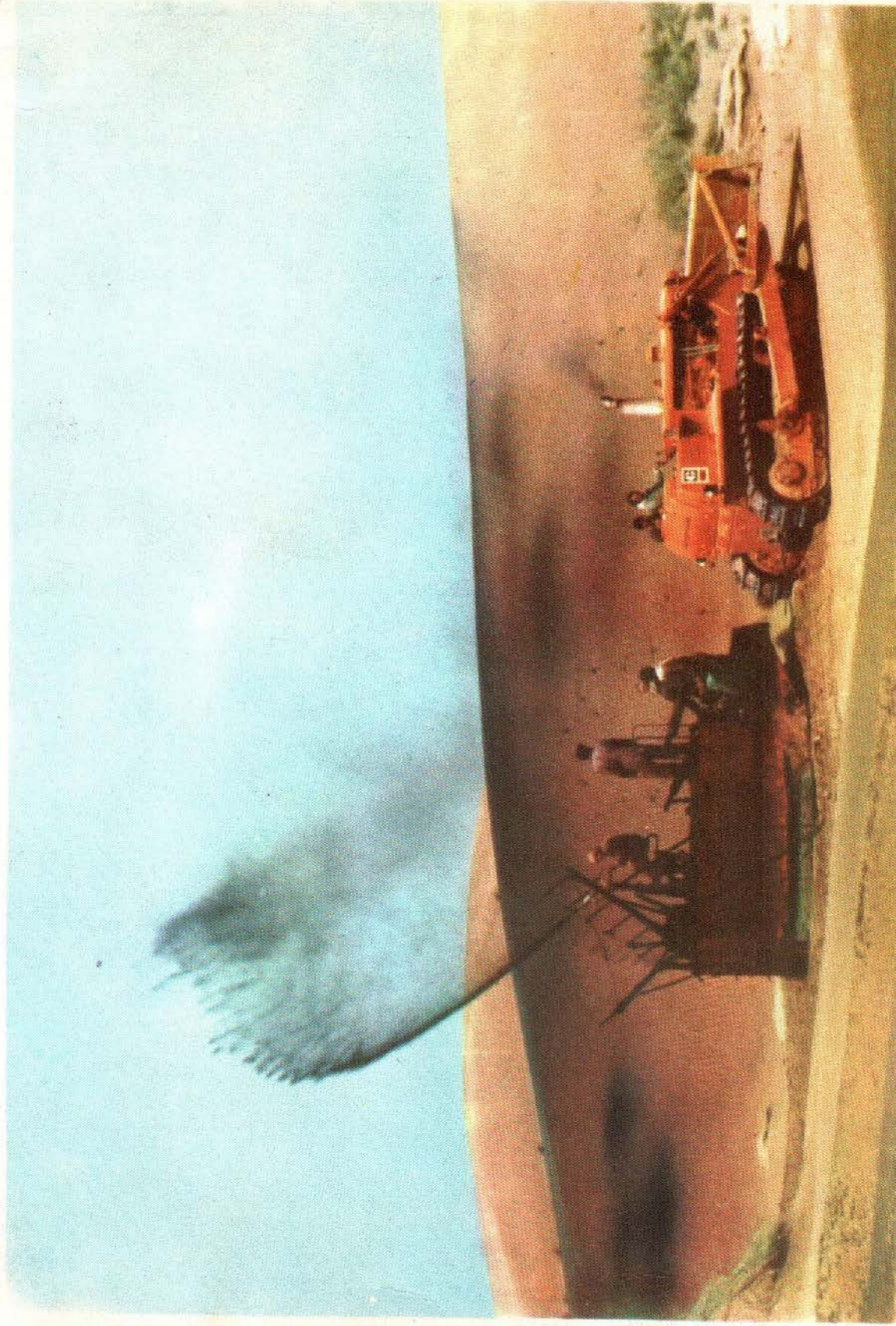


Petroleum Mulch in Sand Dune Fixation





IMPERIAL GOVERNMENT OF IRAN

Ministry Of Agriculture

S.

