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the extent of their co-operation. One of the major handicaps of Indian forestry is lack of trained personnel which may be made good by establishment of adequate number of schools and colleges and research centres for training and research in forestry to man efficiently the plans for rehabilitation of our forests.

SOIL EROSION IN RAJAPUTANA *

(PART II) **

by

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Sheet erosion is also effected by wind. The predisposing conditions for wind erosions are: (1) a dry period; (2) an absence of protective covering for the soil and a low fertility level, causing the soil to pulverize; and (3) a broad, flat or slightly undulating region across which wind and soil can move unhindered. Evidently, the most important of these is the prevalence of drought conditions for a sufficiently long time as a result of which the soil becomes dry and can be easily blown away.

Strong currents of wind on arid country pick up loose particles of sand, clay, leaves, etc., and drive them along. In eastern Rajaputana wind-blown sand deposits itself in many places. As early as 1879 the Editor of the Rajaputana Gazetteer wrote (Vol. I, p. 132): 'Bharatpur forms part of the alluvial basin of the Ganges and Jumna, consequently the great majority of the exposed rocks is alluvial, consisting of modern alluvial deposit, with blown sand which the wind carries from the desert of Rajputana, and occasionally forms into mounds to the leeward of some natural inequality in the surface'. According to Wad,† there is always an encroachment of wind-borne sand on the arable lands of Rajputana as well as a sorting out of finer particles by wind from field surfaces, leaving the soil less retentive of moisture and its surface poorer in plant food. For example, in the northern portion of the Kishangarh State, which is extremely sandy, the sand is blown from the north-western district of the Jodhpur State. In many instances this *blown sand* has been deposited in transverse valleys amongst the hill ranges and seems to *encroach slowly over the entire tract*. Many a farm-stead has been absorbed in an advancing tide of wind-blown sand. As early

* The Territory is now known as the United State of Rajasthan.

** Part I of this article was published in Vol. III No. 2 (September 1948) of the Journal.

† Wad, *op. cit.*, p. 587.

as 1886 it was recorded: 'There is so much sandy waste in Jeypore that plants of the above nature (sand-binding plants) are well worth study, experiment and propagation, both *to protect arable land from inroads of moving sand* and to fix and reclaim the latter, and to protect young seedling trees which spring up among such plants. Plants of this nature indeed merit being considered special objects of Jeypore forestry.'**

Crops in many parts of Western Rajputana are frequently damaged by sand-storms. Regarding Bikaner State, Major Erskine (p. 342) writes: 'High winds often cover the sown fields with a layer of sand and thus prevent the germination of the seed, or, by carrying away the light soil, leave the young plants exposed and cause them to wither up.' As a result of the disturbance of the delicate ecological balance of flora and fauna by over-grazing or other misuse in many portions of Western Rajputana the advancing dunes, no longer bound by the peculiarly adapted vegetation, threaten the people living in Kishangarh and Western Jaipur States.*** These soils, lifted as they are by strong winds, possess a powerful erosive force, destroy the vegetation through which they pass and tear other soil particles from the surface. There have been cases in which standing crops were torn up in one place and buried in another.

It is quite certain that a turbulent dust-storm is able to remove an immense quantity of pulverised soil. The local movements of drifting soil smother near-by vegetation, bury fences and block roadways and railways. The Bikaner,† Jodhpur and Jaipur State Railway authorities have to take many precautions in maintaining a regular flow of traffic on their lines by the constant removal of sand and dust from the tracks in times of sand-and-dust storms. Further, the larger soil particles have a cutting effect on tender plants; on grassland areas the superior grasses are frequently choked or burnt up by the hot dust-laden winds. The effect of sand drifting and blowing on the inhabitants of these tracts is extremely depressing and demoralising. The tracts seriously effected by these present a desolate sight in as much as much soil has been blown away from the fields and the scanty water supplies choked in many cases. It is impossible to keep the fine dust out of the huts, as it penetrates through the smallest openings and gradually covers everything indoors. Sometimes breathing becomes difficult, and painful and pulmonary disorders follow.

An important occupation of the people of Western Rajputana is grazing. Vast herds of cattle, sheep and goats are kept in every village.

