SCOPE OF DRY AFFORESTATION TECHNIQUES IN QUETTA AND MASTUNG DISTRICTS OF BALOCHISTAN

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ABSTRACT

A study was designed to evaluate the effect of different water conservation techniques on the growth and height of different plant\tree species at Karak and Mianghundi (Quetta) and Mastung districts of Balochistan.

Rainwater harvesting and dry afforestation techniques were compared with conventional method of planting (simple pit planting) of three species viz. *Pistacia khinjak*, *Elaeagnus angustifolium* and *Atriplex* spp*.* at Mianghundi Quetta. The above techniques were also compared at Karak valley on *Atriplex canisence, A. lentiformus, Ailanthus sp.* and *Eucalyptus camaldulensis.* Data on survival of all species and height of *Atriplex canisence* was recorded and analyzed.

The survival of species at Mianghundi under different water conservation techniques viz. trenches, earthen bunds, micro-catchments and eyebrow plant pits was 48%, 43%, 33% and 30% respectively while in simple pits it was 26% respectively. But at Karak valley it was 55%, 48%, 43% and 38% and in simple plant pits survival was 33%.

The average height growth of *Atriplex canisence* under trenches, earthen bunds, micro-catchments and eyebrow plant pits was 1.412m, 1.350m, 1.346m. and 1.344m. respectively while in simple pit planting it was 1.270m.

At Mastung for sand dune stabilization trenches and simple pits were compared with surface planting on the following species *Tamarix gallaca, Calligonum* spp*., Saccharum* spp*.* and *Arundo donax.* The survival of species at Mastung under trenches and simple pits was 70.5% and 58% respectively while in surface planting it was only 36.5%.

So it is, safely concluded that various water conservation techniques have a significant effect on survival and growth of plants as compared to conventional planting methods. Within the various water conservation techniques contour trenches and earthen moistures are more economical and are able to keep the period happy and vigorous for a longer period of time. Biological treatment to sand dune stabilization is the only permanent and everlasting solution to this problem.

INTRODUCTION

Water is the basic necessity of life. Its presence and absence determines the fertility and the aridity of the land and the ecosystem that it surrounds. Rain is the first form of water that we know in the hydrological cycle, hence is a primary source of water for us. Rivers, lakes and ground water are all secondary sources of water in present times; we depend on such secondary sources of water.

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Water crisis situation occurs only because, effective collection and storage of rainwater has been ignored. Nature is always kind to us. The problem is that we are not responding it in a matching manner. If only we save each and every drop of water and recharge the under ground aquifer, we can rescue ourselves from this perpetual problem of water scarcity. The potential of rain to meet water demand is tremendous. Unless people are not involved in conserving rainwater from individual households to industrialist, it would be very difficult to meet the looming water crisis.

Therefore, among resources of special interest to Balochistan water tops the list. Balochistan is the largest province of Pakistan. It is 43.6% of Pakistan in area. In Balochistan precipitation is erratic and scanty, evapotranspiration rates are high and consume most of it because of high temperature and hot wind. Under favourable conditions only a small part goes under ground and joins the ground water aquifer. It is through these limited components of precipitation that nature has stored underground water during the past geological times.

Soil erosion is a serious problem in the arid, semi arid and barren regions of Balochistan. Almost 90% of the area of the province is facing the extremes of arid climatic conditions (Soil Survey and Reclamation Project). Rainwater harvesting is an expensive method for water resource development. But in the areas where rainwater is the only source of water. The cost benefit ratio shows that still this method is both economical and beneficial (Raziq 1984).

“Dry afforestation is the afforestation of arid and semi arid areas under rain fed condition by harvesting limited rain water and using this water as a source of moisture to plants for maximum possible period of time”. The main objective of dry afforestation is the restoration of vegetation, to protect the soil, reduce the sediment load, and check its transport and to regulate stream flow. Cheaper solution would be to allow the area to regenerate naturally or to promote regeneration by sowing native grasses, legumes or low shrubs. But uncertain rainfall pattern and biotic pressure are the hindrances in the way of natural regeneration.

MATERIALS AND METHODS

Brief description of the area

Quetta

Quetta derived from kwatta, meaning fort in Pushtu surrounded by hills of Chiltan, Takatoo, Murdar and Zarghun on all sides.

It lies between 30^{o} – 03’ and 30^{o} –27’ N and 66^{o} - 44’ and 67^{o} - 18’ E. Its total area is 2653 Km^2 and the population is 7,59,941. The district is situated at

an altitude of about 1,700 meter. The climate of the district is generally dry. The winter is very cold and the minimum temperature ranges between -15 to -7 degree Celsius. Summer is relatively mild and the maximum temperature ranges between 32 to 35 degree Celsius.