Natural Resources

FORESTRY & RANGE ORGANIZATION

Petroleum Mulch Project

PETROLEUM MULCH IN SAND DUNE FIXATION

Mehdi Mahdavi

By: A. Mansour Moayed



General view of Sand Dune in South West of Iran

INTRODUCTION

It does not at all seem necessary, to talk in this short time about the importance of forests from the view point of Economy, Industry or prevention of Air pollution. It should however be pointed out that the love of Agriculture, preservation of natural Forests and even creation of man-made ones, has been a part of the Iranian religious and governmental customs ever since ancient times, and this can be supported by historical evidences. In his book "The Economic", the Greek historian "Xezephone" quotes as saying; "the Persian Kings often travel to various parts of their Country, and if they notice that a ruler has paid full attention to agriculture and forestry in his region, he is praised and encouraged, otherwise he is punished and replaced". Greek historian "Poulip" writes; "In Persia whoever cultivates a barren land". On the whole, reviving land and forests, plantation of trees and farming were works considered to be signs of love for Ormuzd, and farmers were always considered one of society's top classes. In Zoroaster's book, Persia's oldest religious book, it is said that one who sow a seed, plants the grain of beneficence. Herodotus, the well-known greek historian, recalls letters written some 2500 years ago by King Darius to the presiding officials, ordering them to create forests and plant fruit trees.

At the present time, Iran is unfortunately not a well endowed country in forestry, for the above-mentioned reasons, as well as the fact that its climatic conditions are an added cause, since its average annual rainfall does not exceed 250 millimeters and that with a very wide spread and varied distribution. For its natural and man-made forests in proportion to its total area of 1,650,000 square kilometers not with standing; it does possess relatively large forest areas, which can be considered as part of our National Resources support. The regions around the Caspian Sea and the northern slopes of the Alborz mountain, range from Astara to Bojnourd, which is like a green belt, circling the southern regions of the Caspian Sea and are covered with forests with an area of approximately 3,000,000 hectares.

Some of these areas have superior and industrially productive forest, and the other parts have ordinary forests and bushes which are not productive at the present time due, to the absence of correct protection and maintenance in the past. Besides northern areas, which should be considered the main forest areas of Iran, there are also forests in the Western, Eastern, Southern and Central regions of Iran, most of which have too few trees and many of which are remains of ancient forests, which have now turned into the present undesirable state and for the moment are economically valueless, except for the measure of protectiveness. However, we believe they can be revived. These include the oak forest in the west and south; pistachio and almond forests, tropical forests and those of the salt lime and mountainous regions and those around the sea of Oman. Of these, not more than 3,000,000 hectares can be called real forests.

Sand Dunes are found in many parts of the world, particularly in arid or semi-arid area. Those dunes, whether of the coastal variety or true continental dunes, are a constant menace to communities living in their vicinity. Under the action of the wind, the dunes migrate and engulf good agricultural land, highways and sometimes even villages, and sand blown from them, causes sand storms which can damage crops grown at considerable distances from the dune area. To fully appreciate the severity of conditions, one must visit a sand Dune during a wind storm and witness the movement of sand in the dunes; an awe inspiring sight.

Sand Dune Stabilization In Iran

In Iran the problem of sand stabilization is one of great importance where the moving sand is a constant threat to agricultural development and to the inhabitants of the country-where the birth rate is doubling within the present century.

True deserts occupy about one fourth of area of the Iran (total area of Iran is 1,650,000 Sq./Km), which five million Hectares of this desert, is active dunes.

Vast areas of the South Eastern and Western parts of Iran are covered with sand dunes. The greater area of these are continental dunes, but maritime dunes also occur along the coast line and for some distance inland. All the dunes are "moving" to a greater or lesser degree due to influence of winds sweeping in from the desert from the South during the hot, dry season. These hot winds take a heavy toll of plant life particularly where there is no protection.



Wind is the enemy, smothering life with sand. Above figure shows the wind erosion of sand from roots of planted seedlings.

Although these sand dunes are completely barren, they can, when stabilized, support a surprising cover of plant life, the only other requisite being water, and they fortunately have a moisture conserving capacity.

