ADVANCED

Despite his advances in science and technology, his sophistication and his many accomplishments, man owes his existence to a mere six inch layer of topsoil. This topsoil is, however, being lost at the alarming rate of 12 million tons per annum due to loss of vegetal cover, overgrazing and agents of erosion like wind and water. Since nature has thus richly endowed' the earth with soil and water, it is up to us to preserve both, especially so in those areas which receive erratic rainfall and occasional storms - the dryland areas, still depending only on the rainfall for moisture. India has a land mass of 329 million hectares, out of which 224 million hectares constitute the dryland areas. They are undulating or rolling lands and depend only on rainfall for any biotic growth. Since the past 2 decades, productivity of dry land crops like jowar, tur and groundnut has remained low and stagnant.

Production over time

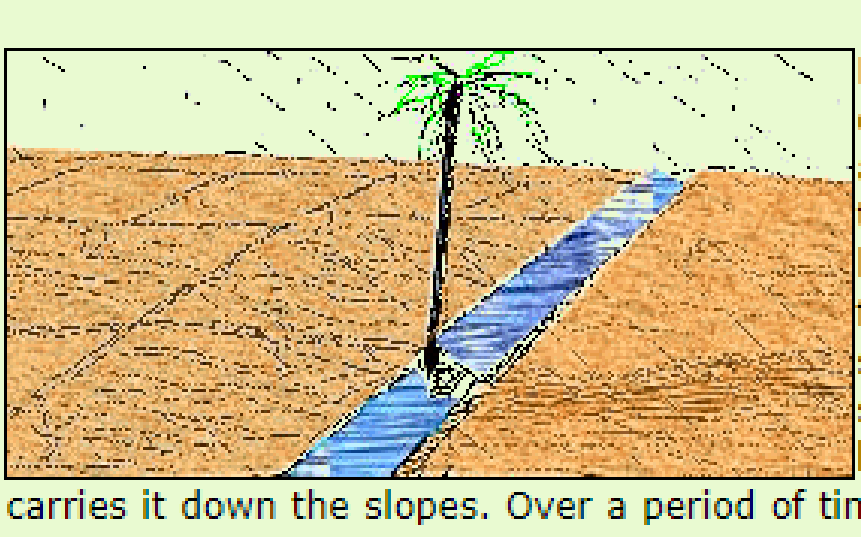
Dryland crops	Average yields 1969-70	(kgs per hectare) 1987-88
Jowar	530	655
Tur	687	722
Groundnut	712	800

Source: Government of India, Status Report on Agriculture, 1989.

This, in spite of the fact that India's annual rainfall is next only to that of South America and much more than anywhere else in the world.

Why then is productivity so low in dryland areas?

Though India has an annual average precipitation of 1150 mm and drains a total volume of 400 million hectare metres, hardly 100 million hectare metres is retained in the soil. The remaining water runs off, carrying with it fertile soil.



Dryland areas are characterised by undulating terrains with varying soil depths. When it rains, the rain water accumulates in the top most rocky areas and gushes down, damaging the lands below. The lands below, termed as common property resources, are neglected. Even small bushes are hacked by the neighboring populace to meet the increasing fuel demand. Grazing livestock peel off the grass cover and trample the soil with their hooves. Population pressure has forced farmers to bring some of these lands also under the plough. With no cover and canopy left, the slightest splash of raindrops dislodges the soil and the runoff carries it down the slopes. Over a period of time, the base material gets exposed. The runoff further enters the fields down the line causing rills,- stagnating against the bunds and damaging crops. Incapable of holding the force of the runoff, some of these bunds get breached.

The water with the soil cascades, breaching more bunds downstream, leading to the formation of ravine's in fragile land.

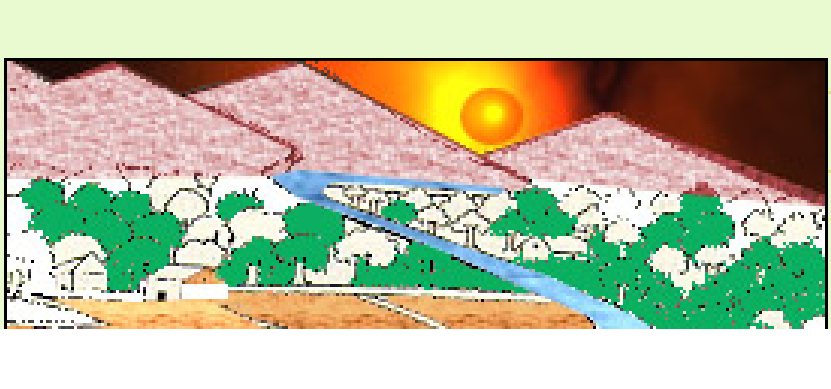
Hence when it rains, rainwater moves with great velocity carrying soil. The nallas in the area overflow with gushing, muddy water. With very little infiltration and 'loss in both soil and water, productivity is lower. Farmers are left with no surplus to compensate this loss of soil and nutrients and are caught in a vicious circle. Farmers in dryland areas with low rainfall of 500 mm or less, have suffered most in this process, for their land has slowly lost productivity in all types of biomass production.

This is the fate of the lands contributing most of our production of millets, pulses and oil seeds.

What then is the solution?

Gone are the days when man blamed the natural occurances of weather and rain. Modern methods prove that even in the scanty rainfall areas, productivity can be bettered. A resource management that conserves and uses rainfall and the fertility of the soil more efficiently and a new production, system which maintains productivity and assures a dependable harvest, have now been developed. Watershed-based farming appears to be a development alternative that would provide greater stability to rainfed agriculture.

What is a watershed?



A watershed is an area of land from which surface water drains into a single outlet like a stream or a river or a lake. The rain water flows from the ridges, along the slopes, into the nallas and finally collects in the village ponds. This entire area with one common drainage is called a watershed.

sustained production, with the minimum of hazard to natural resources. With a bit of acumen and proper judgement, the rain water can be made to move down the slopes slowly, ensuring optimum infiltration and percolation, automatically solving the problem of soil erosion. Reducing the impact of the rain on the soil, checking its speed at various intervals, taking up all operations on the contour and diverting the excess to prevent the, pressure, are some of the procedures one could adopt; a process that starts at the highest point of the watershed and ends right down in the lower parts.

In general, watershed management consists of proper management on the hilltops, hill slopes, foothills and plains with appropriate practices. Hilltops should be kept under forest, and hill slopes up to 25% should be kept under plantations (either horticulture or afforestation). Foothills should always have cover crops to avoid formation of gullies and siltation of plain lands at the foothills. Proper diversion drains for the runoff water from upper catchments in a regulated manner in the foot hills will increase the water availability for irrigation in the plains, by means of wells, tube wells, tails, etc.

Below the foothills., lands should be treated with soil and water conservation measures, either biological or mechanical to avoid sheet erosion and at the same time to preserve the top soil for maintaining the yield of agricultural crops. Finally, plain lands, banks of small streams and rivulets are usually kept under agricultural or horticultural crops with irrigation facilities wherever possible. Cropping patterns are adopted whose growing period is most suited to the amount and periodicity of rainfall.

