

DRY-ZONE AFFORESTATION IN THE JUNIPER FORESTS OF BALUCHISTAN

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The Juniper (*Juniperus excelsa*) forests of Baluchistan occur over about 250,000 acres between Lat. 30° 9' and 30° 27' N, and Long. 67° 11' and 68° 3' E, on hilly and rugged terrain ranging in elevation from about 5000 to 12,000 feet. Because of inadequate rainfall and steep slopes, only physical weathering of rocks—mainly conglomerate, limestones, sandstones, shales—has occurred. And the properties of soils are generally determined by their depth, texture, gravel content, water infiltration and moisture holding capacity, and by topography and drainage. About one third of the area comprises bare rock. Over the rest the soil is shallow, light grey brown, gravelly clay loam with a surface covering of gravel. It is generally underlain by weathered limestone fragments followed by bed rock. The soils are highly calcareous, non-saline and moderately alkaline due to the presence of carbonates. Their organic matter content is negligible except for partially decayed humus under trees and shrubs.

Climate. The mean monthly rainfall and snowfall of Ziarat for the period 1977-1980 is given below:

Month	Rainfall, mm		No. of rainy days		Snowfall, cm	
	Average	Range	Average	Range	Average	Range
January	7	5-10	2	1-6	52	30-93
February	16	10-17	2	1-2	82	2-270
March	56	7-119	4	2-10	8	0-32
April	35	18-53	5	2-8	—	—
May	7	6-13	1	1-2	—	—
June	28	13-72	4	2-8	—	—
July	71	5-115	6	2-13	—	—
August	30	34-45	4	2-6	—	—
September	5	0-19	1	0-2	—	—
October	5	0-20	1	0-2	—	—
November	17	10-27	1	1-2	4	0-15
December	5	0-20	1	0-2	8	5-25
Mean annual	282		32		154	

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Mean maximum and minimum temperatures and relative humidity for the same period are as follows:

Month	Maximum temperature C°		Minimum temperature C°		Relative humidity % at 0900 hours	
	Mean	Range	Mean	Range	Mean	Range
January	6	-3 to 14	-9	-14 to -1	65	9 - 100
February	7	2 to 16	-5	-12 to 0	59	24 - 100
March	12	5 to 20	-1	-8 to 9	50	9 - 100
April	19	8 to 26	5	-3 to 9	51	2 - 93
May	24	15 to 29	7	-3 to 14	38	2 - 94
June	27	18 to 33	11	6 to 15	31	0 - 68
July	26	17 to 32	13	10 to 17	55	11 - 100
August	27	21 to 31	11	9 to 14	39	11 - 94
September	25	20 to 31	8	3 to 12	33	1 - 88
October	22	15 to 30	4	2 to 8	23	3 - 77
November	11	10 to 27	0	-10 to 9	43	10 - 100
December	11	0 to 20	-4	-14 to 0	67	0 - 100

The forest. About 150,000 acres of the area are covered with Juniper forests. The tree grows almost pure, in open crops, with a few scattered *Fraxinus xanthoxyloides* along streams or in cool locations and a few *Pistacia khinjak* on warmer slopes. Associated with juniper are such shrubs as *Artemisia maritima*, *Berberis baluchistanica*, *Caragana ambigua*, *Cotoniaster nummularis*, *Ephedra nebrodensis*, *Prunus eburnia*; and the grasses *Cymbopogon jawarancusa*, *Dicanthium annulatum*, *Pennisetum orientale* and *Stipa pennanta*.

Though the trees are protected officially, considerable cutting probably takes place as the local people have no other source of timber of firewood.

Under favourable conditions, juniper may grow to about 70 feet height and 80 inches diameter at breast height, the usual size is about 50 feet high and 40 inch dbh. It assumes a bushy form on dry sites, at low elevations, and on bare rock. Its growth is very slow: trees five feet in height and about an inch in diameter at breast height overbark may be about sixty years old.

Natural regeneration of juniper is scanty. Though young seedlings may sometimes be seen in spring, they die soon after except where they are protected from grazing, for example inside thorny shrubs.