All sand dunes have, as a common characteristic, the ability to store large quantities of water. This is because very little water movement by capillarity occurs in sand, and consequently dune water is "protected" by a dry top surface layer of sand, provided plant nutrients are available. Therefore, dunes in areas of sufficient rainfall should be able to support vegetation. In practice, however, dunes seldom retain their water for long, because wind erosion removes the upper insulating layer of dry sand, and desiccation of the lower moist layer occurs. Sand movement also, of course, results in the exposure of the roots of

PRIORITIES AND OBJECTIVES FOR SAND DUNE FIXATION

In order to carry out a successful sand stabilization and afforestation programs, the young seedlings must be protected until they can root firmly and begin to grow on their own and, in effect, form their own protective windbreak.

There is evidence from existing sand dune afforestation projects, that the objective of such projects need to be more clearly defined.

These objectives, considering both direct and indirect benefits, may include,

- A) Protection (for roads, agricultural areas, industry, municipalities, airport, etc.);
- B) Production of wood (for timber, fuel, pulp, boxes, etc);
- C) Aesthetic, recreation and — wildlife benefits;
- D) Water supply (protection against local floods, erosion/sedimentation, to increase percolation into the groundwater, etc.);
- E) Grazing benefits, introduction of palatable species of vegetation.
- F) Creation of public works (to combat unemployment.)

The above objective setting should enter into the initial selection of methods, species and stabilization techniques.

ENVIRONMENTAL INFORMATION

The most important environmental data for dunes are:

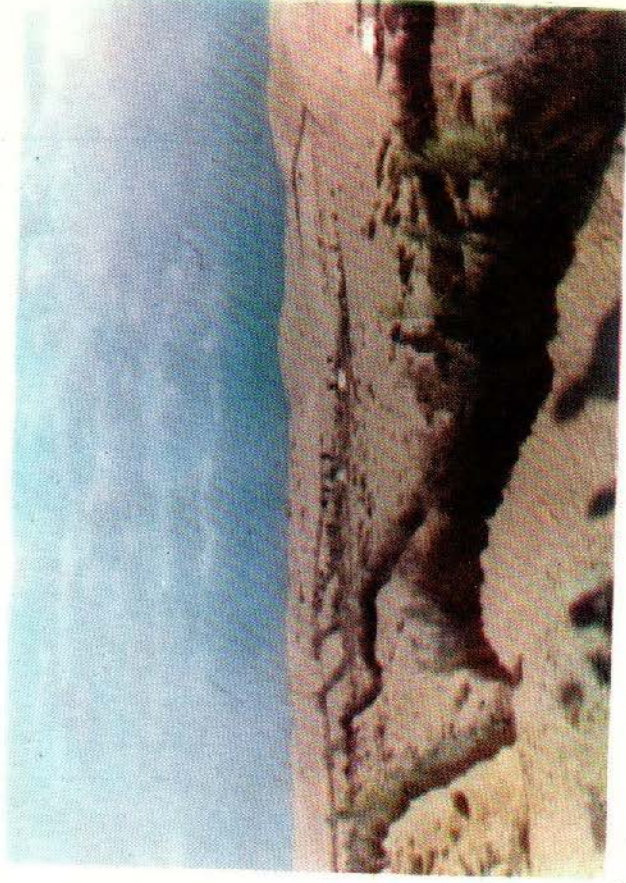
- 1) **Soil information:** Profile, depth texture, salinity, and fertility.
- 2) **Climatological data:** Wind directions, wind intensities, details on precipitation and temperature.
- 3) **Hydrological information:** Details on depth of the groundwater, movement of the groundwater table, flooding and data on soil infiltration rate and moisture conditions;
- 4) **Physical considerations:** Slopes, dune types (whether upper slopes, depressions, etc.), exposure and other physiographic features;
- 5) **Vegetative surveys:** Knowledge of kind, density and distribution of vegetation.

A — Conventional Method

Conventional methods of stabilizing dunes prior to planting usually involves the erection of dried grass or brushwood, generally pallsades *Imperata* grass which is set upright and partly buried in the sand to form hedges.

These hedges are set in a pattern of squares and rectangles over the surface of the dunes and depending on the steepness of terrain vary from 5m x 5m to perhaps as little as 4m x 2m into which squares a tree or trees are planted.

