

Desert & Fringe Reclamation

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1. Vast areas of land with a rainfall of 3 inches to 15 inches in the Punjab-Sind-Rajputana-Baluchistan block of country are showing increasing signs of aridity, and this aridity is also showing definite signs of spreading and extending into lands previously considered safe from desert influences.

2. During the last 75 years, since first the Punjab was confronted with a fuel famine for railway engines then burning wood, and the foresters established Chhanga Manga irrigated plantation to meet this shortage, the forest department has built up a body of experience in desert fringe reclamation which is parallel with but goes further than orthodox agricultural methods. Tree crops of sorts can be maintained indefinitely on subsoil moisture in many tracts with a high water level, but they must have some sort of irrigation during the first two or three seasons. From afforestation experiments in the arid low hills of Campbellpur district we know of a number of tree species suitable for use in desert fringe shelter belts. We also know that where no timber trees will persist owing to drought or physiological water shortage, many shrubs and some cane grasses can be used as shelter belts and wind breaks. We also knew that if flood water is available it can be made use of over a much greater area than can be dealt with by orthodox field husbandry by what in America is called "water spreading", the primitive technique of the Navajo-Red Indians of New Mexico and Arizona having been greatly improved under the Roosevelt conservation programme. In the Punjab we have applied the Chhanga Manga technique to a variety of sites, soils and irrigation conditions, and having in many places failed to grow timber trees we can confidently undertake to produce efficient shelter belts.

3. Whether any of this desert fringe is now producing any farm crops, or worth while grazing, or nothing at all, it is all probable in terms of —

- (a) establishing a better water regime,
- (b) stopping movement of shifting sand,
- (c) establishing a more permanent and better livelihood for present occupants,
- (d) absorbing fresh settlement of demobilised men,
- (e) exerting a modifying influence on climate, run-off, and flood conditions both upon the areas treated and upon neighbouring districts in which increasing aridity is already evident.

4. The success of any such reclamation depends entirely upon the water regime. We must therefore start by surveying each administrative or geographical unit (say each tahsil of the Punjab) and breaking it up into one or other of the following groups:—

- (i) Land already under regular irrigation, either from perennial or inundation canals, or from wells.
- (ii) Land regularly subject to flooding along riverain tracts.

- (iii) Land not at present receiving flood water but which could be incorporated in a water spreading project, by using waste from the tails of existing canals or by leading flood water further along prepared channels than it normally goes of its own accord.
- (iv) Land which is not included in any of the above but which has an underground water table level sufficiently near the surface to justify pumping and redistribution by surface channels, or afforestation.
- (v) Land which has no accessible water table and which is entirely dependent upon its own scanty rainfall.

5. All the above groups except No. 1 can have their water regime improved enormously by means of water catching and spreading. We must capitalise by catching every available drop of moisture whether emanating from rivers, subsoil storage or rainfall, and by getting as much as possible of all these redistributed in order to build up the field moisture capacity of every acre of arid land.

6. Having prepared a rough survey and classification of the land on these lines we have next to undertake a colossal amount of earth working, and this falls under the main heads of (a) terracing, (b) water spreading, (c) working the surface soil to make and keep it more absorptive, (d) subsoiling.

7. Terracing. This consists of a mound of earth aligned along the contour and planned to run across country in very wide sweeps. The alignment must be particularly accurate on flat ground where advantage must be taken of very small differences of level. Borrow pits or borrow furrows should be on the uphill side of every terrace because silting action will in time fill these pits up with good soil. On land with up to a 3 per cent. slope, one good terrace every 200 feet apart measured down the prevailing slope should be ample, the actual cross section of the terrace depending upon the labour and machinery available: With hand labour a steep-sided compact bank with a narrow base is cheapest but with the bullock-drawn "karah" or scoop preliminary ploughing is needed to loosen the soil and a broader based and lower cross section is desirable. With mechanised equipment the limiting factor is the maximum angle at which the bulldozer or road grader ploughblade can be set away from the horizontal but generally speaking a much broader base, upto say 30 or 40 ft. in width is probably cheapest and easiest.