In recent years the valleys of the juniper tract have assumed considerable importance as apple growing areas. Because the returns from apple are very high, the trees are being planted where ever water can be developed. In most places,

planting sites are reclaimed beds of streams which are normally dry but can become roaring torrents in years of abnormal rainfall. And this is the danger of such development: It can so easily be wiped away because flash floods are so common in these bare mountains. To protect apple orchards, the mountain slopes must be covered with natural vegetation.

Planting of juniper. To find out how to improve the vegetative cover of the mountain slopes of the juniper tract, investigations were started in 1975 by the Pakistan Forest Institute under a scheme financed by the Pakistan Agriculture Research Council. The main difficulty encountered concerned the germination of juniper seed: about 60 to 90% of seed is hollow, and germination per cent varies widely from tree to tree: In most cases from 0 to 1%, with exceptional values going up to 3 or 4%. The average germination per cent of seed sown since the start of the work has been as follows:

Year	Total number of seed sown	Number of seedlings germinated	Germination Percent	Percent seed- lings surviving after one year
1975-76	220,000	3,800	1.7	1.4
1976-77	169,375	236	0.14	0.12
1977-78	317,335	253	0.08	0.05
1978-79	1,109,492	3,248	0.29	0.21
1979-80	941,056	9,834	1.04	0.92
1980-81	1,022,055	2,903	0.28	0.25

As the above data indicate, wide variation was encountered in germination percent from year to year. Taking 0.2 as the usual number of seedlings surviving for every 100 seed sown 1000 seed will need to be sown for every 2 seedlings required. Since 3 fresh berries on an average weigh one gram and there are an average of 3 seeds in a berry, each gram of berries would yield 9 seed. So far, every seedling required, about 60 gm of berries will have to be collected.

The most important factor in collecting viable seed is to correctly judge the fully ripe berries. These are reddish in colour and soft and plump and can be squeezed between the thumb and forefinger. Ripe berries are available from about mid-October onwards. Berries ripen over an interval of time varying probably with locality and with the parent tree.

While collecting berries, seed bearers should be chosen carefully, both as regards stem form and vigour, as well as the percent of filled seed. An estimate of the latter can be obtained by breaking ten seed samples of 10 seeds each collected from different parts of the tree and observing the number of filled seed in each sample.

Another very important factor is time of sowing. In the Forest Institute,

Peshawar, where the germination trials were conducted, the peak months for germination are February, March, April. Germination falls off rapidly in May and ceases thereafter, though some seed may germinate after summer rains in July and August, and some next year in March April. As this may be related with temperature, the peak germination period may vary from place to place. At the Institute, the monthly mean maximum and mean minimum temperatures based on the average of the past 10 years are given below:

Month	Mean maximum (C°)	Mean minimum (C°)
January	17	3
February	18	5
March	23	10
April	30	15
May	35	20
June	39	25
July	36	26
August	35	25
September	34	22
October	31	14
November	25	7
December	20	4

Since germination starts 2-3 months after sowing, seed must be sown as soon as ripe berries become available in order to avail of the peak germination period on spring. So a careful search must be launched for fully ripe berries from the middle of October onwards. In most years it should be possible to collect ripe berries from the beginning of November. Efforts must be made to complete the sowing of seed by 15th November so that germination can start from the middle of February.

After the berries are collected, they have to be crushed to extract the seed. This can be done by rubbing them with bricks on a cement floor. The crushed material should be washed in water to separate the seed. Immediately on extraction, it is not possible to separate the hollow seed from the filled by floatation in water. But if the seed is allowed to soak in water for 24 hours, about 25% of the hollow seed can be so separated.