In the past most afforestation has been done by a establishment of pallsades involves planting seedlings in plots during the rainy winter season and surrounding the plots with windbreaks of grass. Afforestation through wind breaks is costly in terms of manpower, slow and is limited by the amounts and location, of sufficient quantities of pallsades.



Conventional Method of Stabilizing dunes by erection of brushwood, generally pallsades *imperata* grass.

B — Stabilization by Petroleum Products



Pouring oil on shifting sands by boom spraying in low sand dune with oil, in Boinzahra area. Trees are held in place while roots firm up.

The particles, composing sand dunes, being non-cohesive, are easily transported by wind. If they are rendered cohesive, for example by wetting the dune surface, it gets stabilized. The heavy petroleum products will wet sand, and cause the particles to cohere, and are not easily lost by evaporation. Petroleum products have been used for this purpose in the past, either to stabilize a whole dune surface, or to redirect or destroy a dune by stabilization of a selected part of the surface, leaving the remainder to waste away by wind erosion.

Also in the past the Petroleum Mulches have been used in agriculture and horticulture for many decades to promote crop growth by altering certain of the physical characteristics of the soil. At least three parameters, soil temperature, soil moisture, and soil structure can be influenced, though the relative importance of each can vary from crop to crop and location to location.

The Esso research has been. Already prominent in the mulching research field and agreed to undertake research into the possibilities of application and spraying of oil as a method of sand stabilization.

Laboratory studies on the resistance of oil treated sand surfaces to wind erosion began in the autumn of 1960 in the laboratories of Esso Research Limited in the United Kingdom and the first field application was made in early February 1961.

The various applications of the oil stabilization technique is described briefly below:

In land reclamation work, oil stabilization should be regarded as a temporary fixation measure, creating conditions for the establishment of permanent vegetation cover. Dunes suitable for such treatment must lie in an area having sufficient rainfall, or should have other water resources for economic plant growth, and in addition, the potential requirement for oil stabilization in any given area will depend on the following factors:

(a) Present nuisance value of the dunes, i.e. the amount of damage caused to surrounding agricultural land, buildings, and installations, by sand encroachment from the moving dunes.

(b) The improvement potential of the wind eroded land. This is dependent on the local market demand for specific crops which can be grown on the reclaimed land.

(c) Land values in dune areas: The existence of under developed higher quality land in the vicinity of sand dunes will often make reclamation unattractive.

Having decided that the land is worth reclamation, a decision must be made regarding its final utilization. Reclamation of the soil for the immediate purpose of uncontrolled cultivation or grazing will in most areas defeat the object of stabilization. The crops planted must be such that they effect permanent stabilization of the area being reclaimed and should be chosen in conjunction with the local Agricultural or Forestry Authorities.

In very many cases afforestation, will be found to be most suitable, but in some areas, a crop such as castor beans, which matures quickly, and has a comparatively long life may will prove most attractive.

Whatever the final utilization of the reclaimed land, oil stabilization must be designed with the following points in mind.

1- the treated surface should not impede the growth of plants.

2- the surface should remain permeable to rain after treatment, so that the dune can be recharged with water during the rainy season.

3- the treated surface must be capable of resisting wind for 1-2 years.



Mulch spraying with self carrying tracked vehicle, through fine nozzle boom distribution system.