Steps in Watershed planning

- Preparation of base maps for carrying out surveys.
- Reconnaissance survey of the watershed for overall development.
- Assessing rainfall characteristics.
- Preparation of soil maps and classification of lands for different uses according to capability classification for agriculture, forestry, pasture, horticulture, etc.
- Preparation of inventory of existing land uses and farm sizes.
- Appraisal of agricultural production patterns and potentials, present and potential markets and possible group action arrangements.
- Carrying out topographic and hydrologic surveys for engineering works.
- Geo-hydrological survey to delineate areas suitable for groundwater development.
- Formulation of an integrated time-bound plan for land and moisture conservation, ground water recharge, development of productive afforestation, agriculture production, grass lands and horticulture.
- Assigning of priorities for implementation of the project.
- Assessing social costs and benefits.

Land capability classification

Watershed management must take into account land capability classification, since a typical watershed may include lands suitable for cropping, trees, pastures, etc. The land classification is as follows:

Class I:

This type of land is nearly level, with minimum erosion, the soils are deep, well drained, with adequate water holding capacity. These soils need ordinary management practices to maintain productivity. Such practices may include the use of one or more of the following fertilisers, lime cover and green manure crops, conservation of crop residues aAd crop rotation. They are fit for agriculture, pasture, forests, etc.

Class II:

These soils have some limitations. They are subject to slight erosion, as they are slightly sloping lands, with less soil depth, occasional drainage problems that can be easily corrected, and they are sometimes saline. They may need one or more of the following practices terracing, strip-cropping, contour cultivation, excess water drainage, crop rotation, use of green manure crops, stubble mulching, the use of fertilisers, manure and lime.

These soils may be used for growing cultivated crops, raising pastures, forests, etc.

Class III:

The factors that limit plant growth are more severe than in class II. These factors could be moderately sloping land, land susceptible to water or wind erosion, land more susceptible to drainage problems, land with water-logging, shallow soil depth, low moisture holding capacity and moderate salinity.

Class IV:

The limitations to plant growth is more severe here than in Class 111 soils. Very careful management is required and the conservation practices are more difficult to apply and maintain. Some of the factors affecting these lands are steep slopes, severe susceptibility to water and wind erosion, shallow soils, low moisture holding capacity, severe water-logging and severe salinity. These soils can be used for crops, pastures, forests and wildlife food, etc.

Class V.

Cultivation is not feasible because of one or more limitations, such as over flow, stoniness, wetness or severe climatic conditions. Examples of this class are soils of low lands subject to frequent over flows which prevent the normal production of cultivated crops, or rocky or stony terrain. These soils are suitable for raising cultivated crops but are not suitable for perennial vegetation.

Class VI:

These soils have very severe limitations that make them generally unsuitable for cultivation and limit their use largely to pastures or forests or wildlife food and cover. Some of the limitations which cannot be corrected are: steep slope, very severe erosion hazard, shallow rooting zone, excessive wetness, low moisture capacity and severe salinity.

Class VII:

The physical condition of the soil is such that it is not practical to adopt pasture improvements and water control practices.

Class VIII:

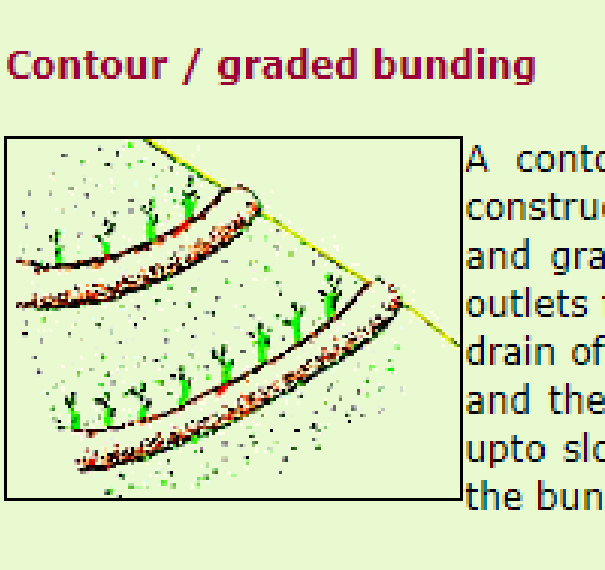
Bad lands, rocky out crops, sandy beaches, marshes, deserts, mine tailings and other nearly barren lands may be included in this class. It may be necessary to give protection and management for plant growth to soils and land forms in class VIII in order to protect other more valuable soils, to control water, or for wildlife or for aesthetic reasons.

Water Management Activities

In situ conservation practices
The best opportunities for moisture conservation lie in the control of the portion of precipitation which is normal runoff. Retaining surface water on the land surface for a longer time, increases the amount of water entering the soil. Effective methods are the following:

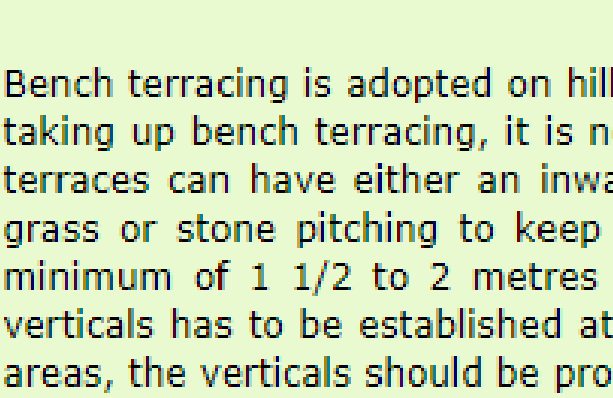
- Contour bunding / graded bunding
- Check dams and gully control structures
- Land levelling / land smoothening
- Bench terracing
- Farm ponds
- Percolation ponds
- Waterways
- Diversion drains

Water conservation starts in the topmost rocky areas where the runoff water needs to be drained out by forming diversion drains. This protects the steep slopes below which are suited only for growing fodder. While prevention of grazing in these areas ensures optimum regeneration, luxuriant fodder cut and fed to the animals ensures better nutrition and health.

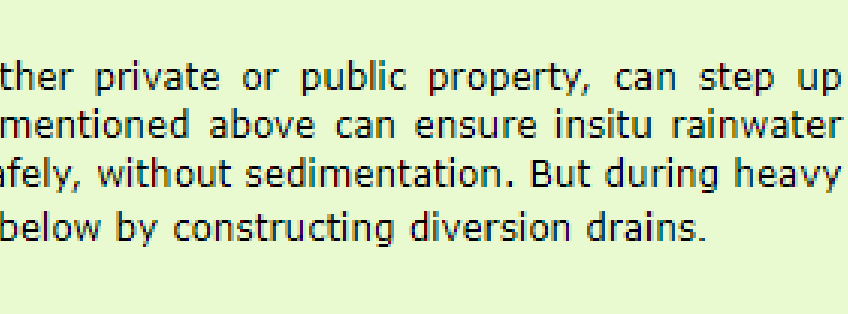


Even on similar private lands, it is always advisable to grow fodder or fibrous crops like agave.

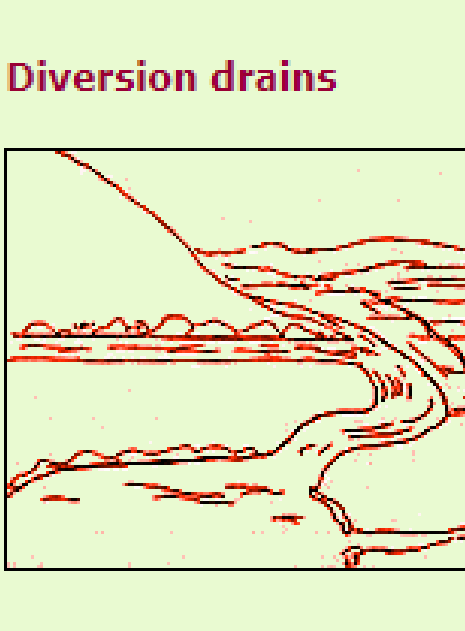
On the lands just below, which are slopes with moderate soil depths, if belonging to the public, V-shaped trenches can be formed which act as speed breakers to the runoff.



