Revival of Water Harvesting Methods in the Indian Desert

Dryland farming in desert areas is closely linked with the constraints of regional climate, economic return from available water, and other issues such as the legacy of native skills and preferences. In critical climatic zones the expected and effective rainfall is structured by local farmers who have used the desert for several generations. Rainfall determines the type of agriculture they follow. The limited crop-growing season in the Indian Desert led early residents to rely on only animal grazing or scattered rainy season (summer) farming of hardy cereals. But one group of native cultivators devised a rain-harvesting technique fully capable of growing winter season crops.

The nearby uplands and rocky grounds have been used as local catchments for collecting rainwater. Desert householders in older localities of Jodhpur and Bikaner cities used the terraces of their homes as catchments for collecting rainwater. Houses were designed such that all rainwater was collected in water tanks just below the house. Similarly, the cultivators followed a unique practice of water harvesting and moisture conservation in suitable deep-soil plots surrounded by some sort of natural catchment zone. These plots were rigorously built and managed to make the entire system a self-contained unit for winter cultivation. Under conditions of intense evaporation, the moisture threshold and soil fertility were maintained. The total energy input of rainwater, sand-silt-clay accumulation, and the cultivator's own activities were interwoven into a complete production system of winter crops. There was a progressive increase of yields every year as more and more fresh silt and clays accumulated and widened the vertical and horizontal dimensions of such plots. This is known as the khadin system of cultivation.

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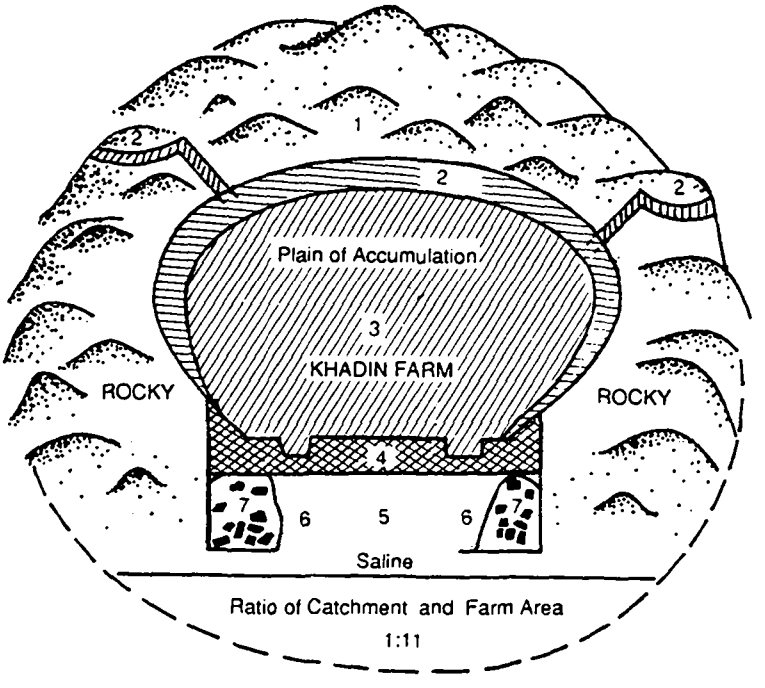
COMPONENTS OF THE KHADIN SYSTEM

The term *khadin* means a low-lying area where rainwater finds its natural way. With a little human effort these ponds are made into wider farm plots and are linked through embankments and trenches to higher grounds in the immediate vicinity. Within this water-tight system a small amount of rainfall will inundate the khadin. Rainwater will not remain on the surface of the pond but will percolate down into the porous soils of the entire farm, leaving it a muddy basin of alluvial silt and clays. Thus the khadin escapes the intense evaporation during the summer rain period.



COMPONENTS OF KHADIN SYSTEM

1 - Low Rocky Catchment Area
2 - Contoured Catchment Channels
3 - Khadin Farm with Ponds
4 - Earthen Bund, Spillways-Sluice
5 - Seepage Area
6 - Dug Wells
7 - Paliwal Settlements

The major components of the khadin system are water collecting areas (low rocky catchments), contoured bands (channels), moisture storage basins (khadin farms), water impounding mechanisms (bands, spillways, and sluice), and a zone of cultivator's settlement (the Paliwal village). Each component will be discussed below.

Low rocky catchment area. The rocky outcrops and denuded hills around Jaisalmer city are the preferred areas for khadin farms. In this part of the desert soils are relatively heavy and plains are almost dune free.

The channels. Rainwater is diverted along the foothill slopes through a mechanism of trenches and contoured banding channeling the entire runoff to the khadin farms. Since distances are short and channels are gravelled the seepage losses are minimal.

