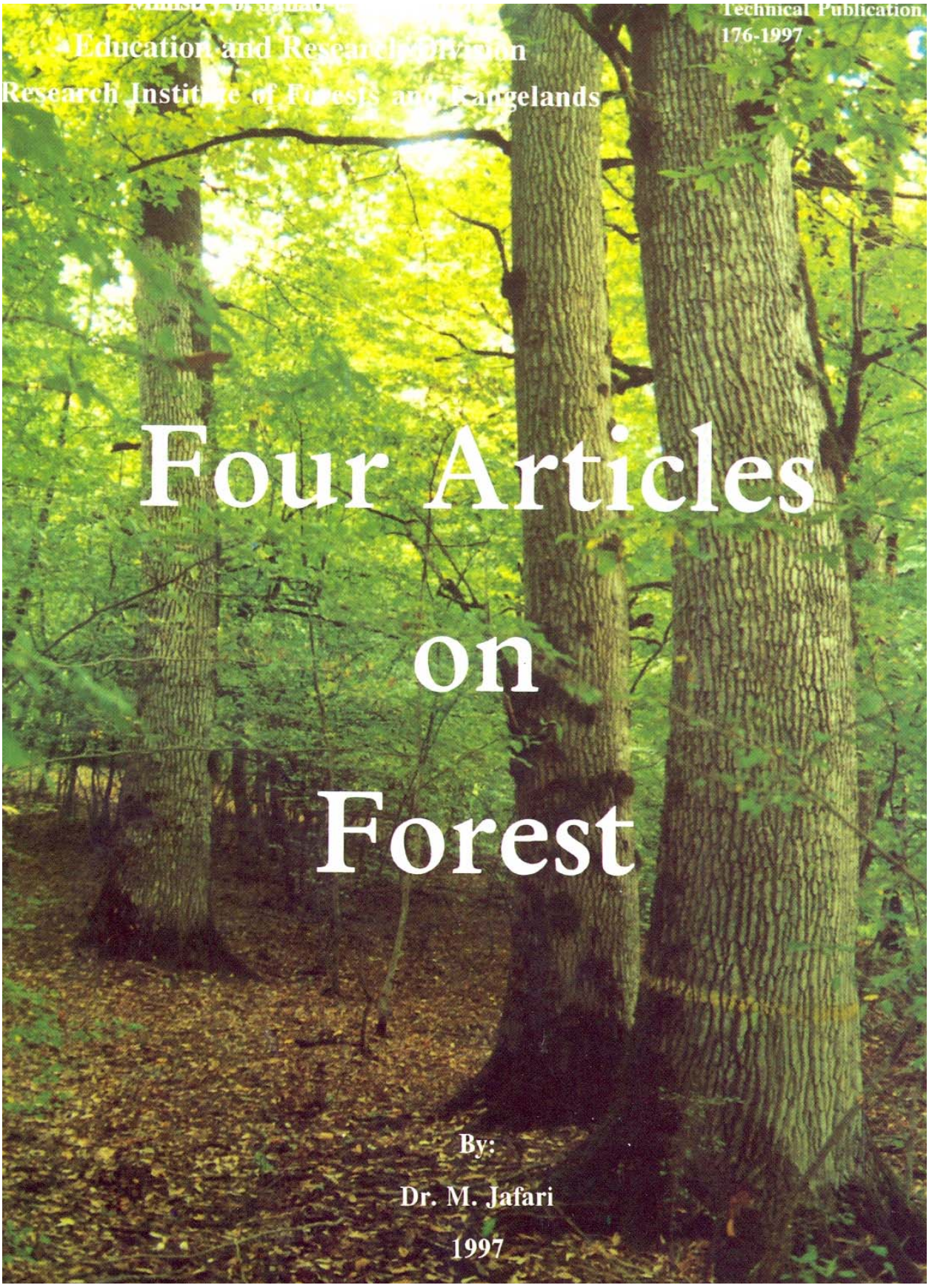
Education and Research Division
Research Institute of Forests and Rangelands
Technical Publication
176-1997
Four Articles
on
Forest
By:
Dr. M. Jafari
1997

In The Name of Allah
Most Beneficient and Merciful

Four Articles on Forest

By:

Dr. M. Jafari
Director, Research Institute of
Forests and Rangelands
1997

"In The Name of God"

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In the Name of God
Most Compassionate and the Merciful

✎ **Dear and distinguished reader**

The present book which is in front of you includes four articles in related to forest and forestry research in I.R. of Iran. Each article presented in an international conference or symposium.

