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Water Management in the Arid Agriculture: A Case Study of Chohtan in Barmer District

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ABSTRACT

Agriculture is a major consumer of water in arid regions. Research by the Food and Agriculture Organization (FAO) emphasizes the importance of adopting precision irrigation techniques. Drip irrigation systems and soil moisture sensors significantly reduce water wastage, optimizing agricultural water use. Water management is done in Chohtan in Barmer, Rajasthan

KEYWORDS: *agriculture, FAO, irrigation, management, Chohtan, Barmer*

INTRODUCTION

Chohtan is a village and tehsil headquarters in Barmer district of Rajasthan state. There are several temples in the area,including Viratra(Vankal), Deri Dungar, Sunya Temple, Kapaleshwar, Krishna Temple, Verthan.[1]

Geography

Chohtan is surrounded by hills in the west and north and by desert in the east and south. The village is located approximately 48km from district headquarters Barmer. They are connected via road. Its location near the border with Pakistan makes it a place of strategic importance. Festivals and other events are celebrated by people. People here are very religious. There are temples, some of them are Jain temple, Viratra Mata Tample, Verthan temple and Shiva temple. In ancient time Chohtan is known as Pandva's Tapo Bhoomi because they resided there.

In the rainy season, natural ponds emerge and water falls can be visited by tourists. From Chohtan there are regular bus service between all major cities like Jaipur, Jodhpur, Jaisalmer, Ajmer, Ahmedabad, Mumbai and Surat.

The Barmer district extends from 70050’ to 72052’ East longitude and from 24058’ to 26032’ North latitude. It is situated in the south western corner of the Rajasthan and is a parts of Thar Desert. It is surrounded by Jaisalmer district in north, Jalore in south, Pali, Jodhpur in the east and Sindh province of Pakistan in the west. Barmer is one of the oldest habitations of the Indian Thar. The administration is exercised through 14 Tehsils and 17 Blocks namely Sheo, Baitu, Pachpadra, Siwana, Gudamalani, Barmer, Ramsar and Chohtan and 479 gram panchayat. It has 2479 villages. The population of this district as per the census 2001 was 19,63, 758 (M 10,35,813, F- 927,945) Gender ratio is 896 female/ 1000 male. The population density of the district is 69 per Sq. Km. The literacy percentage is 59.65 (male – 73.64, female – 43.91). District per capita income is just Rs. 2824, contribution of Barmer district in the total income of the state is as low as 2.5% status of livelihoods is also very poor. Education level is even worse as district is on the bottom.

REVIEW OF LITERATURE

The vital problem which the farmers have to face very often is to keep the crop plants alive and to get some economic returns. The following have been realized as the major constraints in agricultural production in Barmer districts.

Unfavorable weather condition

Water scarcity is a serious problem of this region. The rains are very erratic, uncertain and unevenly distributed. There is a possibility of goods rainfall after 3-4 years internal. A 100 year rainfall data shows that there was 61 times famine in last 100 year out of which were 24 Severe famine and were medium famine.

Abnormal Soil condition conduction

Undulated soil are affected by soil erosion soils are poor in fertility condition, low WHC and organic matter. Salinity problem is also found in Balotra, Siwana block.

Seed Constraints

Inadequate availability, poor quality seed, high price and untimely supply.

Agronomic constraints

Improper sowing time, inadequate seed rate, defective method of sowing, inadequate, intercultural operations, insufficient irrigation, less use of organic manure and fertilizers etc.

Plant protection constraints

Farmers do not adopt plant protection measures.[1,2]

Lack of proper water harvesting technology

Poor socio economic condition of farmers

Poor marketing of the produce.

Larger holding size and wide spread of villages

Miscellaneous constraints

Lack of electricity supply.