8. Spaced at every 200 feet this gives us roughly 200 lineal feet of terrace for each acre of ground worked over. The typical road-grader or bulldozer can complete 3,000 lineal feet of such terracing in a 10-hour working day so machine power at the rate of one machine day per 15 acres is needed. Failing any supply of machinery the amount of man power required is no more than has already been used on the older canal projects, but it would require a special organization to recruit and handle the manual labour which in the absence of machinery would be about 150 man days per acre. In the scattered and often migrant grazier communities of the desert fringe it would hardly be possible to carry out any such project without a large camp for imported labour with all its obligations in the way of food rationing, control of epidemics, &c.

9. Water spreading. In the arid south-western states of Arizona and New Mexico the Federal soil conservation service has perfected various local techniques for the canalisation of torrent run off or accumulated flood water and its redistribution by means of sills, sluice gates, and distributary channels. The object is to turn the water out into fields or compartments where the water can be absorbed into the soil. It is of course only feasible where the main water channel is relatively flat enough to admit of partial penning back by a sill, or diversion by means of herring bone deflection spurs built in the main bed while that

is still dry. Such diversion is the flat land equivalent of the trapping of hill torrents as attempted in Bihar forest areas by Messrs. Owden and Warren, the object of this being to trap water from the bed of a hill torrent and lead it as far as possible round the hillside to encourage seepage. The amount of work and cost involved for flat land water spreading is about the same as for contour trenching, but the pattern is different in that the height and strength of each barrier or conduit decreases with the dispersal of the water, the ultimate field or seepage block being dug with shallow trenches to facilitate flow in the same way as is done in the Punjab irrigated forest plantation technique.

10. Surface soil working. Surface soil working is really complementary to both the above heads and is an essential phase in all types of water conservation. In the case of the typical desert fringe the light surface soil, though powdery when dry, quickly develops colloidal characters when wet and the surface after floodwater has spread and partially evaporated becomes puddled and resistant to further seepage. It is therefore essential to have periodic soil mulching done either by hand or preferably with a multiple harrow pulled by a mechanical tractor. To get the best results in terms of percolation through the surface soil it is desirable to have mulching done after every flood or heavy rain when the soil has dried out sufficiently to render soil working easy and effective. The exact time can best be determined for each locality by trial, but the local cultivators will already have their views based on experience. The number of years over which mulching will be needed depends upon the ultimate use to which the improved land is to be put. Long continued water spreading without establishing a crop or tree cover is likely to produce an excess of sodium clay in the top crust, a condition known as "thur" in the Punjab.

11. Subsoiling. A further and much more fundamental operation in soil working is the use of the subsoiler, the value of which is becoming increasingly apparent in many parts of the world cursed with scarcity of water. The subsoil plough consists of an ordinary compact heavy plough shoe fixed at the bottom of a vertical draw bar. It is forced into the ground and drawn through so that the shoe fractures the subsoil at a depth of about $1\frac{1}{2}$ to 2 feet below the surface, but without turning over the sod. This operation renders the subsoil layer capable of storing many more inches of rainfall, but obviously requires a high power tractor. It is hardly conceivable that any ordinary bullock plough team, even in multiple drought, could work it. The value of this tool in dry zone agriculture is already accepted and it is in use in several farms in India. It is claimed that the extra water storage in the subsoil after subsoiling has vastly improved the prospects of dry zone farming both in the yield and choice of crops which can be produced. For our purposes of desert fringe reclamation the subsoiler obviously opens up a new era of hope and activity, because with its use we can get practically the whole of the rainfall into the soil where previously only a fraction of it percolated in and the rest went straight off to the sea.

12. The ideal way to use the subsoiler would be after the main pattern of terrace bunds has been laid out and built, to run the subsoiler through at 8 or 10 feet intervals, keeping its furrows roughly parallel with the main bund. The cost of this will depend to a great extent on the condition and geological composition of the subsoil but an average for desert fringe land with a rubbly but loose layer of kankar amongst the sands and clays of alluvial deposits is likely to be about one machine day of 10 hours for every 20 acres with a 10-foot spacing. Tractor operating costs show this to be about Rs. 4 per acre, but only about half of this is fuel oil and hired labour.