First paper titled "The Present Status of Forestry Research in I.R. of Iran" presented at XXth. IUFRO World Congress, took place in Tampere, Finland, August 6-12, 1995. The paper draws a picture of forestry research status and ecological zones describtion in I.R. of Iran. Then climatical, social and economical problems have been mentioned. All figures and information presented in tables and appendices were changed based on recent datas (1997).

Second subject covers information related to afforestation activities in Iran, and titled "Present Status of Afforestation Research in I.R. of Iran" which presented at Making the Grade, International Symposium on Planting Stock Performance and Quality Assessment, in Sault Ste. Marie, Ontario, Canada, Sep. 11-15, 1994. The article covers progress concerning afforestation and relevent research carried out in Iran.

Third article gives experience results of plantation in arid and semi-arid climatical condition and is titled "Site Preparation and Seedling Plantation for Afforestation in Semi-Arid Zone With

Climatical Limitation", which presented at Pre-IUFRO XXth. World Congress in Garpenberg, Sweden, and Helsinki, Finland, August 1-6, 1995. This paper is about site preparation and seed or seedling plantation for afforestation in four different sites with some kind of climatical limitation.

The final topic is more general than others and discuss some scope and objectives in global and national scales. Strategies for sustainable development have been considered and some common needs for fulfilment of above mentioned objectives and strategies have been recommended. The titel of the paper is "Renewable Natural Resources: Water Management and Sustainable Development" which presented at 8th. International Conference on Rainwater Catchment Systems, which held on 21-25 April, 1997, in Tehran, I.R. Iran.

Kind reaction of distinguished specialist and coleagues are warmly welcomed.

M. Jafari
Tehran
April, 1997

The Present Status of Forestry Research in I. R. of Iran

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The Present Status of Forestry Research in I.R. of Iran

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2-1- Abstract

This paper drows a picture of forestry research status in I.R. of Iran. Ecological zones will be described, then climatical, social, and economical problems will briefly be mentioned. Policy making will be discussed through organization and administrative points of view. The position of Forest Research Division will be displayed across its scientific relationship with other research divisions.

The role of forest experimental stations in running scientific projects in field as well as in laboratory will be explained. Different research activities in this division will be classified . Finally, Some recomendations and suggestions will be offered and the related publications will be listed. All figures and information presented in tables and appendices were changed based on recent datas (1997).

2-2- Introduction

Research Institute of Forests and Rangelands (RIFR) was established in 1968 to carry out research projects covering various disiplines of forest, rangeland, soil conservation, watershed management and sand dune fixation. After the Islamic revolution in Iran and after the affiliation of National Botanical Garden to RIFR the mandates were further expanded to cover any topics on renewable natural resources. To cope with the increasing research programs, recently the Division of Watershed Management and Soil water Conservation was recognized as an indipendent Research Centre.

There are significant climatic variations and differences, particularly in forest regions of Iran and this caused great diversity in species. Table 1, shows the land classifications in I. R. of Iran.

Table 1: Land classification in I. R. Iran

	Forest	Range	Farm/Garden	Desert/Kavir	Urban	Total
Percent	%7.51	%54.54	%14.30	%20.96	%2.66	%100
Million hectars	12.4	90	23.6	34.6	4.4	165

1-2-1- Forests ecological zones in Iran could be categorised as follow:

a)North, Caspian forest

b)West, Zagros forest

c)North West, Arasbaran forest

d)South, Subtropical forests in Persian Gulf areas

e)Central, Scattering forests

Table 2, presented information on different forest types.

Table 2: Different forest types in Iran.

Type of forest	Location	Annual Rain fall mm	Area million ha.		Area %		Main species
			1958	1994	1958	1994	
Caspian Forest	N.	600-2000	3.4	1.9	2.06	1.15	*Fagus Orientalis, Carpinus betulus, Acer velutinum, Quercus Castaneifolia, Fraxinus excelsior.*
Arasbaran Forest	N.W.	400-700	0.3	0.2	0.18	0.12	*Quercus macranthera, Carpinus orientalis, Acer campestre, Fraxinus rotundifolia.*
Zagros Forest	W.	300-600	5.2	3.5	3.15	2.12	*Quercus infectoria, Q. libani, Q.persica, Celtis caucasica, Amygdalus scoparia A. lycioides, Daphne mucronata Pistacia atlantica.*
Central Forests	C.	100-150	7.5	5.5	4.54	3.33	*Pistacia mutica, Amygdalus scoparia Berberis sp.*
Subtropical Forests:							
-Mangrove	S.	125	0.6	0.5	0.36	0.30	*Avicinia officinalis, Rhizophora mucronata*
-Others	S.	-	1.0	0.8	0.60	0.48	*Acacia tortilis, A. ehrenbergiana, A. nubica, A. nilotica, Prosopis spicigera Ziziphus spina-christi, Capparis decidua*
Total Forests		-	18.0	12.4	10.90	7.51	-