** Forest Administration Report, Jeypore State, for the year ending 31st December, 1886, p. 2 (italics mine)

*** 'Most of this (forest) is in the eastern part, giving no protection to the hot dust-laden winds from the South-West'. Jaipur State Five Year Plan, p. 30.

† The condition of engines is described by webb, (Superintendent, Rajaputana Census, 1941) in the following words. "The engine which had come through from the desert beyond, was patterned, on the windward side of its long boiler-casing with clinging, tawny sand like some gigantic mustard-plaster".

They graze all the available grass. Later on the heat of the sun, hot winds and the trampling of stock pulverise the soil, which is then blown away by the wind or washed away by the torrential downpours which generally follow long periods of drought. In this way much top soil has been gradually eroded away, leaving an infertile sub-soil from which the cultivators can at the best eke out a miserable existence.

In the rainier parts of Rajputana the grasslands are lush with monsoon grass, but in the hot season when the sun is fierce and the growth of grass stands still, there is lack of herbage. Thus pushed by hunger the teeming herbivora graze the pasture bare to the bone. The grass over-grazed becomes worn and thin. Like a garment too much used, the herbage becomes rent, and through the rents rains, often of torrential violence, pierce and sweep away the soil, aggravating the effects of over-grazing. This results in constant impoverishment of the Rajputana soils.

Under these conditions of over-grazing and erosion an age-long struggle for existence seems to have waged among the plants of the Rajputana grassland, and the struggle seems to have been of ever-increasing intensity as the soil became more and more depleted of its mineral contents and its nitrogen compounds. In this struggle those grassland plants with larger requirements of minerals and of nitrogen were the first to succumb. The struggle is still going on, and now only the most niggardly of the plants survive. Except for a brief period in the flush of the monsoon they yield but little sustenance to the animals which graze upon them.

Probably the first recognition by man of the damage committed by erosion came from the method of farming by shifting cultivation practised for a very long period of time in the afforested parts of the globe, under which a very large area of forest either disappeared entirely or was damaged beyond repair. In Southern and Eastern Rajputana this baneful practice has been in existence for a long time. In many tracts the land formerly occupied by valuable trees has now become overgrown with weeds and worthless trees. The Rajputana Gazetteer (Vol. I, p. 23) refers to 'shifting cultivation' in the following words: 'Forests are periodically ruined by the Bhils and other half-savage dwellers in these tracts (States of Sirohi, Udaipur, Dungarpur, etc.). Here, as elsewhere, in the Indian back-woods, the practice of cutting down the woods and burning them on the ground in order to clear room for a field which is manured by the ashes, goes on most destructively. After two or three years' crop the soil is exhausted, and then another felling takes place. Moreover, the woods are set on fire annually to improve and open out the grass for pasture, or to facilitate deer-hunting, and all these waste-

ful ways of subsistence are being followed on a much larger scale as the forest tribes find it more and more difficult to live by robbery, and, being pent up within their own wilds are compelled to draw their food from the soil.

Erosion has been the inevitable result of these evil practices of destroying the ecologically stable forests in order to make way for cultivation. Surface soil has disappeared, and the fertility in many places has dwindled until the land has been merged into the adjoining desert. The waters have dried up or sunk deep into the lower strata and below the economic reach of man. The heavily cut-over and exploited forest lands are often not only worthless agriculturally, owing to soil deterioration and erosion, but also constitute a serious menace to outlying districts owing to the loss of the control which the former forests exercised over the water regime of rivers. Another effect is the reduction in productivity of the bottom lands by over-wash of poor sub-soil material—sand and gravel—swept out of the hills, deterioration of crops grown thereon and declining acre yields.

Tree loppings for fodder are also common. Due to the frequent cutting of thorn branches for fencing and the lopping of trees for fodder dis-forestation gradually occurs, and it becomes a fruitful source of soil erosion. The combination of persistent grazing, browsing and lopping in an arid climate (Western Rajputana and the contiguous portion of Eastern Rajputana) is more than the hardy species of trees can stand, and, therefore, it is disappearing from a landscape already devastated by erosion. The process of desiccation, deforestation and the inevitable erosion can be seen by any intelligent observer on any train journey.