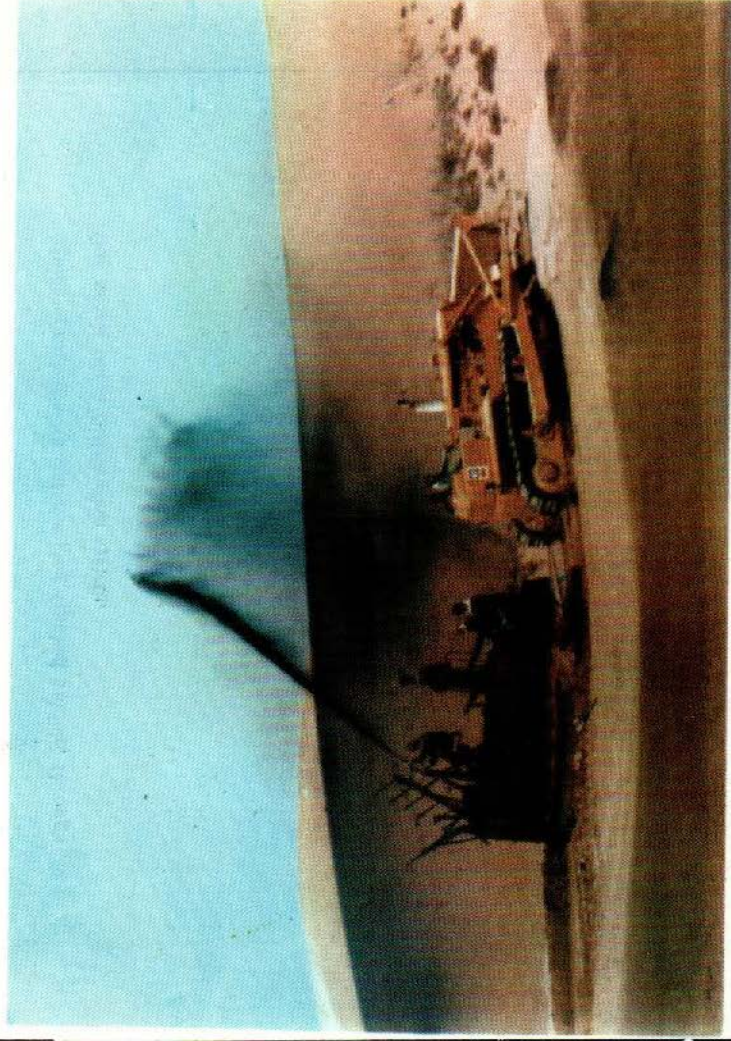
Mulch spraying with self carrying tracked vehicle, through fine nozzle boom distribution system.

**Sand Dune
Stabilization
and
Afforestation
Programme
In Iran**

The first experimental work was made in February 1968 at Boinzahra area 120 Km. from Tehran. An area of 900 hectares, 60% of which were continental sand dunes, was planted and sprayed. The oil was applied by hand spraying, using a 4-wheel drive Mercedes-Benz model LA-911. On the chassis has been placed a tank (thermally insulated), having a capacity of 4.5 tons of oil. The piping system is with two outlet manifolds, one for boom-spraying, the other for hand-spraying with pumps giving a delivery pressure up to 300 P.S.i. Also a 4 wheel trailer having a capacity of one ton of oil, equipped with the spraying unit, drawn by tractor was used for some of the difficult areas.

Before spraying, the product was heated to a temperature of about 50°C.

Due to the experimental and training nature of Boinzahra stabilization, and heavier treatment being given to exposed places and slip faces, while correspondingly lighter treat-



Mulch spraying from a sledge tank spray unit, towed by a bulldozer with a spray gun which can shoot up to 60 meter long, and used for highdunes and slip faces.

ment given to hollows and other sheltered spots, the amount of oil covered was rather variable; however, in the last days it has been constantly measured an average consumption of 3.85 ton/hectare.

Since 1969 we were engaged to stabilize 10,000 hectares of sand dunes in the south west of Iran near AHWAZ, called ALBRVAYEH, ALBAJI and GAMBOYEH. Since the conventional tank truck was only suitable for low and small dunes, this method proved to be too slow, particularly as the program continued to expand in terms of the number of hectares to be covered, and also involved high dunes up to 40-50 meters. To overcome this problem we developed a steel sledge fitted with a tank holding 15000 liters of the stabilizing oil. From the tank extended long antenna like arms of pipe, with attached sprays nozzles which are activated by a pump on the sledge.

A heavy duty tractor tows, or winches the sledge over even the most rugged dunes, leaving a sprayed area of up to 25 meters wide.

This method of application has been remarkably improved with other supplementary dune going vehicles, high pressure spraying equipment etc. Also the spraying teams themselves are, with experience, becoming more efficient. Planting after spraying, means that the spray can be applied in advance of the planting operation, thus saving valuable time once the rains have fallen.