Trenches around the planting can be made with necessary spacing according to the intensity of the rainfall. Trenches 3 to 4 metres apart should be dug, depending on the degree of the slope. It should have a width of 30 cms at the bottom and a width of 50 cms at the top with a depth of 30 to 40 cms., depending on the available soil depth. The soil dug from the trench should be heaped to form a mound on the slope of the hill side where seeds of hardy species can be sown. Mixed species can be planted in these trenches to have a staggered harvest, ensuring a permanent canopy. Fodder can also be grown in between the trenches. Nurturing and protecting these areas can be taken up on a community basis. Strict fire control measures and prevention of cattle grazing will enable good fodder production on these lands, which can be cut every year for stall feeding of cattle. The produce can be shared by the entire community.



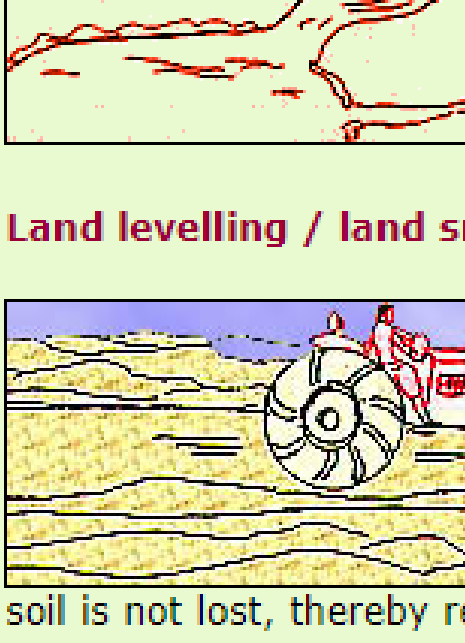
If the lands are privately owned, the farmers can resort to farm forestry or horticulture. Initially the farmer may feel insecure. Hence, agricultural activities may be continued between the rows of trees.



As the trees grow, though agricultural income would drop, the trees would start yielding. This would definitely prove lucrative to the farmer. Thus, if immediate switch over is not possible, strip cropping can be resorted to, to a seasonal cultivation between the wide rows of trees. The runoff- from the agricultural strips is checked as it reaches the row of trees.

For optimum conservation in these lands, contour bunding would be the answer.

Contour / graded bunding

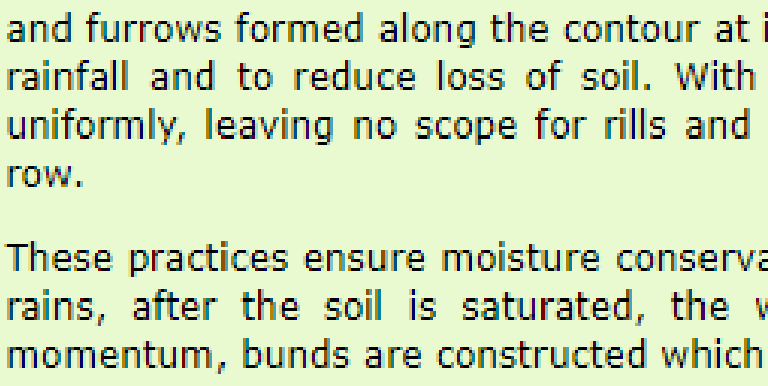


A contour is a line joining points of the same altitude on a sloping land. Bunds are constructed along these lines. Contour bunds are suggested for light soils with low rainfall and graded bunds for all black and red soils with medium to heavy rainfall with necessary outlets for runoff disposal. Wherever the black soil type exists, graded bunding is adopted to drain off excess water to the nearest water streamlet because percolation is slow in black soil and therefore more runoff is expected than in red soil. These types of bunding are adopted upto slopes of 3% - 5%. According to the runoff, disposal outlets should be provided along the bunds to reduce the breaching of the contour bunds.

Bench terracing is adopted on hillslopes to raise commercial or food crops, instead of a plantation programme. Before taking up bench terracing, it is necessary to confirm whether enough soil depth is available for making terraces. The terraces can have either an inward or outward slope. The verticals are not available for cultivation but suitable for grass or stone pitching to keep the vertical intact. The width of the terrace depends on the slope of the land. A minimum of 1 1/2 to 2 metres level ground is required for cultivation., According to the rainfall, drainage of the verticals has to be established at 30 to 40 metres intervals for safe disposal of runoff water. In high intensity rainfall areas, the verticals should be provided with rivetments to avoid erosion.

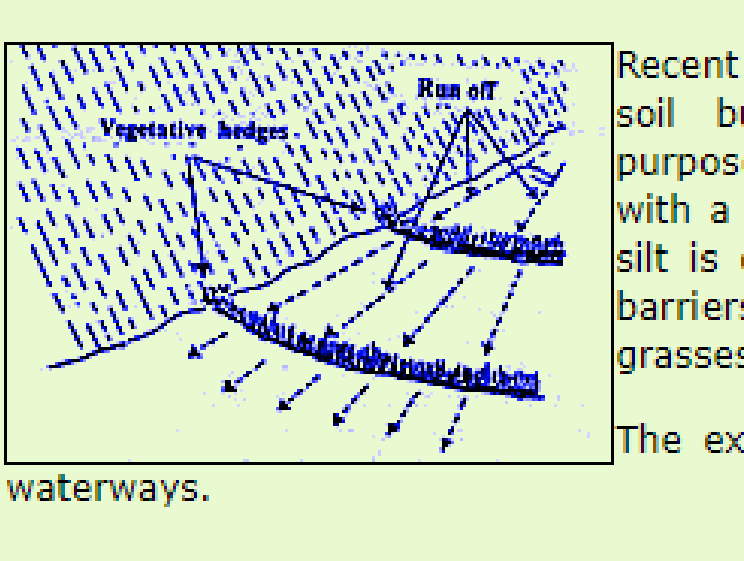
A permanent canopy of bushes, trees, or fodder on the slopes, whether private or public property, can step up productivity and go a long way in controlling erosion. The treatments mentioned above can ensure insitu rainwater conservation during normal rains, and, the water flows out slowly and safely, without sedimentation. But during heavy rainfall the excess is prevented from entering into the agricultural lands below by constructing diversion drains.

Diversion drains



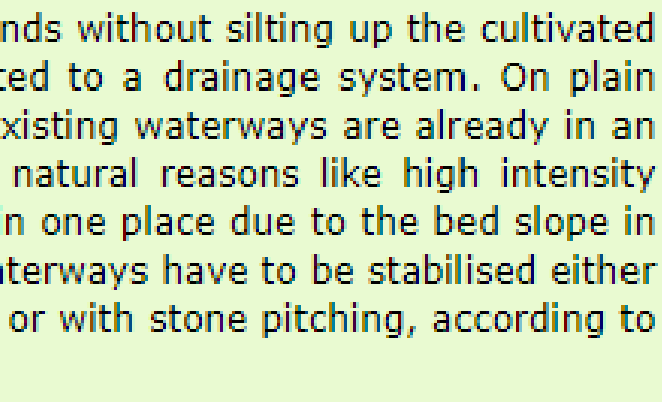
Diversion drains should be constructed at foothills or at the junction of the cultivated land to avoid silting up of the cultivated lands due to runoff water flowing down the hill and across the cultivated lands. In addition to this, diversion bunds have to be constructed at the junctions of roads and cultivated lands to dispose the runoff water to the nearest waterway, nalla or streamlet along the diversion bunds. Quick growing trees have to be planted along the bunds to strengthen them so that there is no breaching of the bunds during heavy rainfall. The bunds may be planted with brushwood or species like casuarina, eucalyptus, agave etc.

