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ARID AGROBIODIVERSITY AND CONSERVATIVE DESERT DWELLERS

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Over a large part of the State of Rajasthan, agriculture is a struggle against inhospitable nature. About a third of the state is stark desert - the Thar, which represents the harshest agricultural environment of India. Conservatism, as regards to agricultural practices and utilisation of agricultural produce is deeply ingrained in the cultivators of Thar desert and is the outcome of loosing everything year in and year out. In a bid to grow, multiply and utilise every blade of grass available, the desert dwellers have found out innovative means of sowing, managing, harvesting and utilizing agro-biodiversity around them. In fact, their livelihood and lives revolve around the genetic wealth which is used extensively and resolutely. Traditionally, they have been very conscious of conservation and have allowed multiplication and regeneration of plants even when utilising it. Some of the practices of biodiversity conservation are unique in this land and have strengthened the life support system of the area for facing challenges of inhospitable hot deserts. The awareness of phenological stages of plants, the optimum time of harvest, the quantum of utilisation and the amount of conservation is ingrained in the traditions and folklores. Though natural catastrophes, overgrazing and overutilisation has threatened plant genetic resources since ages, but in this century it is the fast pace of human intervention, much faster than nature and natural calamities that are a threat to such fragile ecosystems. The need is thus to understand and practice the conservation of desert wealth with the involvement of conservative desert dwellers and their indigenous technical knowledge (ITK) thereby promoting the conservation ethics and retaining the traditional cultural values.

Key words: Arid agrobiodiversity, Rajasthan, indigenous technical knowledge.

The Indian arid zone extending from 24° to 30° N and 70° to 76° E occupies nearly 32 million ha of land, of which 28.6m ha comprised the Thar desert of Western India in Rajasthan and partly States of Gujarat, Haryana and Punjab. Sandy soils of aeolian origin dominate the desert environment. Nearly 62 per cent of the area is occupied by dunes and interdunal plains. Agriculture, here, is a struggle against inhospitable nature. The scenario has been shifting from bad to worse in some situations due to natural resource constraints on one hand and submarginal lands, overgrazing of pasture land and indiscriminate cutting of vegetation for fodder and fuel are the main causal factors. If the cycle goes on without suitable interventions, the process may no longer be reversible. It is inevitable thus, to make the system sustainable and protect the depleting PGR by planning a farming system research (FSR) with maximum possible involvement of farmers/desert dwellers. Planning an on-farm system research requires a perfect understanding of what farmers are actually doing. Three sets of information are needed to initiate FSR- existing resources and socioeconomic conditions of people; their perceptions, priorities, requirements and indigenous technical knowledge.

NATURAL RESOURCES AND EXISTING SYSTEMS

The very reference of Rajasthan brings to our mind the vast number of shifting sand dunes, caravans of camels, scanty, scrubby vegetation and above all too frequent famines. About a third of the State is stark desert. Shifting sand dunes submerge the thin layer of good top soil in adjoining areas. The rainfall is scanty and erratic, resulting in drought conditions once every three years in eastern region and once every two years in the Western region. The State has no perennial rivers and the groundwater resources so far brought under exploitation are meagre. The water table lies very deep and much of the water is brackish and saline. The vegetation is sparse, consists of thorny, stunted shrubs and it occurs in open clump formations with spaces in between. It can be distinctively divided into ephemerals and perennials, is zerophytic in character and contain highly specialised plants (Bhandari, 1990).

THE DESERT DWELLER

Amidst all harsh environmental conditions lives the desert dweller, who had adapted their way of life so as to match the availability of resources and environment. Basically, the requirements are limited and they are very simple people.

Navi munjha ri khat, kay na choovay tapri,

Bhaisan la diya do char, kay na doojay bapri,

Bajar handa vot, dahi mein oolnan,

Itra dey karttar, pher na boolan.

(A bed of newly twisted cords, an unleaking roof, two or three milch cows, bajra bread with curd are all that I desire. If I get all this then I want no more)

They are also knowledgeable and have gradually acquired ways and means to learn about their surroundings, the weather, the crop and the management strategies to be adopted from natural phenomenon occurring periodically or seasonally.

Sawan patti panchmi, jo baje bahu baya,

Kal pare sare des mein, minakh minakh ne khaya.

(If strong winds blows on fifth day of the second half of sawan (July-August), it is a sign of country wide famine when man will eat man).