Khadin farm. At the foothill zone of the command area agricultural farms are developed in a compact amphitheatrical plain of accumulation. The depth, fertility, and moisture status of these farms increase every year by the deposition of new sediments. During the period preceding rains the entire area is covered by sand and dust storms. Following the rains these fine particles are washed into the khadins thereby enriching the nitrogen content derived from atmospheric sources. Even a short spell of torrential rain can account for rainfall much above 10 cm. This rainfall is just enough to provide moisture for several months.

Khadins exhibit a strange synthesis of native dryland farming with a highly efficient moisture conservation technique.

Since the rainy season crops (kharif) are not grown on these khadins, the losses of transpiration are nearly absent. The ratio of farmland and catchment area is regulated to be 1:11 so that a criticality of moisture supply is uniformly maintained. The water-holding capacity and water infiltration rate is balanced by the shallow depth of soils in these plots. The basement of khadins is invariably a rocky surface upon which sand-silt-clay is made to accumulate just to the depth of a few meters. This maintains a convenient supply of natural moisture and nutrients within the crop root zone.

Earthen bands, spillways, and sluice. For intercepting the rainwater and flash floods, earth and stone seals are raised at the lower end of the khadin. The impounded water is allowed to percolate in the khadin farm and as soon as the pot-like basin is full, the excess water flows off through spillways and sluice.

Paliwal village. After years of accumulation the elevation of khadin farms increases like that of pediment plains. The khadin is able to store in a sponge-like fashion the entire runoff of the upper catchments. The seepage from these farms sustains the fresh groundwater supply and other vegetation further downslope below the sluice gate. The Paliwal villages are located at these peripheral zones of vegetation.

AREAS OF KHADIN FARMS

Most of the khadin farms in the Indian Desert are located in Jaisalmer district (26°–1′ to 28°–2′ N latitude and 69°–29′ to 72°–20′ E longitude) in the extreme west of the state of Rajasthan. The area lies in a stable tropical desert environment. Average annual rainfall is less than 20 cm with a moisture index (MI) of –92 according to the Thornthwaite scale. The normal crop growing season is barely six weeks occurring during the months of extreme heat (July–August). The daytime temperature during this period remains as high as 50° C. In areas other than the khadin farms, people grow some pearl millet and fodder which partially meets their annual food requirement. With supplemental input from products of animal origin they live in the desert. But most frequently their economy becomes seminomadic especially during periods of drought. In the case of khadin cultivators the impact of drought is almost negligible.

Remnants of ancient anicuts, wadi floods, and runoff farming are also found in the dryland areas of Israel, Australia, and the United States. In India, the Haweli cultivation in Madhya Pradesh and in Israel the Avdat runoff farms of the Negev Desert have some close affinity to the khadin system. The major difference between these systems and the khadin system lies in the fact that the former systems are irrigation systems while the latter is only a moisture collection system.

PARAMETERS OF THE KHADIN SYSTEM

Climatic, terrestrial, and human factors determine the success of khadins. Climatic factors include flood-generating rains, long spells of dry periods, high values of evaporation, and overall scarcity of precipitation. Terrestrial factors that necessitate a special type of runoff farming include a suitable rock outcrop of sufficient area surrounded by pediment plains and near absence of surface water or groundwater. The long-range ecological impacts of flow irrigation in sandy areas are always detrimental to the soil stability. There is the obvious possibility of desiccation, salinization, flooding, and intense biotic deterioration in such areas.

The question of the eastward march of the Indian Desert has been a subject of much discussion since the publication of the report of the first Five-Year Plan of India (1950). The encroaching desert motivated national planners to monitor and control the spread of desert in otherwise non-desertic areas. Most of their apprehensions were later relieved on the basis of actual evidence of amelioration and recovery; but a new dimension of the problem was reported by the scientists of the Central Arid Zone Research Institute (CAZRI) — the biotic deterioration within the desert itself in the flag end areas of the Indira Gandhi canal system. The problem may be further intensified after irrigation reaches its full range of flow in and around Jaisalmer region. There are still signs of salinization and upward movement of brackish groundwater.

In the upper reaches of the canal there is no such problem where the canal system is fully developed and bringing all but prosperity. In the Ghaggar floodplain area around Suratgarh, Borpal, and Manekthar, every year 7,000 million cubic meters of canal water is being added to the groundwater zone raising the water table at least 20 cm each year. If the water table continues to rise further south and west of Jaisalmer — which is still lower, drier, sandier, and underlain by hardpan surfaces — the entire basin may become a salt (kallar) lake. It will

also become a potent source of shifting sand to nearby areas. This has happened at Nachna which received canal water only a few years ago. These negative aspects of flow irrigation have revived the interest in traditional water harvesting and conservation methods.