Lack of credit in time

Lack of appropriate machinery

Poor storage and processing facilities

Agro Climatic Zones IA (Arid Western Plain)

Agro-Climatic Zone	Characteristics
1 (A) Arid western plain	Arid western Plan Zone 1-a of Rajasthan state has cultivated area of 27 m ha which is 53% of the geographical area. Sand dunes and desrt soils occupy major area in the zone. There are aeoline soils and loamy fine to coarse and calcareous at places. Rainfall in the zone ranges from 200 mm in the west to about 370 mm in the East and occurrence of drought is not unusual feature. The zone covers four of six tehsils of Jodhpur (Phalodi, Shergarh, Osian and Jodhpur) and all tehsils of district Barmer. Pearl miullet is the predominant crop of the zone followed by cluster bean and moth bean. Sesame and green gram are other important kharif oilsed and pulse crops, respectively. Only 7 per cent cropped arera is under irrigation. Cumin rapeseed & mustard wheat and Isabgol are major crops grown in rabi season.

A. Agro Ecosystem

Agro Ecological Situation	Characteristics	Blok Covered
AES-1	Flat older alluvial plain with coarse textured shallow to moderate to deep sandy soil with scattered hummocks and gravelly pediments. Average rainfall 200-250 mm. Mono-cropping cultivated in rotational intensity 20-60%	Sheo Baitu Barmer
AES-2	Sand dunes with inter dunal plains, soil associated with dune complex Average rainfall 175-250 mm Mono-cropping cultivated in rotational intensity 30-80%	Dhorimanna Chohtan Barmer Sindhari
AES-3	Flat older alluvial plain with coarse textured deep soils followed by medium to fine textured deep soil. Average rainfall 275-350 mm Mono-cropping cultivated in rotational intensity 60-100%	Balotara Siwana Sindhari

Soil and Water Conservation

Wind erosion control, Wind break & shelter belt, Cover crops, Crop rotation, mulching etc Moisture conservation. Efficient use of available water by use of sprinkler & drip irrigation system, Organic manure, Deep tillage, Organic matter etc.

Water Harvesting

Farm pond, anicut, water harvesting cum check dam, water diversion & spreading (traditional khadin), roof water harvesting. Traditional water harvesting structure Tanka, Nadi, Pond, Hohad, anicut etc.

Soil Fertility Management

Promotion of integrated nutrient management practices by using compost, vermi compost, NADEP compost, biofertilizer etc, Deep ploughing in suitable field only, Growing of legumes, Soil and water testing[1,2,3]

Improved Package of Practices for Dryland Crops

Management of Pasture Land

Development of oran & gochar land

Establishment of small pasture land at individual farmer's land

Suitable grass – Sewan grass, Dhaman grass

Fodder trees- Khejri, Ber, Babool, Siris, Neem, Kummat

Establishment of Arid Fruit Orchard

Ber, Aonla,Gonda, Leshwa,Kair, Pilu

Cultivation of Medicinal Crops

Gugal, Sonamukhi, Aloe, ashgandh etc.

Alternate Land Use Systems

For arable lands

Agro horticulture system e.g. Ber with moongbean / mothbean / guar

Agri-silviculture system (inter cropping with NFT'S)

For non arable lands

Pasture development

Tree farming e.g. Kummat, Rohida etc.

Value Addition and Post Harvest Management

Collection & processing of – Ker, Sangri, Kummat, Kachari, Tumba, Watermelon seed etc., Pilu Sharbat, ber candy etc.

Promotion of Income Generation Activities

Kummat gum farming,Ber budding

Establishment of agro based industries

Gum factories, Isabgol processing Unit, Castor Oil Expeller, Moth based papad, Dal, Bhujia , Mangori (Nugget), Vada etc.

Management of saline soil and water

Establishment of Seed Bank and SeedVillage.

Promotion of bio fencing

Cactus, sagargota, ber, karonda etc

METHODOLOGY

1. Drip irrigation

Drip irrigation is the most efficient way to provide crops with the necessary water and nutrients for optimal growth. This method delivers water and nutrients directly to the root zone of each plant in precise amounts and at the right time. As a result, farmers can achieve higher yields while using less water, fertiliser, and energy. Drip irrigation allows for precise and targeted application of resources, reducing waste and maximising the efficiency of water and nutrient use in agriculture.[3,4,5]

2. Capturing and storing water

Water harvesting and reuse systems are designed to collect and store runoff and stormwater, which can be used later for various purposes. These systems have local benefits, such as reducing runoff volume and preventing water quality degradation downstream.

They also contribute to sustainable water management by utilising collected water for future use, reducing reliance on freshwater sources, and promoting water conservation. These systems provide multiple benefits, including local water availability, reduced runoff, improved water quality, and enhanced overall water resource management.