Sawan mein jo suryo chale, bhaduri purvai,

Asojan mein pichwa chale, bhar bhat quara lai.

(If the wind blows from north east in Sawan (July-August), from east in bhadon (August-September), from west in Asoj (September-October), the harvest will be a bumper one.)

Khad pare to khet, nahin to kori ret.

(Without fertilizer or manure, agricultural field is nothing but a heap of sand).

As a Custodian

The indigenous landraces of various crop plant species, their wild relatives, the wild and weedy species, shrub and trees that form the basis of arid/semarid plant genetic resources are all highly prized for their potential value as sources of important variations for crop improvement programmes.

Among the most important traits that are believed to exist in these materials are earliness, disease and pest resistance, nutritional quality, resistance to drought and other stresses and characteristics especially useful in low input agriculture. The existence of such diversity has special significance in maintenance and enhancement of productivity of agricultural crops of dry regions with harsh and diverse growing conditions. Such diversity provides security for the farmer against adverse growing conditions. It also allows farmers to exploit full range of highly varied microenvironments such as soil, water, temperature, altitude, slope and fertility. Diversity among species is specially significant to Indian arid region as it represents an important subsistence resource to farming communities in the country. A wide variety of plant and animal species provides material for food, fibre, medicine and other socioeconomic uses. Such diversity is also crucial to sustain current production systems essential for the livelihood of local communities.

As a Cultivator

In Indian arid region, the cultivator or the farmer is instrumental in conserving germplasm as they control the bulk of the specialised and unique genetic resources. His decision making is influenced by socio-economic factors, cultural factors, government policies and environmental factors, on one hand. On the other hand, his diversity management has consequences for the genetic structure of the crop and is also influenced by environmental factors through natural selection. Furthermore, although farmers cannot observe or appreciate the genetic structure of the crop, they gain knowledge of morphological traits expressed (e.g., yield, plant stature, resistance to drought, insects). This knowledge is in turn used in their decision making processes regarding their management of diversity as is done by farmers all over the world (Bellon *et al.*, 1997).

Despite modernisation in agriculture and modern varieties, the small farmer of this region is very conservative in his approach to accepting a change. They use modern varieties, especially of bajra, but yet they continue to grow locally adapted or desi varieties. They grow mostly rainfed crops (bajra, mung, moth, guar and til) and some irrigated crops like chillies, groundnut, wheat and brassica wherever irrigation facilities are available.

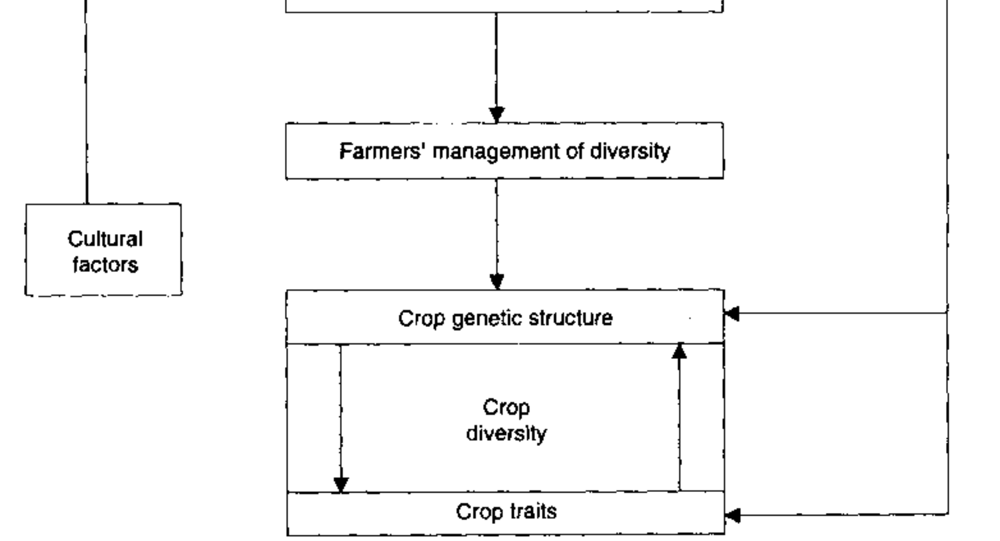

Fig. 1. Conceptual model of the factors that influence farmers' management of diversity

Fig. 2. Sowing of crops in mixtures to ensure survical of at least few of them in the event of drought. Seen here are plants of cucurbits, bajra, mothbean and mungbean crop.