13. The tractor salesmen's literature indicates that subsoiling deeply is likely to injure rather than help cereal crops where the available moisture is deficient, but this is presumably only a short term effect which will be smoothed out over a series of years.

particularly when a better water regime is being established and the chances of building up a better field moisture capacity are improving. This factor of deep subsoiling may however influence our allocation of land as between farm crops and purely conservation measures. To start with, at any rate, we must keep a high percentage of the reclaimed ground under trees and grass.

14. Allocation of land uses in reclaimed areas.

Having established the best possible system of water catching it now remains to make the best use of the ground in terms of introducing the most suitable permanent dry farming, afforestation and shelter belt practice. The choice of crop will naturally depend upon the behaviour of the water in the soil. For cereal straw crops a good field capacity at the 2 to 4 feet level is essential, but gram amongst winter crops and many of the monsoon millets can of course be produced with much less, and cane grass and small trees with less again. Whatever is given out for ordinary cultivation should be on a definite understanding of safeguards:—*e.g.*, no browsing animals whatever; ploughing to be along the contour; mulching as per best local practice; maintenance of terrace bunds and sluices; acceptable rotation of crops to be prescribed; maintenance of whatever shelter belts have been established on neighbouring terrace bunds.

15. The remainder of the ground must be under shelter belts with a choice of:—

- (a) afforestation, and
- (b) grass production.

In any case grazing must be under very strict control. Afforestation need not necessarily be with timber trees and much of the desert fringe in its present condition simply will not produce them. We can however do a great deal with the giant cane grasses (*Saccharum munja* and *Saccharum spontaneum*) which have previously been treated as weeds in the Punjab. Where the contour terrace bunds are at right angles to the prevailing wind these should be heavily stocked as wind breaks. Where the contour terrace system falls parallel to the prevailing wind then a separate series of wind breaks of grass, trees and bushes must be established, preferably on a system of low bunds at right angles to the wind. The ideal form of shelter belt to break the force of the desiccating summer west wind is probably an outer and lower fringe of agaves, then cane grass and shrubs leading up to higher trees in the rear.

16. The use in Uganda of similar coarse grasses grown as a 3 or 4 year fallow is a recent innovation, the importance of which has not yet been appreciated in India either in silviculture or agriculture. Any coarse cane grass will serve the purpose, as they all produce a very large bulk of cane, leaves and roots from a minimum of moisture. It serves a two-fold purpose; firstly by covering the fallow land with a mat of vegetation it reduces surface sheetwash to a minimum, and secondly it provides a mass of vegetable matter which when ploughed under, helps to build up a far better tilth, particularly where sheet erosion has already swept away the top soil and left only a clay or kankar subsoil exposed.

17. Where *Saccharum munja* is at all prolific, as it may readily become under the improved water regime of our proposals, its roots are so big as to present a real problem to the individual cultivator with only his bullocks and a light plough and even after burning the grass tops. The answer is again in mechanised equipment, but the cultivator can only secure its aid either through collective farming, or if government continues to provide the necessary machines and trained staff over a period of years for the proper maintenance of all these conservation items.

18. The potential value of grass as a means not only of preventing soil erosion but of actively building up a better tilth is summarised clearly in the newly published Imperial Agriculture Bureaux Joint Publication No. 6—Alternate Husbandry. From this it would appear that under arid conditions a fairly long "ley" under grass should be followed by a fairly long period under ordinary crops, because the first crop after grass in arid land may be disappointing and the gain is likely to be shown only by subsequent crops which profit by the gradual breaking down in the soil of the grass roots and stems. I suggest that 4 years under cane grass followed by 4 years of other crops should be given widespread trials under all the various combinations of soil and moisture presented by the desert fringe country. We also must learn how far we can eliminate burning which at present is the cultivators' method of exterminating cane grass from any ground he is preparing as a seed bed. The roots are often so massive as to be obstacles even to a heavy mechanised plough, and will in any case take years to rot down unless pulverised before being ploughed under.