The principal attribute of the spraying system is that it stabilizes the whole of the surface area, whereas with the conventional method, the sand within the pallisades squares, particularly on steep slopes on the windward side, is liable to be blown out following planting. Spraying remains intact for a much longer period, and it also has the advantage of conserving moisture in the upper layer where the young roots system have easy access



A sky (Spray Gun) sledge tank towed by D9 Caterpillar tractor.

and can develop rapidly. Another point in favour of oil stabilization, is that in no case so far, has there been evidence of root exposure, whereas on the slip faces of pallisaded dunes, following high wind storms, either roots or the tree seedlings may be buried in sand.

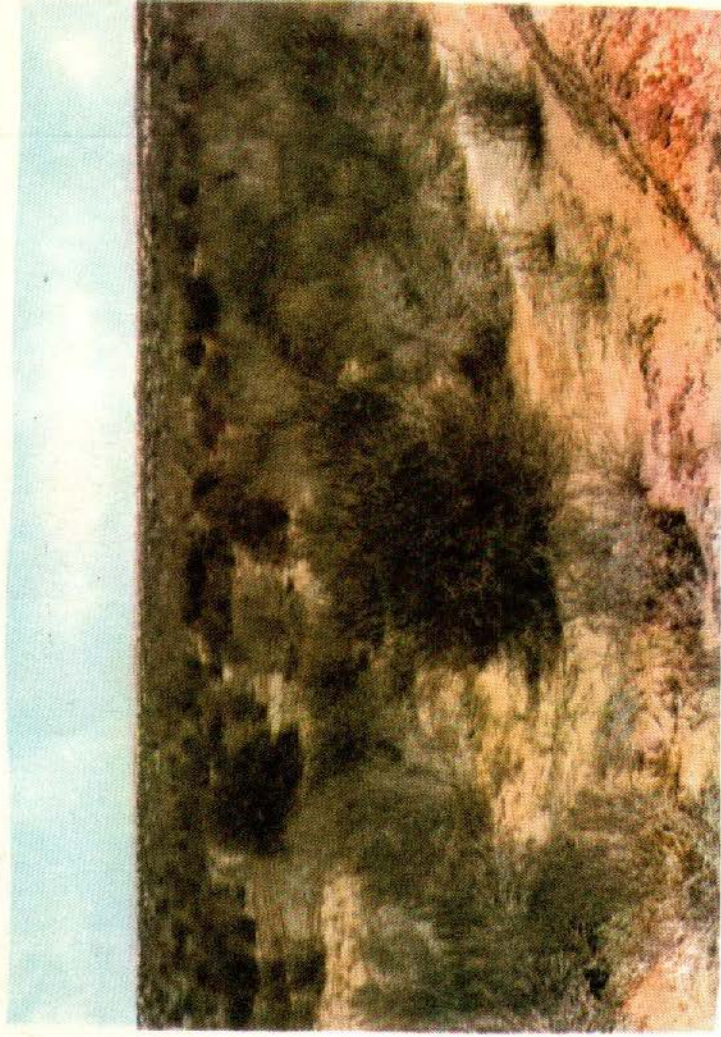


Some of the two years old trees seedling such as *Tamarix*, *Haloxylon* and *Calligonum* in AHWAZ. It was first planted and then sprayed. Some of them are taller than 2. meters.

The greatest long term prospect offered by the mulch spraying system is the possibility of afforestation by direct sowing.

If good stands of the seeded species are achieved, the saving by this method in labor and in nursery production and afforestation would be immense and rapid initial growth could be expected following successful establishment of the crop.

Mulch aids germination both by conditioning the soil and preventing wind from eroding the surface soil and scattering the seed.



Direct seeding of HALOXYLON (2 years old), after mulch spraying.