Land levelling / land smoothening



For cultivation of agricultural crops generally in dry lands, it is levelled with a meagre 112 % slope to avoid accumulation of water during rainfalls and at. the same time drainage disposal is provided. Land levelling or smoothening is done either by bullock. drawn wooden frame levellers, or by tractors. In case of undulating land with rolling topography, land levelling is done using bulldozers. During land levelling operations, care should be taken that the top soil is not lost, thereby reducing the yield from these lands. Mixed crop or intercrop cultivation can be adopted to get maximum benefit even during drought conditions.

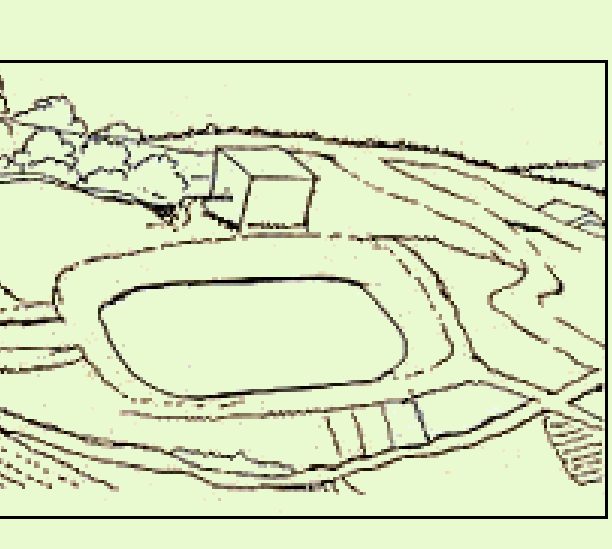
Mulching



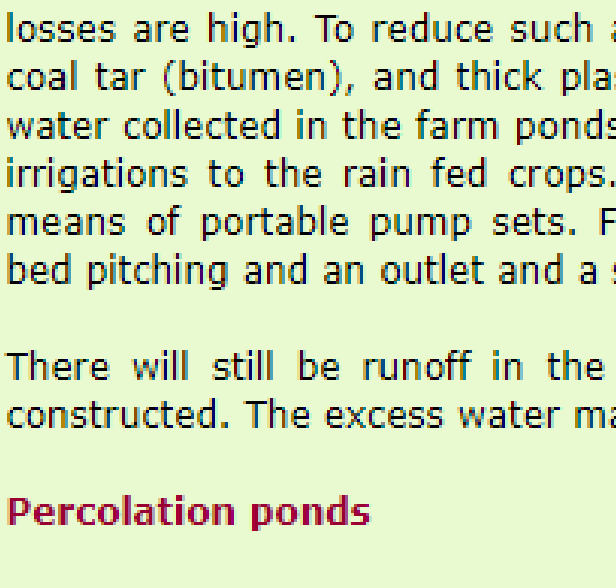
Use of green manure and mulching ensures better retention of water and also increases the organic content in the soil.

Contour ploughing

Ploughings are carried out in contour. At every 3 metres, deep contour furrows, are opened and a small section bund is formed every 10 metres to check the flow of rain water. These types of ridges and furrows formed along the contour at intervals of 3 to 6 metres help to form plots for moisture conservation during rainfall and to reduce loss of soil. With ploughing and sowing done on a contour, the rain water gets distributed uniformly, leaving no scope for rills and gullies. In widely spaced crops like tur, deep furrows are opened for every row.

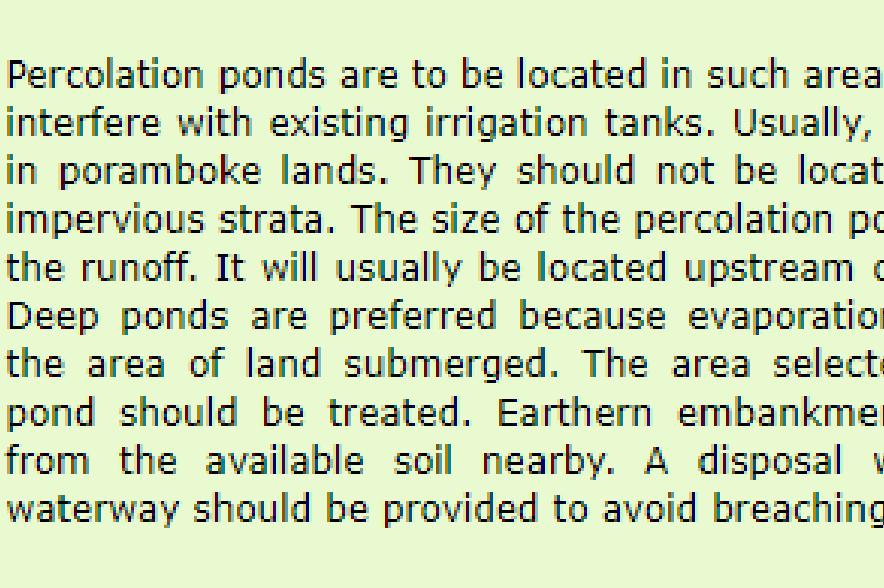


These practices ensure moisture conservation during normal rains. But during heavy rains, after the soil is saturated, the water starts moving faster. To arrest this momentum, bunds are constructed which are stabilised with a vegetative cover.



Recent developments suggest the supplementing of soil bunds with vegetative barriers. For this purpose, a deep rooted grass, like khus/vetiver with a tendency to grow thick is ideal. Here, water does not stagnate. Instead, the silt is deposited on the upstream, and the filtered water oozes out all along the barriers. Under experimental conditions, vegetative hedges with different types of grasses have proved very successful.

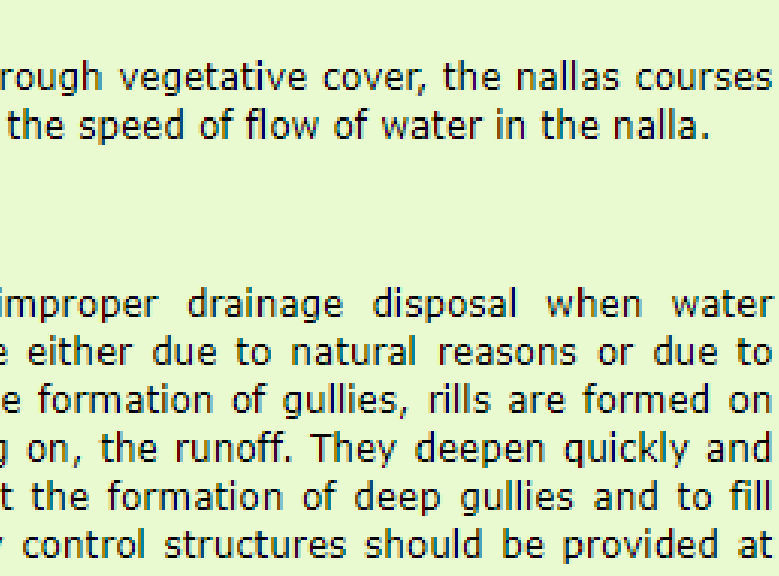
The excess water along the bunds is channelised through grass-lined outlets into waterways.