In Jodhpur State *“land is being put out of action progressively, and the same cause is behind the dust content of the storms experienced during the hot weather of the last three years”*.* In a number of cases the forests and grasslands have been mismanaged in Southern and Eastern Rajputana. The inevitable result has been that unnecessarily great quantities of water are discharged into the rivers during the wet, and abnormally small quantities during the dry seasons. Any traveller in these two seasons may see the rivers leap to life in the rains which attack the earth, carve it out and bear it away, and run muddy with the soil washed from the land. Most of the rivers are characterised by marked irregularity of flow, periods of flood being followed by periods of very low water, which greatly reduces their utility for irrigation purposes. The rivers Gulendi, Parbati, etc., are generally reduced to narrow streams about 5' to 6' wide and 2' to 3' deep during the months of May and June; but in the rainy season they have torrential flow and erode their banks and the adjoining lands. Other rivers such as the

* Stamp Committee Report, p. v. VI

Mashi, Dain, etc., are completely dry during the hot season, but are inundated during the rainy season, causing erosion on their banks. In the affected areas a few large trees are to be seen, otherwise the vegetation consists mostly of stunted trees, shrubs and grasses. The landscape is illustrative of the erosional behaviour of the soil. Wherever the process of erosion has been carried too far, the land has become unfit not only for agricultural purposes but also for pasturage.

On the edges of the main drainage channels in Eastern and Southern Rajputana the writer has observed numerous ravines. The aching scene of desolation of many miles of ravines that look like a barren wavy sea has its counterpart in a marked and quick deterioration of fertility and standard of living and farming in the entire tract bordering the ravines and in the destruction of pasturage. The beds of streams remain dry and stony except after a fall of rain when the torrents descend their stream beds in the hills with great violence, and, when they reach the plains, spread out in fans and form numerous channels, behaving in a manner similar to that of torrents in regions of greater rainfall. In the less rainy parts of Eastern Rajputana are to be found sandy torrent beds caused by the erosion of steep but low hills immediately adjoining the plains.

In the absence of the necessary statistical data it is not possible to say whether soil erosion has led to a marked loss of fertility in Rajputana. But this much can be said on the basis of existing agricultural conditions that there is some deterioration in the physical properties and fertility of the soil. On account of wind and water erosion the soil has been deprived of its capacity for remaining in a fixed place and also of its productive power. This loss of soil-stability has had its repercussions on soil fertility because the loss of soil protection caused by the erosive effects of wind and rain has not been recompensed by a cultural system that could produce the same or equivalent physical effects on the soil as did the natural vegetation. Every year a large quantity of surface soil is lost making the land poorer for crop production.

The harmful effects of the three forms of soil erosion go far beyond the removal of the valuable top soil on which plants depend for their nourishment. Gullies have consumed and disgorged enormous quantities of soil, leading to a wearing away of the land surface and gradual decline in the crop yields which are already low due to a number of causes. This more than offsets any gains brought by manuring and seed selection. It is evident that under such conditions any attempts to stimulate crop growth by surface treatment of the soil with manure are only partially successful. Field tests carried out since 1932 in these areas have provided ample confirmation of this. It has been correctly

observed: 'No agronomic improvement can be introduced on any wide scale unless this disturbing element is brought under control'.*

In regions like Rajputana where there is strictly limited agricultural water supply, the total natural productivity of land is immediately reduced by soil erosion, since the maximum productivity is fixed by the amount of rain retained by the soil rather than by the total rainfall. According to the observations of engineers the proportion of run-off to total rainfall in Rajputana is sufficiently high at present, the underground water supply, normally fed by water filtering slowly through the soil, has diminished, and, therefore, the productivity of the land has become low. The economic balance has been upset and man and his animals are living at disharmony with their surroundings. An advancing desert accompanied by general aridity is the future of Rajputana (Eastern and Southern) if grazing and exploitation of the natural vegetation are permitted without efficient control.

Whatever other essential raw materials the people may dispense with, they cannot dispense with soil—they cannot exist without it. So, in order to avoid regional suicide, serious and sustained efforts should be made to save those tracts of Eastern and Southern Rajputana which are comparatively fertile from the encroachment of sand and from erosion. The rehabilitation of these degraded and deteriorating lands will present many problems which will have to be solved if the soil is to be regenerated from its present useless state as sand or dust and is to produce specially adapted crops.

* Wad, *ap. cit.*, p. 538.