3. Irrigation scheduling

Irrigation system managers use irrigation schedules to determine the appropriate frequency and duration of watering. Water management takes into account the method of irrigation, as well as the amount, timing, and frequency of water application. Farmers regularly monitor weather forecasts, soil moisture, and plant conditions to adjust their irrigation schedules accordingly and prevent both under-watering and over-watering of their crops. This proactive approach helps optimise water use, ensuring that crops receive the right amount of water at the right time for optimal growth while avoiding water waste and potential negative impacts on plant health and productivity.

4. Crops resistant to drought

Farmers can enhance their crop productivity per unit of water by cultivating crops that are well-suited to the local climate. Drought-resistant crops are particularly advantageous, as they can reduce the risk of crop failure during periods of water scarcity, improve overall yields, and enhance economic stability for farmers.

Additionally, these crops can contribute to water conservation efforts, which are vital for sustainable agriculture and environmental preservation. By growing crops adapted to the local climate and requiring less water, farmers can optimise water use, mitigate risks associated with drought, and promote long-term sustainability in agriculture.

5. Dry farming

Dry farming is a method of crop production that does not rely on irrigation during dry seasons, but instead utilises moisture stored in the soil from the previous rainy season. It is a location-specific, low-input strategy for growing crops within the constraints of the climate. In this approach, a crop may receive minimal irrigation or none at all.

This method emphasises maximising the natural moisture content of the soil and adapting crop choices and management practices to suit the local climate, with the goal of achieving sustainable crop production with minimal water use.

6. Rotational grazing

Rotational grazing involves moving livestock across fields in a planned manner to promote pasture regeneration. Proper grazing management practices enhance the fields' ability to absorb water and minimise runoff, leading to more drought-resistant pastures. This approach offers water-saving benefits, as it can increase soil organic matter and improve fodder coverage, leading to improved water retention in the soil. By carefully managing grazing patterns, farmers can optimise pasture water use, improve pasture quality, and enhance drought resilience, ultimately contributing to sustainable livestock management and better water resource utilisation.

7. Compost and mulch

The combination of compost and mulch can be highly effective in improving soil health and fertility. Compost is incorporated into the soil prior to planting, while mulch is applied around plants after they have been established. Both compost and mulch can be produced on-farm, making them a cost-effective technique for farmers to enhance soil quality. Compost enriches the soil with organic matter and nutrients, while mulch helps conserve moisture (by slowing evaporation), suppress weeds, and moderate soil temperature.[5,6,7]

8. Conservation tillage

Conservation tillage refers to a collection of farming techniques aimed at reducing soil erosion, conserving water, and enhancing soil health. These practices create a protective layer on the soil surface that helps retain moisture, making them particularly beneficial in regions with limited water availability or frequent drought conditions. By minimising or eliminating traditional tillage methods that disturb the soil, conservation tillage helps maintain soil structure and organic matter, reduce water runoff, and prevent erosion.

9. Cover crops

Cover crops play a vital role in protecting bare soil from erosion, water loss, and compaction by providing a protective layer that reduces the impact of wind and water erosion. They also compete with weeds for water and nutrients, helping to control weed growth and potentially reducing the need for herbicides and other chemical inputs.

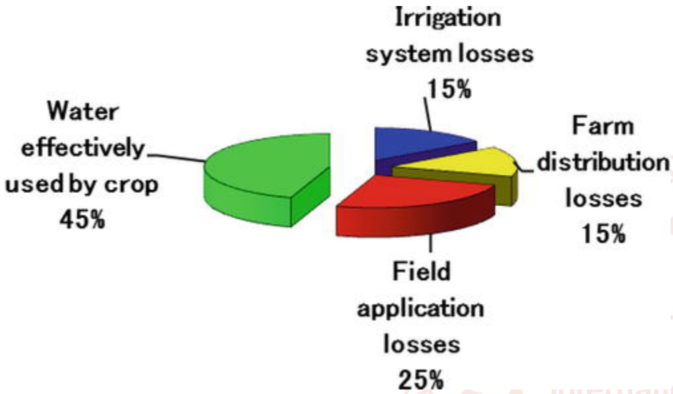
Cover crops are a form of carbon farming practice that can enhance water preservation and soil health. They are planted between primary crop cycles to protect the soil from erosion, improve soil fertility and water retention, and offer additional benefits such as weed suppression.