In watershed development activities, waterways are used for the safe disposal of runoff water near foothills areas and at the junctions of agricultural and non-agricultural lands without silting up the cultivated lands. The waterways are connected to a drainage system. On plain lands, foothills or hill slopes, the existing waterways are already in an eroded or silted condition due to natural reasons like high intensity rainfall or concentration, of water in one place due to the bed slope in the gullies and valleys, etc. The waterways have to be stabilised either with grass or with stone rivetment or with stone pitching, according to the construction material locally available.

In addition to this, necessary checks should also be constructed along the waterways for storage of runoff water and to reduce the bed erosion of the waterways.

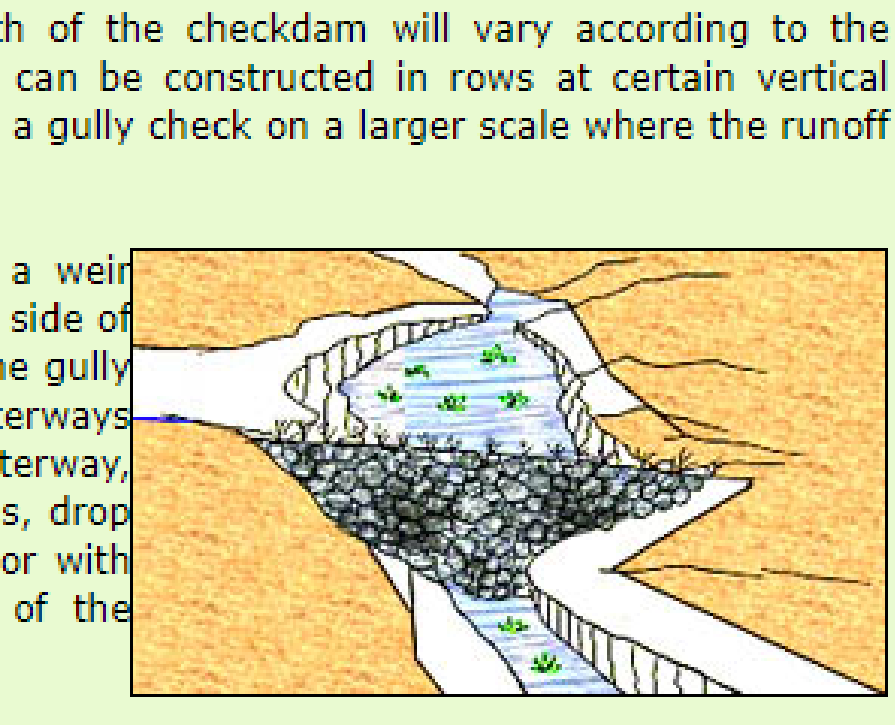
Through these waterways, water is collected in the farm ponds.



Harvesting runoff into small ponds and recycling this water to the donor area is a recent approach. The size of the pond needs to be 250 to 300 metres per hectare of catchment area. In red soil areas, the percolation losses are high. To reduce such a loss, a mixture of soil and cement (8:1), coal tar (bitumen), and thick plastic sheets are used to avoid seepage. The water collected in the farm ponds can be used to give one to two life-saving irrigations to the rain fed crops. Effective irrigation can be carried out by means of portable pump sets. Farm ponds should be provided with stone bed pitching and an outlet and a silt trap to avoid silting up of the pond.

There will still be runoff in the fields even after erosion prevention measures have been taken and farm ponds constructed. The excess water may be collected by constructing percolation ponds at appropriate places.

Percolation ponds

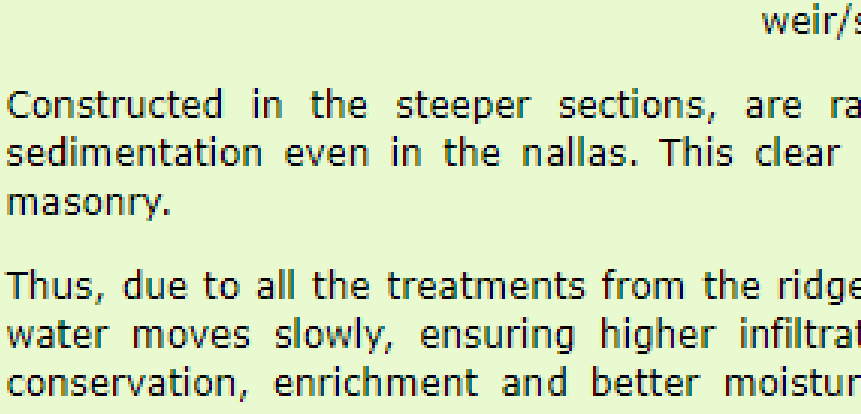


Percolation ponds are to be located in such areas so that they may not interfere with existing irrigation tanks. Usually, the location should be in poramboke lands. They should not be located in heavy soil or in impervious strata. The size of the percolation pond varies according to the runoff. It will usually be located upstream of the cultivated lands. Deep ponds are preferred because evaporation is minimum as also the area of land submerged. The area selected for the percolation pond should be treated. Earthern embankments should be formed from the available soil nearby. A disposal weir and an overflow waterway should be provided to avoid breaching of the embankments.

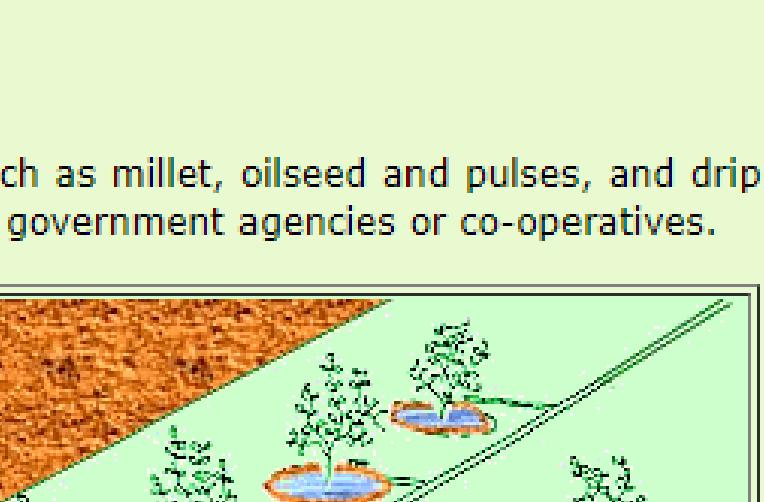
In addition to runoff water collection, the percolation ponds are helpful in recharging the ground water in the area and stabilising irrigation. It is estimated that the pond may be effective up to a distance of 1000 metres, depending on the strata in that area.

Despite all the care, if there is still excess water, it is led into the nallas. Through vegetative cover, the nallas courses are stabilised. Gully checks with vegetative or brushwood dams help control the speed of flow of water in the nalla.