Fig. 3. Selective pruning of khejri trees leaving behind few apical portions to ensure regeneration of entire tree.

As a Consumer

He uses every blade of grass available :

Ak ra jhopra, phog ra bar,

Bajra ri roti, moth ri dal,

Dekho ho raja, teri marwar

(We live in huts made of *Calotropis* plants, put fences of *Calligonum* and other plants, we eat roti (bread) made of pearlmillet flour along with dal of moth. This is all about your Marwar O'King). Some of the major plants used by desert dweller are as in Table 1.

As a Conservor

Conservation efforts as regards to agricultural practices and utilization of agricultural produce is deeply ingrained in the desert dweller; a sad outcome of loosing everything year in and year out. They have devised several ways and methods to conserve plant, vegetation, trees, shrubs and agricultural produce in usable form.

Farmers always retain some seed stock of numerous crops for severity unless disruptive circumstances prevent them from doing so. Mechanism have also been developed for safe storage of seeds.

Individual farmers often store seeds in clay pots and straw baskets which are sealed, buried or stored in secure places. Length of storage may vary from a year as seed stock, for food in current year or for long term storage for some social event. In times of famine, farmers bury their seeds in some secured place within farm premises

Table 1. Some plants commonly used by desert-dwellers

Forage Plants	Medicinal Plants	Industrial Plants	
Lepidagathis cristata	Barleria prionites	***Fibre Plants:***	Acacia nilotica
Pluchea lanceolata	Blepharis indica	Calotropis gigantea	Acacia planifrons
Tecomella undulata	Lepidagathis cristata	Calotropis procera	Acacia senegal
Sarcostemma	Wrightia tinctoria	Leptadenia pyrotechnica	Prosopis cineraria
pauviflorum	Sarcostemma acidum	Opuntia elatior	Flacourtia sepiaria
Opuntia elatior	Dicoma tomentosa	Cordia dichotoma	Moringa oleifera
Kochia indica	Heliotropium strigosum	Acacia leucophloea	Calligonum polygonoides
Anogeissus pendula	Boswellia serrata	Butea monosperma	Mitragyna parviflora
Acacia nilotica	Opuntia elatior	Crotolaria burchia	Morinda citrifolia
Acacia planifrons	Capparis decidua	Sida cordifolia	Ailanthus excelsa
Acacia senegal	Haloxylon recurvum		
Alhagi psuedalhagi	Kochia indica	***Fuel Plants :***	***Dye and tannin plants***
Crotolaria burhia	Cressa cretica	Aerva persica	Wrightia tinctonia
Crotolaria medicagenia	Citrullus colocynthis	Leptadenia pyrotechnica	Kochia indica
Prosopis cineraria	Euphorbia caudicifolia	Sarcostemma acidum	Anogeissus pendula
Rhyncosia aurea	Acacia senegal	Boswallia serrata	Acacia nilotica
Rhyncosia minima	Butea monosperma	Capparis decidua	Butea monosperma
Anamitra cocculus	Crotolaria burhia	Haloxylon recurvum	Cassia auriculata
Aristida adscensionis	Crotolaria medicagenia	Euphorbia caudicifolia	Morinda citrifolia
Cenchrus ciliaris	Dichrostachys cinerea	Securinega leucopyrus	
Cenchrus setigerus	Mimosa rubicaulis	Acacia jacquemontii	***Gum, wax and***
Cympogon jwarancusa	Prosopis cineraria	Acacia nilotica	***resin Plants:***
Dactylolectenium	Flacourtia sepiaria	Acacia planifrons	Sarcostemma acidum
aegypticum	Secrinega leucopyrus	Acacia senegal	Boswellia serrata
Dactylolectenium	Leucas cephalotus	Prosopis cineraria	Commiphora wightii
indicum	Leucas utricaefolia	Moringa oleifera	Anogeissus pendula
Desmostachya	Anamitra cocculus	Calligonum polygonoides	Acacia jacqemontii
bipinnata	Mollugo nudicaulis	Zizyphus nummularia	Acacia nilotica
Eleusine compressa	Chionachne koenigii	Mitragyna parviflora	Acacia senegal
Elyonurus hirsutus	Cymbopogon	Balanites aegyptica	Butea monosperma
Eragrostis ciliaris	jwarancusa	Grewia tenax	Prosopis cineraria
Lasiurius ecaudatus	Desmostachya bipinnata	***Timber Plants:***	Moringa oleifera
Melanocenchris	Zizyphus nummularia	Wrightia tinctoria	Salvadora oleoides
jacquemontii	Morinda citrifolia	Tecomella undulata	Salvadora persica
Panicum turgidum	Salvadora oleides	Boswellia serrata	Ailanthus excelsa
Sehima nervosum	Salvadora persica	Anogeissus acuminata	
Zizyphus nummularia	Ailanthus excelsa	Anogeissus latifolia	
Salvadora oleides	Balanites aegyptica	Anogeissus pendula	
Salvadora persica	Tamarix troupii	Anogeissus rotundifolia	
Ailanthus excelsa	Grewia tenax	Cordia dichotoma	
Grewia tenax	Clerodendrum phlomidis	Cordia gharaf	