The dramatic decrease in forest area between 1958-1994 is mainly accused to forest degradation and some to agricultural land expansion. The degraded forests still have the potential for reforestation and regeneration. The Caspian forest area is about 1.9 million ha. which 1.3 m. ha. is industrial with mean annual yield of 2.5 to 3 m^3 per hectar and with total annual yield of 3.5 to 4 million m^3.

2-3- Main problems

Drought or water deficiency is one of the most critical climatical factor in Iran. About 50% of Iran can be classified as arid or semi-arid zone. Climate parameters, particularly precipitation various significantly in different parts of Iran. In North, the Caspian forest is a narrow line of temperate forest with rainfall up to 2000 mm per year. There is not a good annual rainfall distribution in most regions of Iran which limits the plant development and growth. Not only high temperature in southern, central and low lands of Iran is another limiting factor, but in low temperature in northern, western and highlands is a limiting factor as well.

Some soil properties like poor drainage, very light texture and high salt density when combin with low rainfall make, problem for plant growth in arid and semi-arid areas.

Social and economical problems have serious effects on existing forests. About 500'000 people are living in Caspian forest area and are keeping about 5'000'000 Units of domesticated animals in forest. The following reasons can cause forest degradation, shifting cultivation, overgrazing and elegal tree felling for fuel and building construction.

2-4- Policy making and forest strategy

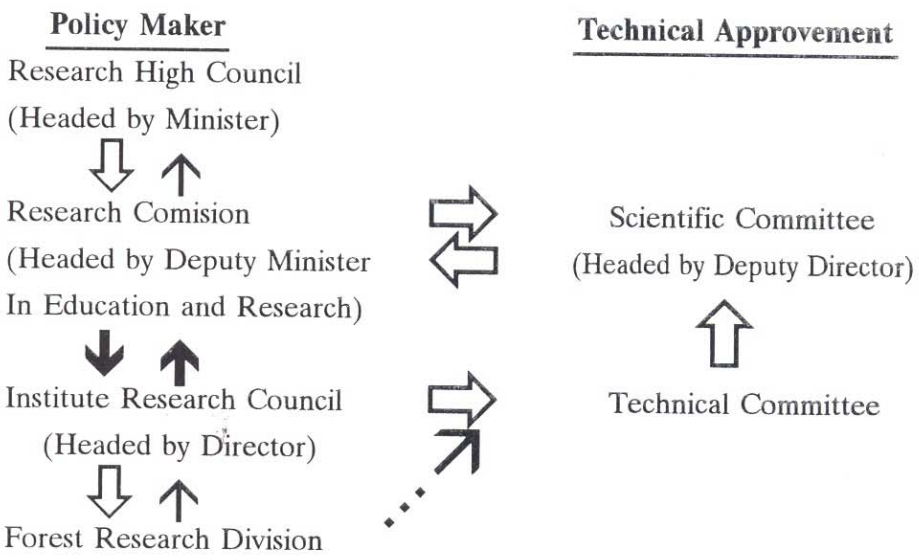
The Research Council and Scientific Committee of RIFR which consists of members from all Research Divisions are responsible for policy making and research priorities highlighting.

The former strategy was focused on afforestation by exotic and fast growing species and now on forest ecology, silviculture and afforestation by native and exotic species.

Approval of a Project Priority

Fig. 1, shows the processes and stages of the research projects control and approval in our ministrial research system.