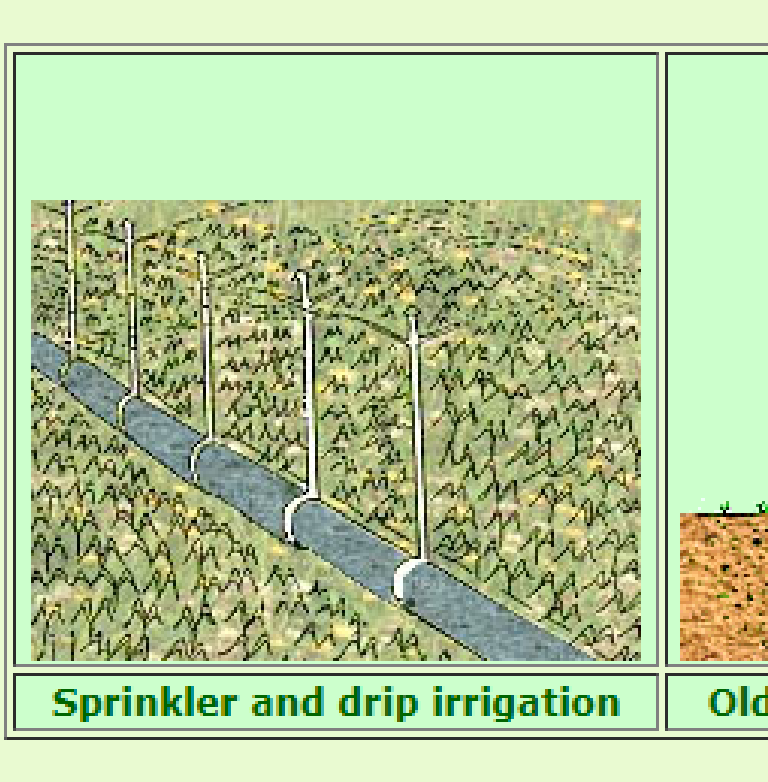
Check dams and gully control structures:



A gully is formed due to improper drainage disposal when water accumulates in a single place either due to natural reasons or due to artificial conditions. Before the formation of gullies, rills are formed on gentle sloping land depending on, the runoff. They deepen quickly and form small gullies. To prevent the formation of deep gullies and to fill up the drainage course, gully control structures should be provided at appropriate places with locally available materials. Checkdams could be Constructed across small streams and gullies which would act as mini percolation ponds having a catchment area of less than 20 hectares. The length and breadth of the checkdam will vary according to the width and depth of the gully or nalla- Brushwood or stone checks can be constructed in rows at certain vertical intervals according to the bed slope of the gully. Nalla bunding is also a gully check on a larger scale where the runoff water is also high.



The control measure requires a permanent.masonry structure like a weir across the nalla and the strengthening of the embankments on either side of the nalla. Accumulation of too much water in the upstream side of the gully should be diverted by means of diversion drains or grass covered waterways to the nearest stream or overflow weir. To avoid erosion in the waterway, whatever there is a difference in the elevation of more than 2 metres, drop structures should be constructed either with a vegetative structure or with bed pitching, according to the discharge in the overflow portion of the waterway.



If there are a number of shallow or medium gullies in the waterway, stone check structures should be constructed to protect it from further erosion and to facilitate growth of vegetation. It is also possible to establish in situ stone structures at 100 to 200 metres horizontal intervals along the gullies in the watershed.

The upper catchment of the gully should be covered with vegetative crops or grass to reduce the runoff. Gully heads can be checked with wooden poles or stones to avoid entering of the gully into the upstream areas. Check Dams may be constructed according to the bed slope, either with an overflow weir/stone filled checkdams with oven wire of small size.

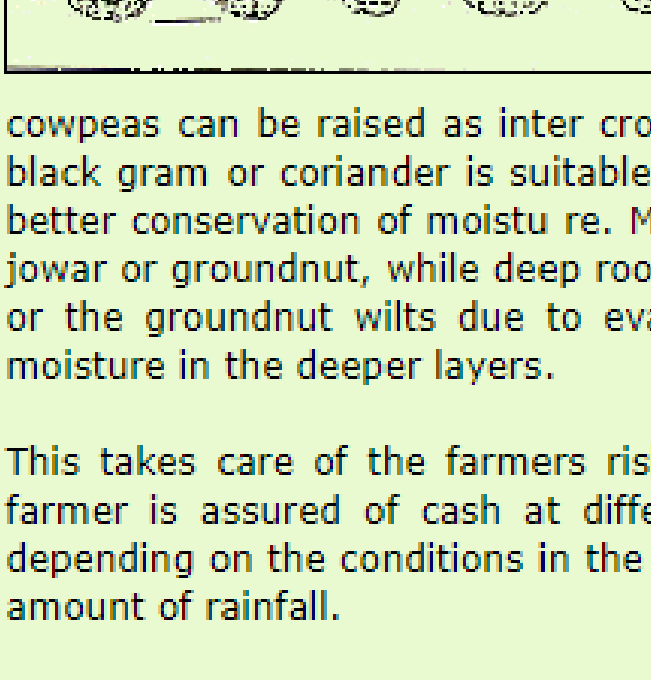
Constructed in the steeper sections, are ravine control structures. So water flows slowly, safely and without sedimentation even in the nallas. This clear water is impounded behind nalla bunds which are either earthern or masonry.

Thus, due to all the treatments from the ridge to the valley, along all the arable and non-arable lands, when it rains water moves slowly, ensuring higher infiltration and, even better, underground recharge. With this kind of soil conservation, enrichment and better moisture retention, farmers can get a better yield even with their present farming and cropping practices.

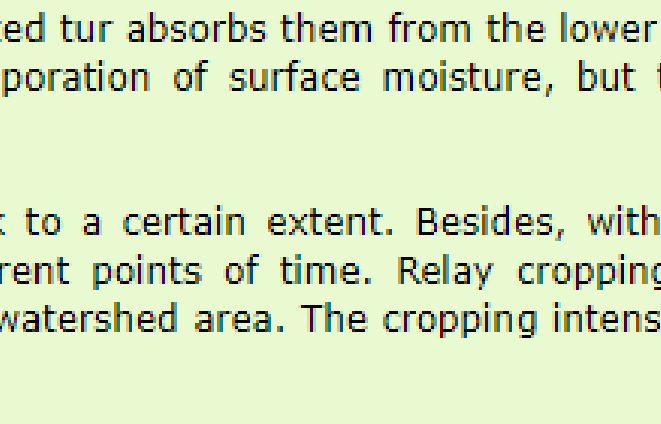
When there is a prolonged dry spell, the water stored by the various methods already mentioned may be used to give supplemental irrigation.

