soil's fertility^[25]. Half of the experts (50%) consider no-till farming to be scientifically valid, highlighting its effectiveness in enhancing soil moisture retention and facilitating nutrient recycling. However, 25% of experts still view it as unscientific, arguing that continuous ploughing is essential for efficient farming. Another 25% remain uncertain, reasoning that no-till farming may not yield long-term benefits and can potentially cause gully formation in fields. They also express concerns that leftover plant material may not decompose quickly, leading to potential soil damage (Table 3).

Eight practice: Windbreak/ plant trees

Windbreaks are rows of trees or shrubs planted to reduce wind speed and protect the soil from erosion. Windbreaks play a critical role in soil conservation, particularly in regions prone to strong winds, such as arid and semi-arid areas^[26].



Wind break

The data in Table 3 indicates that the majority of experts (95%) consider the practice of "windbreaks/planting trees" to be scientific. This is because windbreaks are strategically designed in rows to shield crops from wind and help retain soil moisture. Additionally, planting trees can boost crop production and provide fruit-bearing trees for growers. However, 5% of the experts deem the practice unscientific, arguing that in the event of strong winds, trees could break and cause more damage to crops than the wind itself.

Ninth practice: Cover cropping

Cover crops are plants grown primarily to protect and improve the soil rather than for harvest. They are a key tool in soil conservation, often used between periods of regular crop production to prevent soil erosion, improve soil fertility, and maintain soil structure^[27].



Cover crop

The data in Table 3 indicates that the majority of experts (80%) consider the practice of using a "cover crop" to be scientific. This is because growing a smaller crop connected to the soil helps suppress the growth of unwanted plants and restores soil fertility, while a taller crop provides protection from wind damage. However, 15 per cent of the experts considered uncertain as they argued cover crop is home of unwanted insects in roots of cover crop and 5 per cent of expert considered unscientific as they reason is that the farmers are using extra fertilizer or pesticides. Thus, cropping can be used for canker reduction and reduce soil erosion.

Tenth practice: Strip cropping

Strip cropping is a soil conservation practice that involves planting alternating strips of crops across a slope or along the contours of the land. These strips are typically composed of different crops or combinations of row crops and cover crops. Table 3 clearly shows that the majority of experts (95%) consider the practice of "strip cropping" to be scientific. They believe that strip cropping effectively controls soil erosion and helps conserve rainwater due to the narrow strips of crops grown across the land's slope. However, 5% of the experts view it as unscientific, arguing that it reduces the overall crop yield. Despite this, strip cropping allows for easy crop rotation within the same area.

Conclusion

The study highlights the significance of indigenous practices

in soil and water conservation, with 85% of rural women already adopting such methods at medium to high levels. This highlights the crucial role women play in environmental stewardship, particularly through sustainable agricultural practices such as vegetative barriers, crop rotation, strip cropping etc. However, the relatively low use of traditional techniques like farm pond and tank construction reveals gaps in water conservation efforts. A panel of 20 experts conducted a scientific evaluation of ten indigenous practices used by these women. Of these, eight—including well construction, farm pond construction, vegetative barriers, crop rotation, intercropping with cover crops, windbreaks, cover cropping, and strip cropping—was deemed scientifically valid. However, some experts expressed uncertainty regarding two practices: traditional tank construction and no-till farming. The findings recommend that the scientifically validated practices be disseminated more widely to enhance the conservation of natural resources. Additionally, practices that experts considered uncertain or lacking scientific backing, require further research and development. Bridging the gap between traditional wisdom and modern sustainability initiatives is essential for promoting more effective natural resource management.

Recommendation

Based on the study findings, it is recommended to promote scientifically validated indigenous practices (e.g., vegetative barriers, crop rotation, intercropping) through government/NGO-led training programs, especially focusing on rural women as key agents of environmental conservation. Furthermore, traditional techniques like tank construction and no-till farming, which received mixed responses from experts, should be subjected to localized scientific studies to assess their effectiveness and adaptability under varying agro-climatic conditions.

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Author's Contribution

Conceptualization and designing of research work (N. Khandelwal, S. Jai & P. Dashora)

Execution of field/lab experiments and data collection (N. Khandelwal)

Analysis of data and interpretation (N. Khandelwal, S. Jain & P. Dashora)

Preparation of manuscript (N. Khandelwal)

Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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