The total annual mean rainfall during 1983 -95 has been 308.2 mm, ranging from 143.2 mm in the month of June to 68.5 mm in the month of March.

The watersheds are either completely devoid of plant cover or having poor stunted and scattered growth, whenever vegetation exists, is either heavily grazed or grubbed out by the people living in the vicinity of watershed for fuel. Due to lack of vegetation cover, high intensity but short duration of rainfall, rapid runoff and low infiltration rates, about 70% of the incoming precipitation is lost (Provincial Soil Conservation Wing Balochistan Forest Dept.).

The dominating type of forest found in the district is natural forest. These can be found in Quetta (10,694 hectares) and at Urak (23,940 hectares).

Following are main species of the district; *Artemisia martima, Cymbopogon* spp*., Chrysopogon* spp*., Nepeta juncea* and *Astragalus stocksic*. However, in the protected areas like Hazargunji and Karkhasa, C*ymbopogon* spp. is more common.

Mastung

Mastung district is situated 50 kilometer south of Quetta. It lies between north latitudes 26^{o} 56' to 28^{o} 57' and east longitudes 65^{o} 52' to 66^{o} 35' the greatest length from north to south is 58 kilometers and the greatest width from east to west is about 82 km. Its total area is 5,896 Km^2, which lie at an elevation from 1500 to 2000 meters above sea level.

Dry hot summers and mild to cool winters characterize the climate. Most of the rainfall is recorded in winter, during which snow falls in the valleys of Mastung and Dasht.

The summer is dry with a hot dry summer wind blowing from Iran. Winter lasts from September to March. The maximum and minimum temperature is 28.4^{o}C and 3.6^{o}C respectively.

Following are main species of trees, shrubs, herbs and grasses; *Artemisia* spp., *Halloxyon griffithi*i, *Tamarix* species of *sulsola* Cumin spp., *Arafetider* spp*.* (hing), *Hyssup* spp*., Peganum hurmalu, Juniper, pistachio*, *Haloxylon salicornicum, Artemisia* spp*., Klpinea linearis, Heliotropium* spp*.* and *Othnopsis* spp.

Methodology

For primary data collection three sites; two in Quetta and one in Mastung districts were selected. The watershed and water harvesting activities were studied in Quetta district at Karak and Mianghundi sites. While the dry afforestation for sand dune stabilization activities were studied in Mastung district at Pringabad, Shamsabad and Pithabagh.

For survival percentage estimation under various water harvesting techniques 60 plants of various species in each of the water harvesting techniques were selected at random. Then the survival numbers of plants in each technique out of total (60) were studied and data was recorded in pre-designed proforma. The same procedure was repeated at Karak, Mianghundi and Mastung sites.

For average height comparison of *Atriplex* spp. under different water harvesting techniques study was carried out at Karak site of Quetta district. Five plants per techniques were selected. The height of each individual tree in each of the five water-harvesting techniques was obtained. Then the average per technique was calculated by taking simple mean. The data was recorded in pre-designed Performa.

RESULTS AND DISCUSSION

The study area was comprises of two sites i.e. Mastung valley and Quetta valley, purpose of study was to evaluate dry afforestation techniques, to check the response of different plant species and calculate the survival percentage of the different species. So, results are presented in two parts.

Mastung

In Mastung valley the study was carried out to check the survival percentage of *Tecoma gallaca, Calligonum* spp., *Saccharum* spp. and *Arundo donax,* which were planted for the stabilization of sand dunes. Two methods viz. trenches and simple pits were used to compare with surface planting.

The results showed that the trenches and simple pits were quite successful as compared to surface planting for the establishment of forest plant species, as given in the Table 1

Table 1. Survival percentage of plants under various water conservation techniques (WCT) at Mastung (survival out of 60 plants)

Water Conservation Techniques	*Tamarix gallaca*		*Calligonum* spp.		*Saccharum* sp.		*Arundo donax*		Average % age
	SURVIVAL		SURVIVAL		SURVIVAL		SURVIVAL		
	No.	%	No.	%	No.	%	No.	%	
Trenches	49	82	39	65	38	63	43	72	70.5
Simple pits	35	58	34	57	35	58	36	60	58.0
Average	42	70	37	61	37	61	40	66	64.5
Surface planting	25	42	17	28	23	38	23	38	36.5

The survival percentage of forest plant species under different treatments i.e. trenches and simple plant pits was 70.5% and 58% respectively, while over the surface of the sand, it was 36.5%. The survival percentage with water conservation techniques among the plant species viz. *Tamarix gallaca, Calligonum* spp., *Saccharum* spp. and *Arundo donax* was 70%, 61%, 61% and 66% while it was 42%, 28%, 38% and 38% with surface planting respectively.