Sprinkler and Drip Irrigation

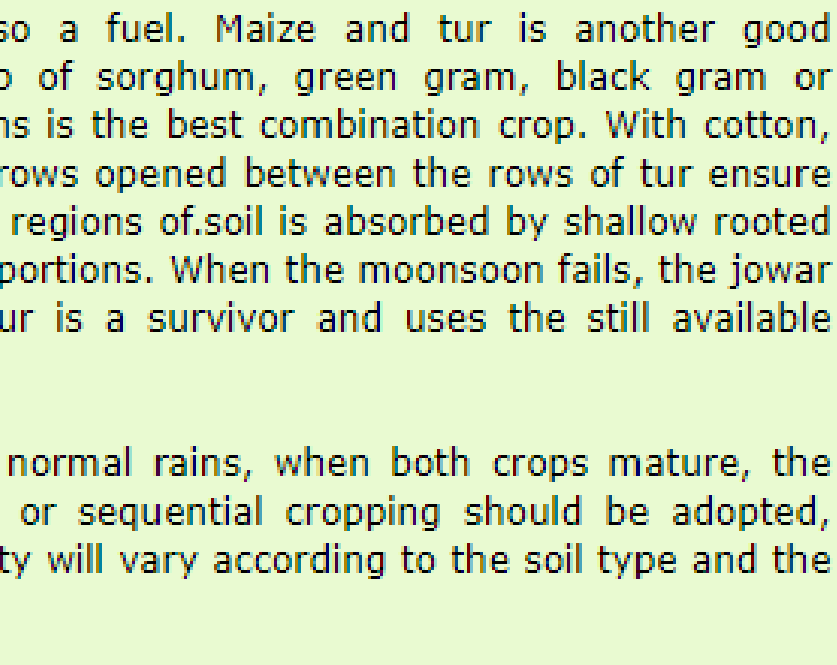
To economise the use of water, sprinkler irrigation can be used for crops such as millet, oilseed and pulses, and drip irrigation can be used for horticultural crops. Sprinkler units are hired out by government agencies or co-operatives.



Sprinkler and drip irrigation



Old method of drip irrigation



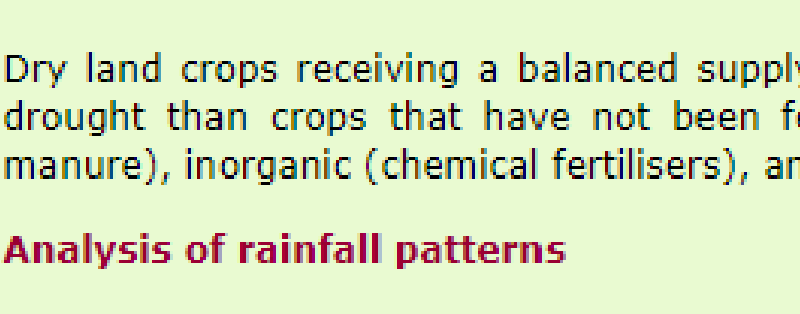
Modern method of drip irrogation

Use of ground water

Watershed schemes offer an increase in ground water potential. To recharge ground water flow in the watershed, small subsurface dams may be constructed. The available ground water in the watershed should be pumped and better water management practices should be observed.

Dryland crops

With moisture available in the top and bottom layers of the soil, a mix of shallow and deep rooted crops or even double crops can be planted. With good biomass planning, farmers can obtain fodder, fuel and fruits from the upper portions of lands, cereals and pulses from the middle, and commercial crops like vegetables, fruits and flowers from the lower areas where water from the farm ponds can be used for protective irrigation.



For the better utilisation of soil moisture, farmers can plan a combination of third rows of tur in crops of ragi, groundnut or soyabean. Alternatively, these crops can be rotated with tur. Tur fixes nitrogen and produces a lot of leaf fall. Its stock is also a fuel. Maize and tur is another good combination. In a base crop of sorghum, green gram, black gram or cowpeas can be raised as inter crops. In bajra, cowpeas or cluster beans is the best combination crop. With cotton, black gram or coriander is suitable for intercropping. The contoured furrows opened between the rows of tur ensure better conservation of moistu re. Moisture and nutrients from the upper regions of.soil is absorbed by shallow rooted jowar or groundnut, while deep rooted tur absorbs them from the lower portions. When the moonsoon fails, the jowar or the groundnut wilts due to evaporation of surface moisture, but tur is a survivor and uses the still available moisture in the deeper layers.

This takes care of the farmers risk to a certain extent. Besides, with normal rains, when both crops mature, the farmer is assured of cash at different points of time. Relay cropping or sequential cropping should be adopted, depending on the conditions in the watershed area. The cropping intensity will vary according to the soil type and the amount of rainfall.

Weed control

Weeds compete with crops for water and nutrients, thus bringing down the yield. Therefore, timely and effective weed control measures will increase production of dry land crops by 25 to 50% over unweeded crops. Sorghum should be kept weed-free from 21 days after germination upto 35 days to obtain maximum yield. For cotton, the weed-free Period must be between 30 to 50 days after germination.

Optimum plant plantation

Optimum plant density is ensured by farmers for optimum assured yields. For example, for sorghum there should be 148,000 plants per hectare for maximum yield. Seed drill sowing with compaction is the best way to maintain optimum plant population and achieve higher yield.

Low cost fertilisation

Dry land crops receiving a balanced supply of nutrients through fertilisers have been found to be more tolerant to drought than crops that have not been fertilised. Nutrients supplied through t combination of organic (farmyard manure), inorganic (chemical fertilisers), and bio-fertilisers (rhizobium) help to improve the yield of rain-fed crops.

Analysis of rainfall patterns

Analysis of long-term rainfall data to assess the quantity, distribution and probability of occurance is a very important technique. Annual, seasonal, monthly and weekly rainfall data are analysed to determine the distribution pattern, the beginning and end of the rainy season, the timing.and duration of wet and dry spells and the probability of rainfall. The probable rainfall with regard to water holding capacity of the soil, and evaporation demand, can be used to develop the soil-moisture availability pattern during the growing season, and a suitable cropping pattern can thus be suggested.

Dryseeding before the monsoons

Dryseeding before the onset of the monsoons, especially in black soils is helpful in making better use of the initial rains. The sowing of sorghum and cotton 2 and 3 weeks respectively before the monsoon season, has been found to give better yield. Sowing at an optimum depth is important. Sorghum and cotton should be sown at a depth of 5 cms and bajra, blackgram and other grain crops at a depth of 3 cms. Pre-hardened seeds develop an efficient root system, improve drought tolerance and have vigorous initial growth.

Use of improved crop varieties

The combination of genes for dwarf plant stature and resistance to lodging, with genes responsive to applied nutrients and drought tolerance, is proving successful with sorghum, cotton and millet. Improved varieties and hybrids significantly out-yield local varieties in most of the rainfed areas.

Agricultural implements and machinery

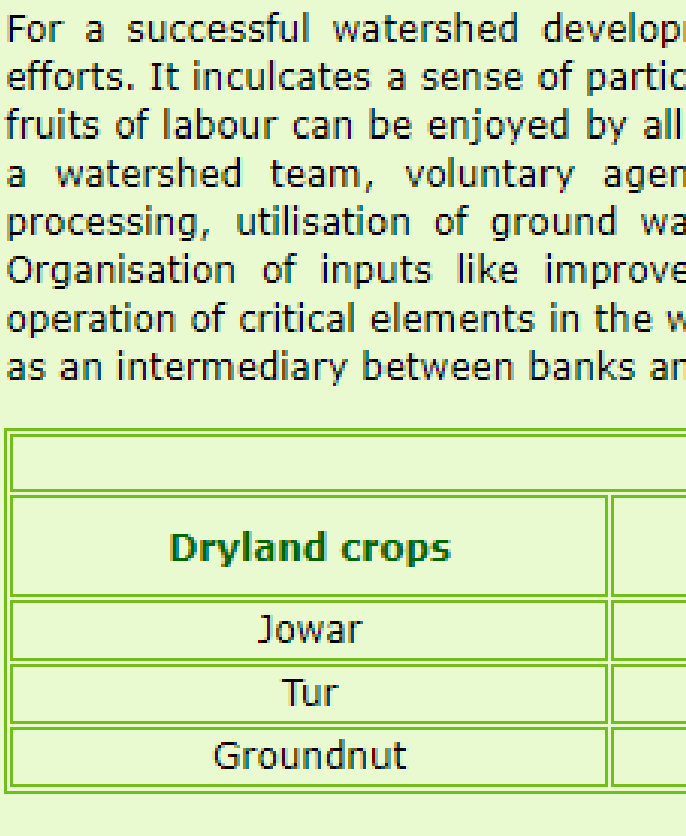
Ploughing the field after the harvesting of the crop, land levelling and shaping formation of field drains and community drains, broadbed furrow sowing, application of fertiliser, weeding, etc., require tractors and improved bullock-drawn and power-operated implements that will permit quick and efficient completion of the various operations. These implements should be made available in the watershed area through government agencies or cornmunity organisations. Customers Hiring Units may be formed for the purpose.

