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Effect of Landuse Systems on Soil Health in Arid Western Rajasthan

N.R. Panwar, J.C. Tewari, Mahesh Kumar, Khushbu Khichi, Prafful Joshi[1] and Ram Partap

ICAR-Central Arid Zone Research Institute, Jodhpur, Rajasthan

Introduction

Arid region in India is spread over in 38.7 million hectare area. Out of the total, 31.7 m ha lies in hot and remaining 7 m ha lies in cold region. The hot arid region occupies major part of north-western India (28.7 m ha) and remaining 3.13 m ha is in southern India.

About 62% area of arid region falls in western Rajasthan followed by 20% in Gujarat and 7% in Haryana and Punjab. Andhra Pradesh, Karnataka and Maharashtra together constitute about 11% area of arid region.

In the arid regions of Rajasthan, Haryana, Punjab and eastern Gujarat, aeolian and alluvium are the major formations. These aeolian and alluvial parent materials are the quaternary formations. During that period this region witnessed wide spread alluvial sedimentation. However, the overall environment was semi arid (Dhir *et al.*, 1994). The Dune forming aeolian activities began at least 200K years ago and terminated around 13,000 years B.P. (Singhivi *et al.*, 1983).

Land use is the human modification of natural environment of wilderness into built environment. India has about 18% of world's human and 15% of livestock population to be supported with only 2.4% of the world's geographical area and 1.5% of forest and pasture land (Ram, 2009). Per capita availability of land in the country has reduced from 0.4 ha in 1950-51 to 0.14 ha in 2000-01. With the prevailing trend it may be further reduced to 0.077 ha by 2020.

In the hot arid ecosystem of India low and erratic rainfall, extremes of temperature, high evaporation loss, saline and meagre groundwater, absence of perennial streams, and dune-covered and rocky/gravelly terrain, are the major factor influencing the land uses. Agriculture, which is the most dominant land use, is mainly rainfed and subjected to high risk and uncertainty.

The arid regions contribute significantly to the economy of India in terms of employment, land holding, mineral assets, crop, forage and livestock production, including dairy products and industrial production. This, despite a hostile climate and limited natural resource base. Soils in the drier regions have low reserves of soil organic matter which results in low fertility, as it serves as sink for nutrients in soil. Therefore, soil survey was conducted in 8 villages covering major agricultural systems and landuses prevailing in arid western Rajasthan to know the effect of various agricultural systems & land uses on soil health.

A total of 321 soil samples were collected from the surface (0-15 cm) layer to represent the entire watershed. Each sample was a composite of 4-5 cores, randomly collected from the area represented by a crop, prominent land uses and covering upper, middle and lower parts of landscape. These soil samples were collected from irrigated and rainfed systems, open scrub and fallow lands from a village. Soil samples belongs to irrigated (80), rainfed (151), khadins (52) and Oran/gochar (38) landuses. Soil samples were processed and analysed for various chemical properties using standard methods (Singh *et al.*, 2005).

The result clearly indicates soil samples are poor in fertility *w.r.t.* to soil organic carbon, available nitrogen, phosphorous, potassium, sulphur and micronutrients (cations) (Table 1).

Table 1. Physico-chemical properties of soil from different land uses

Soil Properties	Oran / Gochar	Rainfed	Irrigated (TW + C)	Khadin
Soil pH	8.41	8.47	8.61	8.51
EC (dS m^{-1})	0.099	0.186	0.313	0.262
O.C. (%)	0.160	0.134	0.164	0.190
Available N (kg ha^{-1})	77.4	66.6	86.9	93.1
Available P (kg ha^{-1})	6.16	9.29	11.34	1.89
Available K (kg ha^{-1})	200.0	192.8	184.1	330.3
Available S (µg g^{-1})	9.64	8.68	11.39	15.13
DTPA - Zn (µg g^{-1})	0.35	0.41	0.54	0.38
DTPA - Cu (µg g^{-1})	0.76	0.74	0.79	2.51
DTPA - Fe (µg g^{-1})	0.80	0.88	1.11	1.68
DTPA - Mn (µg g^{-1})	0.43	0.37	0.42	0.80
DHA (µg TPF/g soil/d)	34.4	63.2	75.5	68.3
$CaCO_3$ (%)	1.19	0.93	1.04	2.25
50% GR (t ha^{-1})	0.57	0.63	1.32	0.80

Highest soil organic carbon and soil fertility is observed in *khadin* system (Damodara and Dhedha villages) which is due to addition of organic matter with runoff water coming from nearby areas. This system is a typical example of subsistence farming in arid western plains of India. Soil samples were low in soil organic carbon (99%), available nitrogen (100%), available phosphorous (84%), available potassium (42%), available sulphur (49%) and DTPA extractable Zn (93%), Cu (65%), Fe (90%) and Mn (60%). All the soils from surveyed villages are poor in fertility (Fig. 1). Arid zone soils are low in organic matter because of low vegetation cover, high temperature and coarse texture. The problem of low nutrient use efficiency is conventionally viewed as a consequence of temporal asynchrony and spatial separation between applied nutrients and the crop (Praveen-Kumar *et al.*, 2009).