The desert people are efficient water conservationists. They use each and every drop of water for herds and crops in such a way that the productivity of the land is maintained and even enhanced. As the canal water has reached up to Mohangarh — some 649 km away from the headwaters of Sutlej — the main emphasis of its utilization has been changed from conventional irrigation agriculture to pasture development and filling of cattle drinking water ponds. The ancient khadins have been again utilized.

CROP CULTIVATION IN KHADINS

Khadins exhibit a strange synthesis of native dryland farming with a highly efficient moisture conservation technique. The cultivation is carried out without any flow channel irrigation — it is a sort of farming in conserved soil moisture. The sequence of farm operations starts after the rainy season in the months of October and November. During the period of rains (July–September) the khadins are left to be fully saturated with rainwater. No summer crop is raised in these farms. Household cattle and livestock are stocked near the mud beds. Their regular excreta adds to the fertility of the fields. In late autumn and early winter the farms are plowed and sowed. Wheat and chickpeas are grown without any irrigation. As the winter evaporation is low the crop gets enough moisture in the early growing period. By March the harvest is reaped. In the millet-dominated region of the Indian Desert the wheat crop fetches a handsome price. Khadins are the only areas where winter crops are raised under rainfed conditions.

REVIVAL OF KHADINS

The khadin system of cultivation has witnessed a fluctuating fortune. Evidence of khadin-type farms is not altogether absent in the lithic assemblage around the archaeological preserves of Kalibanga and Rang Mahal culture of the Indian Desert which are presumed to be of Harappan age (3000 B.C.). But actual khadin farms were first constructed by Paliwal Brahmins of Jaisalmer in the fifteenth century. The Paliwals were vegetarian natives of the desert who left the priesthood and became cultivators. They connected almost all the local catchments into a well-knit system of khadin land. They were able to cultivate all possible crops during even the worst years of drought. Their rapid prosperity was envied by the other users of the desert land, mainly the animal graziers, which led to occupational rivalry between the cultivators and seminomadic tribes. The industrious khadin owners guarded the runoff channels which were the lifeline for the sustenance of their farms. Several local wars were fought for the defense or destruction of diversion channels. The Paliwals were able to overcome all assaults.

But during the nineteenth century the Rajput rulers of Jaisalmer state joined hands with the pastoral nomads and the khadin farmers were persecuted and driven off by the mounting pressure of these groups. The rulers considered the

diversion of rainwater to a few khadin farmlands as a cause of frequent droughts. Rising population and proliferation of conventional agriculture in the eastern margins of the desert were prohibiting the widespread use of long-distance pastures. Some of the general famines in this part of India further added to the systematic annihilation of khadin farms. These rich cultivators had to leave the land. With them, they carried the wealth accumulated during many centuries of successful cultivation. Most of the Paliwals migrated and settled in Jaipur and Agra and developed business communities. The khadins were completely neglected and fell into disrepair. Still hundreds of ghost villages in the Jaisalmer region remain a living testimony of former booming settlements during the heyday of Paliwal supremacy.

It was only during the second half of the twentieth century that the government again recognized the need of khadin cultivation. Old khadins were repaired and new farms were constructed. Since the original khadin cultivators had lost the link with the area, the farms were leased to new cultivators. The government of Rajasthan state irrigation department has taken over the charge of repairing and maintaining these historical khadins. Since 1965 the government has repaired 66 khadins in Jaisalmer district. At present more than 500 khadin farms have been revived covering an area of 12,150 hectares of farmland. The state government is providing financial subsidies for the repair and maintenance of forgotten khadins under the Drought Prone Area Program (DPAP). The command area of each khadin is fixed individually as per requirement of the available water supply. New designs of farms are being developed to optimize the process of infiltration, runoff generation, routing, and soil water storage capacity. ◆

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Mobilizing for Reforestation

For decades the "poor stepchild of development agendas," reforestation is now gaining priority among governments, international agencies and private organizations a recent publication points out.

More than 320 million acres (130 million hectares) of tree planting, covering an area slightly larger than Ethiopia, will be needed by the year 2000 to meet growing demands for fuel and industrial wood products, to stabilize soil and water resources, and to help slow the global warming trend, write Sandra Postel and Lori Heise in Worldwatch Paper 83, Reforesting the Earth. "Collectively, global aid contributions to forestry are likely to increase from roughly $600 million in 1984 to over $1 billion in 1988."

Successful local and national projects — such as the agroforestry and tree farming program sponsored by the U.S. Agency for International Development in Haiti and the Greenbelt Movement in Kenya — are already showing the way and demonstrating in particular "the value and efficiency of working through NGOs that had grassroots networks alre in place. . . . Nature," note the Worldwatch authors in a strikin passage, "employs a wide variety methods for expanding tree cov coconuts that float between trop islands, aerodynamic seeds, and luscious fruits that attract anima carriers." Now, "Strategies equa diverse and ingenious are neede . . . Reforesting the earth is possi given a human touch."

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