For the past six years numerous attempts have been made to increase the percentage of germination or reduce its period. But no consistent results have been obtained and no treatment has proved superior to control, so far. The various treatments tried were:

1. Soaking in concentrated H_2SO_4 for 10, 15, 20, 30 and 45 minutes and then thorough washing for two hours in running water.
2. Stratification in moist sand for 90 days at $5^\circ C$ temperature.
3. Acid treatment for 10, 15, 20 minutes, followed by washing and then stratification for 90 days at $5^\circ C$ temperature.
4. Soaking in cold water for 24 and 48 hours.
5. Soaking in water at $90^\circ C$, which was then allowed to cool for 24 hours.
6. Soaking in H_2SO_4 for 5, 10 and 15 minutes through washing rolling in Arasan fungicide powder and stratification for 90 days at $5^\circ C$.
7. Rolling in Arason, stratified for 90 days at $5^\circ C$.

Seed can be sown in raised nursery beds comprising garden soil, sand and leaf mould in equal parts and the beds kept moist by running water in the intervening furrows. It is essential to protect the seed and the seedlings from birds and rats. This can be done by covering the beds with a frame of wire gauze. As soon as seedlings emerge, when still at the cotyledonary stage, they should be transplanted to polythene tubes of size 8 x 20 cm with 48 punch holes and containing a mixture of equal parts by volume of garden soil, sand and leaf mould. Transplanting should be done on a cool, dull day and the seedlings placed in partial shade for several days thereafter.

The seedlings should be regularly watered with a fine rose to keep the soil moist and protected from bird and from hail. Since the seedlings will stay in the tubes for a minimum of two years, black coloured tubes of durable material should be used so that they do not tear in the nursery or in transit.

So far the seedlings have been raised at the Institute and transported 700 miles by truck to the planting site. For planting on a field scale it will be preferable to grow them closer to the juniper tract. Since the growing season there is short and growth is slow, it may be preferable to grow juniper in the Loralai nursery which is about 50 miles from the centre of the juniper tract. In this case the seedlings should be brought to the planting site in October for planting the next year.

As is shown by the rainfall and snowfall data, the seedlings can be outplanted in two seasons: March and August. But summer rainfall is not reliable. So the best month for planting is March, as soon as the snow is off the ground and the soil can be worked.

Because juniper must develop extensive surface rooting to survive under such arid conditions, the seedlings should not be planted closer than 30 feet apart. The planting site should be carefully chosen to provide the best possible micro climate to each seedling—sufficient soil, preferably shade from south and west provided by a tree, bush or rock. It is preferable to plant so that the collar is about 6 inches below the soil surface. Such pit planting will provide better

moisture conditions to the seedlings. Each seedling should also be covered with locally available thorny shrubs. These will protect them from nibbling by picas and other rodents and will also provide them partial shade from strong sun. If the soil is rocky, the excavated pit will have to be filled with soil collected from the surrounding area. Before planting the polythene tube should be given several vertical slashes with a blade and carefully removed from the ball of earth surrounding the root system of the seedling.

If water is close by, the survival of the planted seedlings can be greatly increased by watering at the time of planting. If this is not possible, planting should be done when it is raining. Careful selection of planting spot, using two year old stock, planting in early March, either watering at the time of planting or planting in rain, and covering the seedlings with thorny shrubs should give about 80% survival, unless subesequent rains are below normal.

We tried out planting germinating seedlings, and six months, one year and two year old seedlings. Germinating seedlings failed to survive. Six months old seedlings survived all right, but their growth was slow. Though one year old seedlings can be outplanted, two year old stock is sturdier and better able to stand the rigours of field planting.

Because soil moisture is seriously deficient in the juniper tract in most years, various water catching and conservation devices are expected to increase survival and growth.

Planting of other species. In addition to juniper a number of other species were also planted in the area. Of these *Fraxinus xanthoxyloides*, *Cupressus arizonica*, and *Gleditschia triacanthos* are surviving so far. Amongst these, *F. xanthoxyloides* is indigenous and is likely to perform well. The future performance of the latter two cannot be forecast at this stage. *Ephedra nebrodensis* is an important medicinal plant of the tract and a factory in Quetta is manufacturing Ephedrine from it. Since its over cutting has exterminated it from easily accessible areas, planting of tube raised stock of *Ephedra* was also attempted successfully.