Fig. 4. Some permanent/semi permanent structures created for long term seed storage in villages by desert dwellers. They store entire cereals and pulses in these structures even today.

before they migrate to other regions, returning to reclaim and plant the seeds after the drought is over. The desert dwellers have also been instrumental in creating, maintaining and promoting crop genetic diversity through a series of other long standing activities which include sowing of mixture of seeds in order to ensure survival of atleast one or two type of crop (Fig. 2), planting trees in farm, optimum drying of seeds, optimum pruning of trees especially khejri trees (Fig. 3), etc. They have also designed storage structures for seeds (Fig. 4) like *kinaras, kothis*, etc. They mix the seeds with *rakh* or ash (Fig. 5) and store the seeds. Specialized storage structures have also been developed for the storage of fodder and fuel for short as well as long term. Medicinal plants deserve special attention because not only are they of immense value in averting or treating common ailments but their conservation also means retention of the indigenous knowledge associated with their unique properties and correct applications.

THREAT OF GENETIC EROSION

The broad range of genetic diversity existing in Indian arid region (like in other arid regions of the world) particularly the primitive and wild gene pools, is presently subjected to serious genetic erosion and irreversible losses. This threat which

Fig. 5. An old desert dweller displaying the mixture of mung seeds and rakh kept for storage. She has been using this method since long now and is not aware of any other way the seed could be stored.

involves the interaction of several factors, is progressing at an alarming rate. The most crucial ones include displacement of indigenous landraces by new genetically uniform crop cultivars, changes and development in agriculture or land use, destruction of habitats and ecosystems and drought.

Famines and severe droughts sometimes force the farmers to eat their conserved seeds in order to survive or to sell the seed as food commodity. This often results in massive displacement of native seed stock by seeds of hybrid varieties provided by relief agencies in the form of food grains. Also a high proportion of alleles of the major crop plants have been conserved *ex-situ*, with the evolutionary process nearly frozen in time, such that new germplasm is not generated (Worede, 1997). On the social front, there has also developed a communication gap between the youth and elders in farming communities which affects the flow of indigenous knowledge related to biodiversity and its utilization in farming systems (Damania, 1996).

NEED FOR *IN-SITU* CONSERVATION

The maintenance of species and genetic diversity in fields is an effective strategy that desert dwellers have long adapted to sustain a stable system of conservation for low input agriculture. *In-situ* (on site) conservation of land races on peasant farms which is also known as **evolutionary conservation** would therefore, provide a valuable option for conservation of crop diversity (Worede, 1991). More importantly, it will help to sustain the evolutionary systems that are responsible for the generation of genetic variability. This is especially significant in regions of the country subject to drought and other stresses, because it is under such environmental stresses that variation useful for stress resistance breeding is generated. Also, under these conditions, access to a wide range of local land races would probably provide the only reliable source of planting material. The ability of landraces to survive under these stresses is conditional by their inherent broad genetic base (Worede, 1997)

Under these extreme environments, locally adapted landraces would provide suitable base material for institutional crop improvement programmes. Thus, *in-situ* conservation provides a broad genetic base, maintenance of population structure, stability of population numbers and opportunities for future adaptive expansion. However, agricultural crop diversity cannot be preserved *in-situ* without simultaneously encouraging the traditional culture of the farm community which fostered it and protected it. There is therefore, an outstanding need to maintain landraces growing under these conditions in their dynamic state and this can probably be best achieved through farm or community based conservation programmes.