The response of *Tamarix gallaca, Calligonum* spp., *Saccharum* spp. and *Arundo donax* was satisfactory in water conservation techniques than surface planting. It was found that the above plant species were outstanding and gave best results as compare to other available local and exotic plants, grasses and shrubs. The planting was quite successful and within a period of three years about 35% of vegetative cover was established permanently and movement of sand was stopped altogether. The planting was continued in a phased programme and until now more then 5605 hectares have been covered. It was due to the water holding of the techniques; they retained more water, while in case of surface planting water leached down easily without any obstruction

Quetta

In Quetta valley the study was carried out at two places namely Karak and Mianghundi, the purpose of the study was to check the survival percentage and height of the plants. *Pistacia khinjak*, *Elaeagnus angustifolium* and *Atriplex* spp. were studied in Mianghundi, while *Atriplex canisence*, *A. lentiformus, Ailanthus* spp., and *E. camaldulensis* were studied in Karak valley. Four methods viz. Earthen bunds, Trenches, Micro-catchments and Eyebrow plant pits were compared with simple pits.

The results showed that all water conservation techniques were quite successful as compared to planting in simple pits for the establishment of forest plant species, as given in the Table 2.

Table 2. Survival percentage of plants under various water conservation techniques (WCT) at Mianghudi, Quetta. (Survival out of 60 plants)

Water Conservation Techniques	*Pistacia khinjak*		*Elaeagnus angustifolium*		*Atriplex* spp.		Average % age
	SURVIVAL		SURVIVAL		SURVIVAL		
	No.	%	No.	%	No.	%	
Earthen Bunds	42	70	39	65	6	10	48
Trenches	37	62	35	58	5	8	43
Micro-catchment	29	48	27	45	3	5	33
Eyebrow pits	28	47	23	39	3	5	30
Av. of W.C.T.	34	57	31	52	4	7	39
Simple pits	23	38	21	35	3	5	26

The survival percentage of forest plant species in Mianghundi under different treatments i.e. Earthen bunds, Trenches, Micro-catchments and Eyebrow plant pits was 48%, 43%, 33% and 30% respectively, while it was 26% in simple pits. The survival percentage with water conservation techniques among the plant species viz. *Pistacia khinjak*, *Elaeagnus angustifolium* and *Atriplex* spp. was 57%, 52%, and 7% respectively, while it was 38%, 35%, and 5% with simple pit planting respectively. The response of *Pistacia khinjak* and *Elaeagnus angustifolium* was satisfactory but *Atriplex* spp. shown a poor growth in both water conservation techniques and simple pit planting.

The data of Table No. 2 indicated that in earthen bunds the average of survival %age of species was maximum (48%) followed by contour trenches (43%). It could be due to more water holding capacity of these two techniques as compared to others having less water holding capacity. The limited rainwater is retained for longer period of time and used by plants during dry periods.

Among the species *Pistacia khinjak* proved to be the best (57%) followed by *Elaeagnus angustifolium* (52%) while the survival percentage of *Atriplex* spp. was very poor only (7%). This could be due to the better adaptability and less water requirement of the first two species as compared to last one. As the soil over this site was gravelly; the water holding capacity of the soil was low and percolation was more. *Atriplex* spp. has shallow root system; so it was unable to utilize the surface moisture and ultimately died.

The survival percentage of forest plant species at Karak valley under different treatments i.e. Earthen bunds, Trenches, Micro-catchments and Eyebrow plant pits was 55%, 48%, 43% and 38% respectively, while it was 33% in simple pits.

Table 3. Survival percentage of plants under various water conservation techniques (WCT) at Karak valley Quetta. (survival out of 60 plants)

Water Conservation Techniques	*Atriplex canisence*		*A. lentiformus*		*Ailanthus* spp.		*E. camaldulensis*		Average % Age
	SURVIVAL		SURVIVAL		SURVIVAL		SURVIVAL		
	No.	%	No.	%	No.	%	No.	%	
Earthen Bunds	45	75	44	74	20	33	22	37	55
Trenches	41	68	38	64	17	28	19	32	48
Micro-catchment	39	65	34	56	14	23	16	27	43
Eyebrow pits	35	59	29	49	12	20	14	23	38
Av. of W.C.T.	40	67	36	61	16	26	18	30	46
Simple pits	31	51	28	46	8	13	12	20	33

The survival percentage with water conservation techniques among the plant species viz. *Atriplex canisence*, *A. lentiformus, Ailanthus* spp.*,* and *E. camaldulensis* was 67%, 61%, 26% and 30% respectively, while it was 51%, 46%, 13% and 20% with simple pit planting respectively.