10. Organic farming

Organic farming encompasses a set of farming techniques that prioritise using natural methods and materials to promote soil fertility, reduce reliance on synthetic chemicals, and conserve water. For instance, crop rotation helps to diversify the types of crops grown in a field over time, reducing the risk of nutrient depletion and pest buildup and promoting healthier soils that can retain water better.

DISCUSSION

In Chohtan, Barmer, Rajasthan



Water-shortage crisis in Chohtan is threatening the food production and sustainable development around the world. Especially for arid agricultural regions, it is necessary to plan sustainable agricultural water management strategies for improving water use efficiency.[6,7,8] But there are many complexities in it, such as multiple decision-making levels, objectives, water users and uncertainties. To effectively tackle these complexities, this study presents a novel optimization-modeling approach consisting of a multi-level multi-objective stochastic programming (MLMOSP) model and weighting quantification method for formulating sustainable water-allocation schemes in arid agricultural regions. The MLMOSP model incorporates multi-level programming, multi-objective programming, and stochastic expectation programming into a general framework. The proposed approach is capable of: 1) quantifying key factors affecting water-allocation systems through weighting quantification methods; 2) describing the main conflicting objectives of each decision-making level, including economic benefits, environment impacts, fairness, effectiveness, and crop yield; 3) considering tradeoffs among conflicting objectives, and 4) reflecting the leader-follower relationship under different scenarios of surface water availability at a regional scale and a monthly temporal resolution. The proposed approach is applied to a real-world case in a typical arid agricultural region of northwest China for verifying its validity. From this real-world case, it is found that: 1) optimization results corresponding to different flow-level scenarios of surface runoff can provide upper-, middle-, and lower-level decision makers with a set of decision alternatives to help identify the most appropriate management strategy; and 2) multiple model comparisons show that the MLMOSP approach can not only give more practical results guaranteeing the achievement of decision-making goals at different decision-making levels, but also help reduce groundwater extraction under different flow level scenarios of surface runoff.

RESULTS

There are several factors in Chohtan, Barmer, to consider while developing a water management plan: local climate, soil, freshwater availability, crops grown, technological capabilities, and more. Management strategies designed with these factors in mind can ensure sustainable water use and the continued success of agricultural systems.

Precision irrigation leverages technology to moisten crops more efficiently. As opposed to traditional uniform irrigation, precision techniques tailor agricultural use of water based on crop needs and environmental factors. Sprinkler irrigation, in which moisture is sprayed from above, and drip irrigation, in which moisture is delivered directly to the roots, both work well in agriculture to meet the needs of different soil types and crop varieties. Variable-rate irrigation (VRI) further enhances agricultural efficiency by allowing for precise management of watering cycles.[7,8,9]

The principle behind rainwater use is elegantly simple: capture rainwater during precipitation events and store it for later use, creating a supplementary source of water for agriculture that reduces dependence on external supplies and helps lessen the burden on already overtaxed rivers, lakes, and aquifers. Compared to groundwater or surface water for agricultural use, rainwater has the advantages of being free, widely available, and low in salts and minerals. A good case in point is the widespread installation of agricultural rainwater tanks, where they are used to sustain animals and irrigate crops despite an ongoing trend of drought

Drought-tolerant and native crop planting, as well as crop rotation, are successful management strategies that help promote sustainable agricultural water usage and minimize the effects of drought on plants and yields. Here's how each of these practices works towards the purposes of agriculture:

Use crop varieties that are specifically bred for their drought tolerance. Such features as deep root systems, reduced moisture loss through transpiration, and the ability to rebound from water-deficit stress allow these cultivars to thrive in arid environments.

Plant native crops that have evolved to flourish in the specific climate and soil, making them more likely to withstand drought and lessening your agricultural water use.

CONCLUSION

Rotate crops to make agricultural systems more resistant to abiotic stresses like drought and soil salinity. Crop rotation also enhances groundwater table levels and helps establish a balance between local water security and the needs of agricultural production[9]

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