CONSERVATION AND UTILIZATION

The value of landraces to farming communities in region which are dry and with erratic rainfall lies in their utility as a dependable source of planting and breeding material. It is therefore, important that locally adapted/enhanced seeds are multiplied and distributed to farmers whose requirements have not been adequately met by modern high input cultivars. It may otherwise make very little sense to conserve landraces or may even be difficult to convince farmers to do so unless the landrace conservation activity is oriented towards supporting sustainable production.

The Community Seed Banks can be established. These are low cost technological systems that can be used and managed by local communities involving existing community service cooperatives. It comprises of two major components, a seed store and a germplasm repository for local crop improvement. The seed store represents a seed reserve system. The small traditional storage units clay pots, pits etc., form an integral part of traditional storage systems.

Lately, on-farm conservation (Altizeri and Merrick, 1987; Oldfield and Alcorn, 1987; Brush, 1991a) has been advocated to complement *ex-situ* conservation. For more than two decades, on farm conservation of crop and landraces was considered impractical and inappropriate (Arnold *et al*, 1986. However, concern in developing countries about the concentration of genetic resources in genebanks and the fact that static conservation halts evolutionary processes have opened a debate concerning the value and objectives of on-farm conservation methods. Rural societies maintain agricultural biodiversity because it is essential for their survival. They select and breed new varieties for the same reason. There is no useful distinction for them between conservation and development. Indeed, conservation as such may not be a concept known to farmers. On-farm conservation of local varieties is an existing strategy for food security. By its very nature on-farm conservation is dynamic because the varieties farmers use continue to evolve in response to natural and human selection. It is believed that in this way crop population retain adaptive potential for the future (Bellon, *et al.*, 1997).

Endowed with so much knowledge on use and conservation of indigenous plant species besides crop, the desert dwellers of Indian arid zone cannot be ignored during planning elaborative conservation programmes. In fact, the Vishnoi people, basically a farming community of Rajasthan have communal ownership of land and they assign rights to the whole ecosystem in the land under their influence. Their benevolent and peaceful disposition towards all forms of life precludes the cutting of living trees for wood and they have conserved innumerable forms of indigenous crops, flora and fauna for many centuries (Tiwari, 1993). Thus, they need to be involved as primary consultants of conservation programmes.

Till now more than 12,000 germplasm accessions have been assembled of diverse crops for *ex-situ* conservation. But little effort has been made to document the wealth of information available with these villagers on economic and medicinal plants, then utilize the information by actually finding the scientific principle behind each tradition and trying to upgrade this information and modify this information to be returned to villagers.

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REFERENCES

Altizeri, M. A. and L. C. Merrick. 1987. *In-situ* conservation of crop genetic resources through maintenance of traditional farming systems. *Economic Botany* **41**, 86-96.

Arnold, M. H., D. Astley and E. A. Bell. 1986. Plant gene conservation. *Nature* **319**, 615.

Bellon, M. R., J. L. Pham and M. T. Jackson. 1997. Genetic conservation : A role for rice farmers. *In* : Plant Genetic Conservation: The in-situ approach, (eds) N. Maxted, B. V. Ford-Lloyd, and J. G. Hawkes, Chapman and Hall, London, p 263- 285.

Bhandari, M.M. 1990. Flora of Indian Desert. MPS Repros. Jodhpur. 459p.

Brush, S.B. 1991a. A farmer-based approach to conserving crop germplasm. *Economic Botany* **45**, 153-165.

Damania, Ardeshir, B. 1996. Biodiversity conservation: A review of options complementary to standard *ex-situ* methods. *Plant Genetic Resources Newsletter* 107, 1-18.

Oldfield, M. L. and J. B. Alcorn. 1987. Conservation of traditional ecosystems. *Bioscience* **37**, 199-208.

Tiwari, J. K. 1993. Vishnois: The saviours of desert wild-life. *Hornbill* 3: 2-6.

Worede, M. 1991. Crop genetic resources conservation and utilization: an Ethopian perspective. *In: Science in Africa: Achievements and Prospects*, AAAS, Washington, DC, p103-123.

Worede, M. 1997. Ethopian in situ conservation. *In*: Plant Genetic Conservation : the *in situ* approach, (eds) N. Maxted, B. V. Ford-Llyod and J. G. Hawkes, Chapman and Hall, London, p 290-300.