Plantation programmes in community lands

Community lands which are owned by panchayats or by the Government are kept fallow. These lands have rocky outcrops and no adequate soil depth due to the eroded condition of the soil. No proper soil or water conservation management practices or treatment are carried out on these lands. They should be brought under social forestry programmes or under pasture development according to the type of land and its suitability. The lands which are slightly away from the villages may be brought under pasture development by means of water harvesting from the upper catchment areas. But the planted area has to be strictly protected from grazing for at least five years to ensure the survival of the planted seedlings.

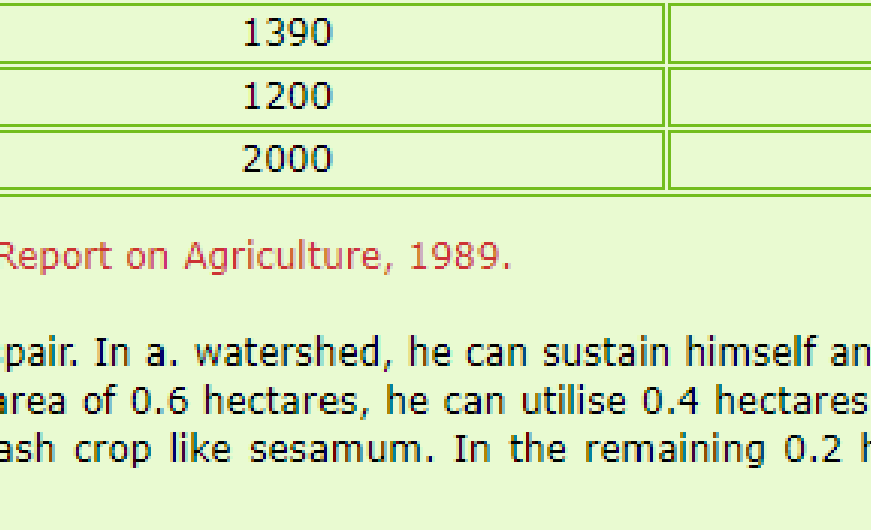
In case of plantations in wastelands, the available annual fodder and grass can be increased if it is treated by means of trenches having suitable grass species namely, Stylosanthes hamata, Dicanthium annulatum, etc. In social forestry plantation programmes, leguminous fodder trees, such as subabul, and other quick growing trees can be planted, with necessary protective measures taken for the first five years. If possible, pot irrigation should be taken up in summer. To avoid over grazing, stall feeding of cattle right from the second year should be resorted to. In addition to this, incase of badly eroded and gullied lands, along the contour agave plantation can be taken up with proper spacing and a proper drainage system with diversion drains, gully plugs, check dams, nalla bunds, etc. In case of heavily eroded lands, it is necessary to take constructed protection methods like fences to prevent cattle grazing. The best method to develop community land is to lease it either for pasture or for plantation programmes with inter-cultivation wherever feasible.

Avenue plantation



Along the roads in the districts, villages and urban areas, avenue plantation raising can be taken up. Two rows of trees should be planted on either side of the road, the first row to improve the aesthetics and to produce, in course of time, several items of minor forest produce for collection and use by local villagers. The second row of trees would produce fuelwood and fodder from mostly fast growing hardy species . Plantation programmes should be taken up with necessary techniques like afforestation with pits, soil and moisture conservation programme etc. Proper planning should be done for future widening of roads when avenue plantation is planned.

Development of wind breaks and shelter belts



It is necessary to have wind breaks in areas where the land is silted up due to wind erosion. A wind break consists of five rows of species planted at an interval of 500 metres. Wind breaks act as a barrier against the wind speed and make the land in between the wind breaks suitable for cultivation. Wind breaks are best adopted in areas where there are sand dunes, to avoid the moving of sand dunes from one place to another. Shelter belts are nothing but wind breaks planted around the periphery of horticultural plantation areas like mango to avoid high wind speed during the flowering season and to prevent the dropping of fruits. The species for a shelter break is selected in such a way that it would not affect the horticulture crop by infecting them with pests, etc.

Community participation

For a successful watershed development, team work is very essential. A task of this nature requires community efforts. It inculcates a sense of participation. With the responsibility shared and the drive towards a common goal, the fruits of labour can be enjoyed by all. Farmers owning land or having access to public land can seek the assistance of a watershed team, voluntary agencies and banks. For optimum results plant protection seed protection and processing, utilisation of ground water recharge, etc., have to be taken up on a group basis in the watershed. Organisation of inputs like improved seeds, fertilisers, etc., organising bio-mass planning, and ensuring timely operation of critical elements in the watershed, can best be taken up on a community basis. Such a group can also act as an intermediary between banks and farmers.

Productivity in watershed		
Dryland crops	Average yields within Watershed	Average yields outside Watershed
Jowar	1390	055
Tur	1200	722
Groundnut	2000	800

Source: Government of India, Status Report on Agriculture, 1989.

"Even a marginal farmer need not despair. In a. watershed, he can sustain himself and become viable by adopting the agri-horti-model. Out of a total farm area of 0.6 hectares, he can utilise 0.4 hectares for growing crops, and in a year of early rains, he can even grow a cash crop like sesamum. In the remaining 0.2 hectares, he can plant trees and grow some crops in between".

Total area of farn	0.6 hectares
Ragi + Tur	0.4 hectares
Mango plantation + phased reduction of Tur andGroundnut	0.2 hectares

Cost Benerit per year (in Rupees)			
Year	Cost	Gross come	Net income
1st year	2910	5655	2745
2-5th years	2470	6095	3625
6-10th years	2406	8041	5635
11-20th years	2406	9049	6447
21st onwards	2252	11830	9578

Source: National Bank for Agriculture and Rural Development.

Participation of Financial Institutions

Bankers participation is very crucial. The bank can draw the resource plans for every farmer in the watershed for optimum bio- mass production and also contingency crop plans to overcome weather uncertainties. The bank is in a unique position to dovetail technology with socioeconomic factors and also the constraints of the individual farmers in the area.

Thus in a compact area, development of a watershed of 1000 to 2500 hectares can be implemented with a multi-disciplinary approach. There is an urgent need to develop an effective system of watershed management. This would be an important step towards the essential improvement of the living conditions of the farmers who subsist on rain fed agriculture.

In conclusion, watershed development, if managed efficiently, can result in an increase in the output of fruits, cereals, pulses, oilseeds and even straw. This is a very rewarding experience for the farmer. But this is just the beginning and with proper planning for the next season, he can reap a richer harvest. So the farmer has learnt to make wise use of the gifts of nature, namely water and soil. Thus, a successful watershed development programme, by conserving water and increasing the fertility of soil, gives greater stability to agriculture and ensures a bountiful harvest.