The data of Table No. 3 depicted that among all water conservation techniques the earthen bunds were the best giving maximum average of survival parentage (55%) followed by trenches having a survival percentage of (48%). The least effective method was planting in simple pits supporting only 33% surviving vegetation.

This could be due to the more and prolonged storage of harvested rainwater in bunds and trenches as compared to other techniques. The other reason could be siltation of simple pits and other small water storage techniques; as the soil over this site is clayey and loose (susceptible to erosion).

The performance of the four species studied showed that *Atriplex canisence* was best over this site (67%), being hardier, and having better rate of growth and best adopted to moisture retaining clayey soil of this site. The second best performance was shown by *Atriplex lentiformus* (61%) having more leaf surface area (transpiration) as compared to the previous *Atriplex* spp. the performance of other species were 30% and 26% in descending order.

The average height attained by *Atriplex canisence* planted with water conservation techniques and conventional pit planting is presented in the Table 4.

Table 4. Average height data of *Atriplex canisence* under different water conservation techniques (m)

Water Conservation Techniques	*Atriplex canisence*					Total	Average
	1	2	3	4	5		
Earthen Bunds	1.460	1.410	1.380	1.420	1.390	7.060	1.412
Trenches	1.380	1.350	1.360	1.320	1.340	6.750	1.350
Micro-catchment	1.360	1.340	1.350	1.330	1.350	6.730	1.346
Eyebrow pits	1.340	1.360	1.330	1.350	1.340	6.720	1.344
Av. of W.C.T.	1.385	1.365	1.355	1.355	1.355	6.815	1.363
Simple pits	1.280	1.260	1.250	1.290	1.270	6.350	1.270

The average height growth of *Atriplex canisence* planted in earthen bunds, trenches, micro-catchment, eyebrow plant pits and simple pits were 1.412m, 1.350m, 1.346m, 1.344m. and 1.270m respectively. The average height of *Atriplex canisence* with all other water conservation techniques was comparatively higher then simple pit planting. Within the techniques the response of earthen bunds was higher (1.412m) then the other techniques, but simple pit planting showed a poor response (1.270m). It could be due to water holding capacity of the earthen bunds they retained more water and moisture persists for a longer period of time.

DISCUSSION

The preliminary results of the study have shown that water conservation techniques prove quite effective tool in the afforestation programme of dry regions including sand dune stabilization. The techniques have proved not only its usefulness in increasing the survival rate of plants but also enhanced the growth rate of the plant species. There design is effective for intercepting the surface runoff from the large area and concentrating it at a point where seedling is planted. The water collected in all techniques on each rainfall, infiltrate into soil up to considerable depth and is thus conserved and used by the plants. The soil moisture under the earthen bunds, trenches, micro-catchment and eyebrow plant pits is available for a longer period to plant during dry period, but the seedlings planted in simple pits are moisture stress. It is also observed that the moisture content within the techniques was higher in earthen bunds because of their sizes. There is water deficit during most of the time of the year; the water conservation structures intercept even a little shower of 10 mm upto a considerable depth.

The water conservation techniques used were equally effective for soil conservation. The runoff of catchment treated with water conservation treatments was reduced due to the retention of water in the conservation structures. The staggering of the techniques reduces the slope length and thus velocity of runoff.

Therefore, the water conservation treatment by reducing the mass as well as velocity of surface runoff decrease its erosive power (kinetic energy) to a great extent and thereby prevents the erosion.

In addition to the solving the problem of constant menaces of moving sand dunes in Mastung Valley, the following benefits were also observed by stabilization of sand dune through planting. Though temporary stabilization has good effects to provide opportunity for seed, seedling or cutting to grow and strike root undisturbed. But for permanent stabilization of dunes, plant cover must be fully restored. For this purpose, mixed activities were also practiced. The plantation / afforestation, however, has the following overall benefits.

- Planted areas become completely stabilized and biologically productive after two or three years. Effective protection of the sand dunes movements, since the plant cover is established and provides a natural homogeneous sand trapping system.
- Positive effects on the ecology of respective area, e.g. improved soil moisture, wildlife and microclimate.
- A reserved biomass for the periods of prolonged droughts and during scarcity of forage these can be used for the controlled grazing of livestock.
- The species like *Tamarix* and *Calligonum* can be used for fuel and material for thatching purposes.

The initial cost of water conservation techniques is higher but it is compensated by the reduced cost of restocking due to higher survival rate of plants as compared to those of pits. The cost of earthwork, plantation, restocking and maintenance is based on the prevailing schedule of expenditure of the department. The cost of restocking is estimated according to the average mortality rate of seedlings.

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