Highway

Railroad

Airport

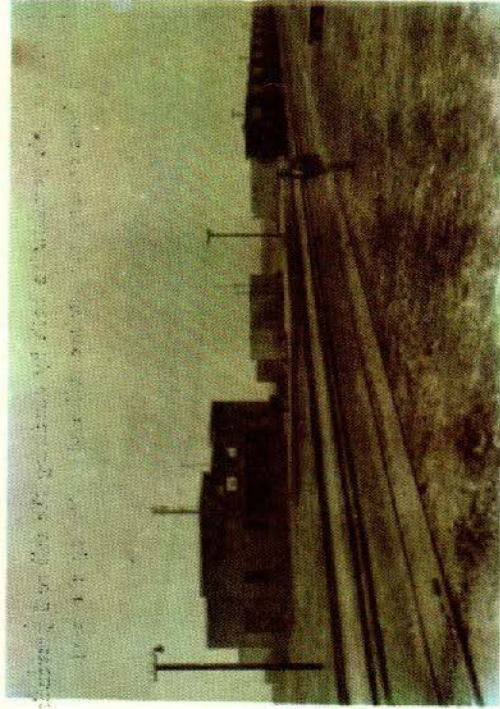
Protection by

Petroleum

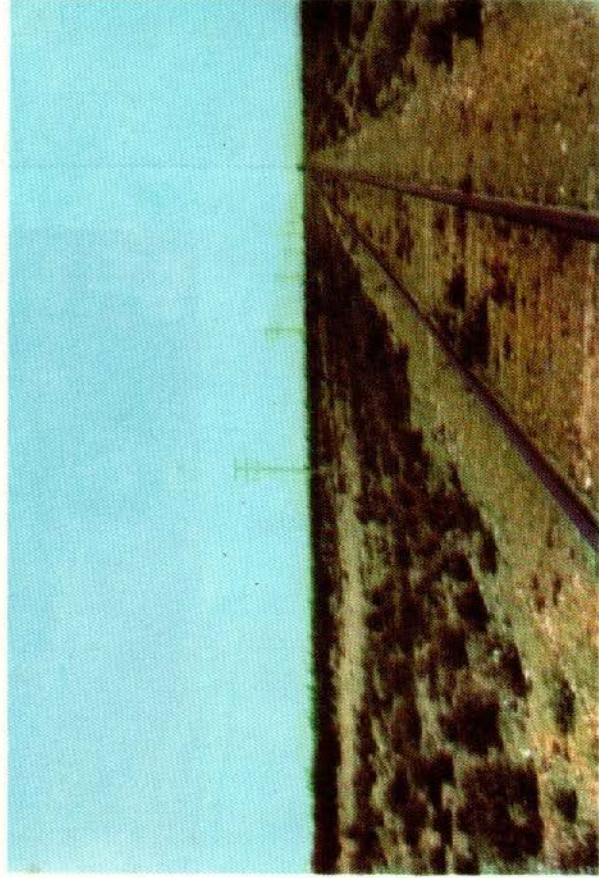
Mulch in Iran

Sand control, is important in many dry regions, in which rainfall is not enough for establishment of vegetative cover able to resist wind erosion.

A selected site along the railway Ahwaz-Kharamshahr (south west of Iran) at a distance of about 250 meters in a flat area containing great amount of pebbles and grit mixed with sand, on two sides of railway, with a width of 250 meters, was sprayed and planted with drought resistant tree seedlings. The total length of experimental protection was 5 Kms.



Show Hamced Railway Station before spraying.



Hamced Railway Station area after spraying

MULCH SPRAYING DENSITIES

Some Figures for usage and coverage of mulch is given below.

High Way Protection	Average Rate of cover (Tons/ha)
Continental and maritime Dunes Irrespective of rainfall, wind & sand sheet	3.5 - 4
Airport Protection	4 - 5
Maritime Dunes	3.5-5
Dune Isolation	
Irrespective of Bitumen and additives required	4.5-5.0

Explanation:

- 1- The above table is taken only an average obtained in Iran and acceptable for non-emulsion mulches. In the case of emulsion mulches other tables are applicable.
- 2- Apart from adjustment of equipment for the kind of the mulch, sand sheet and wind, the main factor in the measurement of oil cover and uniformity depends totally on personal judgement. In other words, judgement of the correct rate of spray is made visually by the operators, in fact mulch sprayers, must pay scrupulous attention.

Guide of Oil Coverage Required

Type of Dunes	Average Rate of Cover	
	(Tons/Ha.)	
	Moderate Wind Intensity	Severe Wind Intensity
Continental		
Low Dunes (Up to 15 ft.)	2.4 - 2.8	2.8 - 3.2
High Dunes (Up to 45 ft.)	2.8 - 3.2	3.2 - 3.6
High Rainfall Area (Above 300mm)		
Low Dunes (Up to 15 ft.)	1.5 - 2	2.0 - 2.5
High Dunes (Up to 45 ft.)	2 - 2.5	3.5 - 5.0

We have not yet acquired much experience regarding the rate of coverage of maritime dunes, because most of the operations have been done on continental dunes, but the Esso Oil Company has tables in this field which can be consulted.