The soil dehydrogenase activity was higher in irrigated systems because microbial activity in desert soil is highly dependent on characteristics such as temperature, moisture and the availability of organic carbon (Rao and Tarafdar, 1998). The dehydrogenase activity is positively correlated (r= 79**) with soil organic carbon.

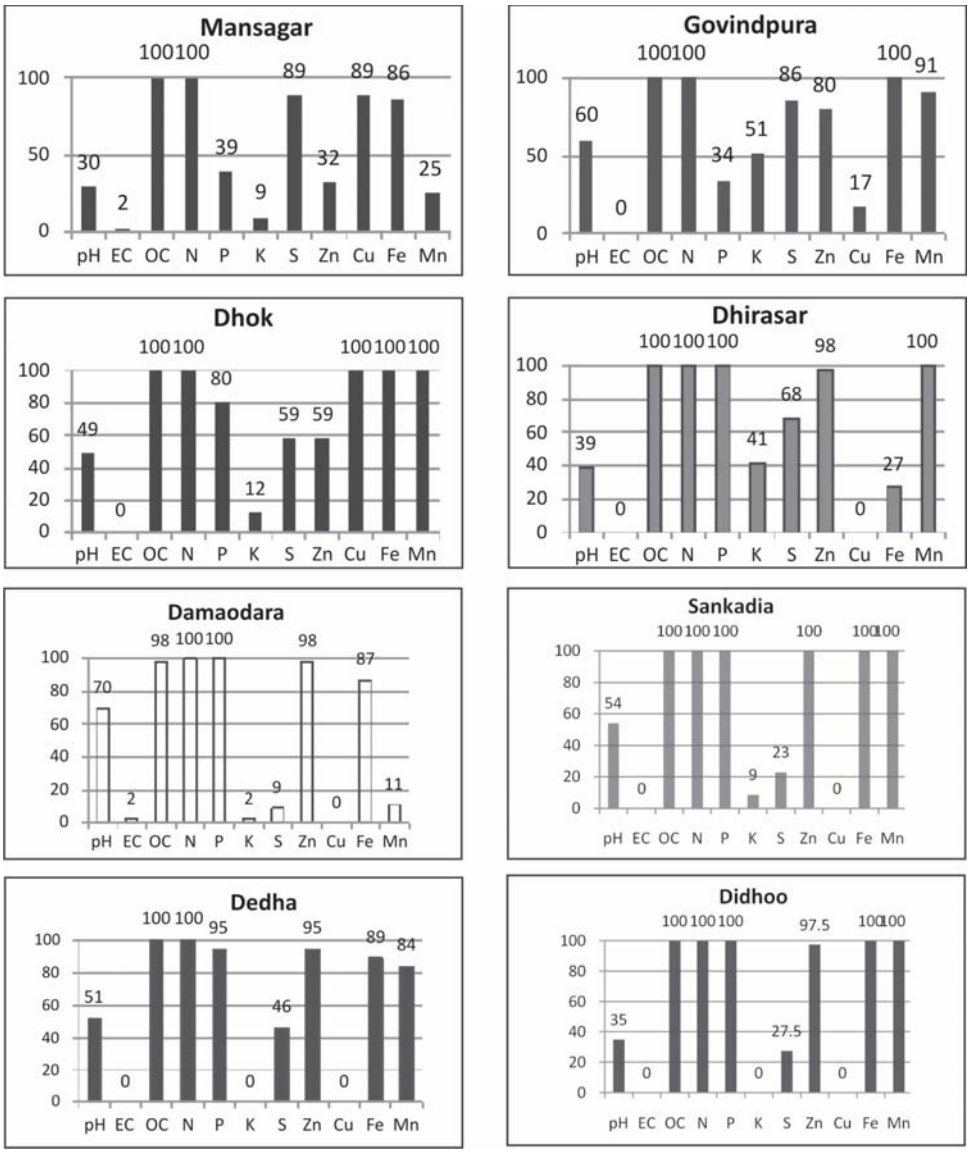

Fig. 1. Nutrient status in surveyed villages from arid western Rajasthan

Soils from higher altitude in villages are low in fertility due to aeolian deposition. In general, soil samples collected from Jodhpur are high soil fertility as compared to soils of Jaisalmer and Barmer. Sodic soil was also observed in *khadins* (Damodara and Dedha) and small areas in Govindpura, Mansagar and Dhok villages of varying level (GR 0.0-9.82 tha^{-1}). Salinity build-up is also observed in groundwater irrigated soils in comparison to unirrigated soils.

Based on these results it is concluded that landuse systems and management practices influence soil properties. These soils are poor in fertility due to low soil organic carbon and limited use of inputs. Irrigation is having positive effect on soil nutrient status. Characteristically these soils are very low in organic matter/ humus and most of the nutrients reserve is present in un-weathered mineral forms. These soils have low clay and silt, and therefore nutrient adsorption and retention by these soils are very low. Soils are generally alkaline in nature and high in soluble salts and calcium contents.

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