So far we have not applied more than 4 tons of mulch, with a viscosity of 1500 to 2000 R.W.1. in Iran and unless we do not encounter more severe conditions or areas in the future, we shall not have to increase this rate.

Plant Ecology Studies Needed for the Projects and Technique of Petroleum Mulches

Experiences during the last few years have shown that the program of planting sand dunes with seedlings should include the following stages:

1- Complete stabilization by petroleum mulches.
2- Establishment of natural covering and immediate planting with regard to the species of bushes from the view point of industry and profitability with regard to the plant ecology of the area.

3- when the dunes are completely stabilized, it will have found natural covering, and sufficient natural ecologically bushes and vegetation should have been established then.

Considering the ecology of the areas so far treated, the following species have been quite successful and their multiplication has become part of the final program.



Shows the area of BORVAYEH after two years, the great success in this area has been achieved with the **PANICUM**, **TAMARIX STRICTA**, **HALOXYLON**.

HALOXYLON PERSICUM

Fam: **CHENOPODIACEAE**

There are four kind of this species in Iran with names:

Haloxylon ammodendron

Haloxylon aphyllum

Haloxylon recvrum

Haloxylon salicornicum

Various kinds of the species grow in salt deserts of Iran and it is Called "Sauxal" in English, French and German. These species are being multiplied in sand areas of the Russian Turkistan, so much that a thousand hectares were due to be planted with **HALOXYLON** by the end of 1974.

The result of planting these species on sand dunes with 110mm, of annual rainfall have been excellent

An important point to be noticed, is that multiplication of these plants on sand dunes, has brought about changes in the climatic conditions of this area, causing the young roots of these plants to be attacked by various reptiles including mice. These plants should therefore be protected against these invaders during the first two years. Also the wood of HALOXYLON is hard and most suitable for the production of heat energy, and is valued to a certain extent as food for farm animals specially in cold seasons.

Acacia Species

Three kinds of Acacia are found in our country. Some of it has had good results in Lybia in sand dunes stabilization operations and since we have some areas with the same climatic conditions, we are also hopeful of good results.

Other kinds of our native plants have been recognized suitable for sand dunes stabilization and establishment of hand-planted forests and these have been used on theoretical and experimental basis. Some of them are the following.

SALVADORA PERSICA	in southern part of Iran
PLDULUS EUPHRATICA	in central deserts
ZYGOPHYLLUM ATRIPLICOIDES	in all central deserts
PARKINSONIA ACULEATA	" " "
VITEX — VERBENACEAE	" " "
ZIZIPHUS SPINA CHRISTI	" " "

TAMARIX STRICTA

Fami-TAMARICAEAE

There are many kinds of this species in Iran, and because of their resemblance, they are rather difficult to distinguish. They are found in the salt deserts of Iran. It has wood of constructional value. It's application in the reclamation of sand dunes stabilized with mulch had excellent results, and it's multiplication excels in an area with a minimum of 120mm annual rainfall.

CALLIGONUM

Fam: POLYGONACEAE

This is one of the desert trees in Iran, growing on sand dunes in different parts of the country. Its planting on mulch stabilized sand dunes has had excellent results. This plant grows in the deserts of Arabia and Egypt and some kinds of it are spread from the Russian Arminia and Iran to India.

CALOTROPIS PROCERA

Fam: ASCLEPIADACEAE

This is one of the Rubber producing plants, coming from tropical areas and growing in the southern coasts of the Persian Gulf and the Oman Sea. The results gained from the application of this species in the sand dunes stabilization project have been very successful, but production of its young seedlings in nurseries calls for care.

ACACIA

Fam: LEGAMINOSAE — MINOSACEAE

Various kinds of this plant are found in Iran and its multiplication in sand dunes is under consideration, particularly some of its resistive kinds, e.g., ACACIA ARABICA.



By : Mehdi Mahdavi
A. Mansour Moayed