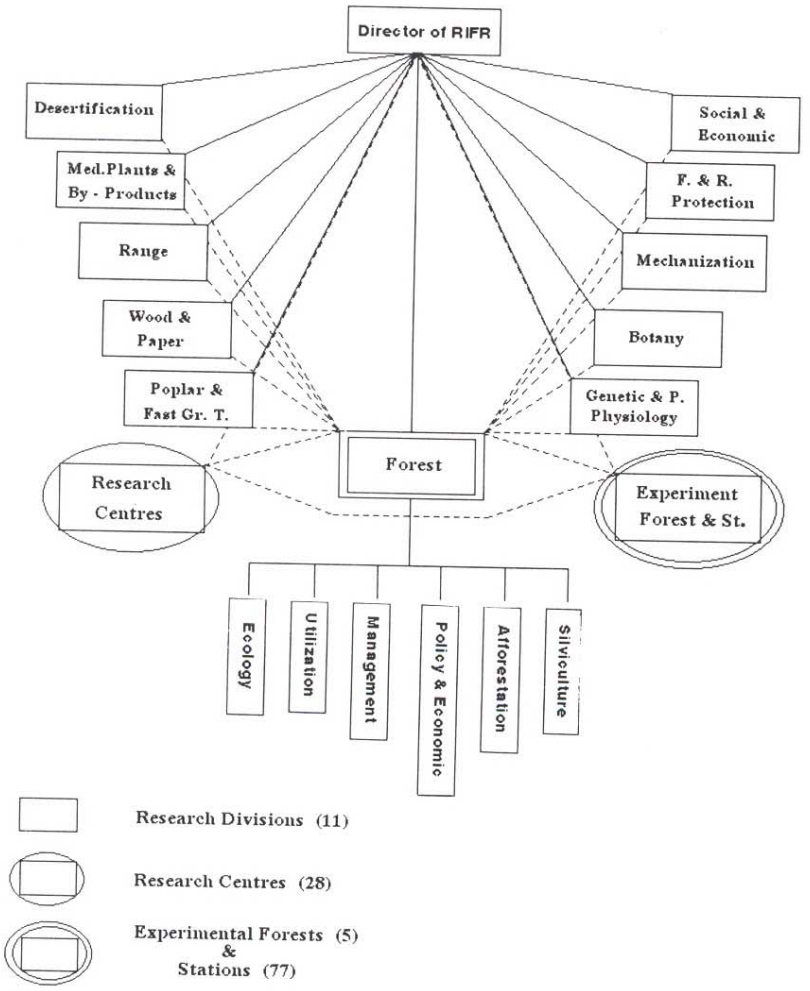
Fig. 1: Research policy making and projects approval.



2-5- Organization and Adminesteration

The position of Forest Research Division in RIFR and its relationship with other research divisions and bodies, is shown in Fig. 2.

Forest Research
in
Research Institute of
Forests and Rangelands in I. R. of Iran



2-6- Scientific relationship

There were 12 research divisions in our Institute with different disiplines which decreased to 10 research division. Forest Research Division is one of the most important and oldest division in the Institute. **Forest Research Division** is in colaboration and cooperation with other research divisions which are as follows:

1-Poplar and Fast Growing Trees Research Division.
2-Wood and Paper Science Research Division.
3-Botany Research Division.
4-Natural Recources Mechanization Research Division.
5-Genetic and Plant Physiology Research Division.
6-Medicinal Plants and By-Products Research Division.
7-Rangeland Research Division.
8-Combating Against Desertification and Sand-Dune Fixation Research Division.
9-Social and Economic Research Division.

Watershed management was as a research division in our Institute which became indipendent centre in the same Ministry. Social and economic aspects are considered seperately. Fundamental activity was done for using GIS in this Institute. (In 1993)

In 1995 Forest and range protection Research Division was acted as independent Research Institute, entitled: Forest and Range pest management Research Institute.

2-7- Experimental forests

Forest experimental stations are sited in different climatical zones to run experiments in natural scales. The most important forests are mentioned as follows:

a)North, Vas Experimental forest.

b)North West, Arasbaran Experimental forest.

c)West, Darbadam Experimental forest.

d)South, Mangrove Experimental forest. (in process)

e)South West Pistacia Experimental forest (in process)

2-8- Research centres

For administrative and scientific reasons and because of wide areas of the country, 28 Natural Resources Research Centers were established in all provinces. Classification of the centres activities are based on geoclimatical boundaries, so few research centres might be categorized in one geoclimatical region.

Staff

Table 3, displays the scientific and administrative staff in RIFR. (1997)

Table 3. Scientific and administrative staff in RIFR (1997).

Degree	Ph.D.	M.Sc.	B.Sc.	College	Diploma	Others	Total
Head Office	42	72	64	16	85	311	590
Research Centres	5	98	266	31	64	83	541
Total	**47**	**170**	**330**	**41**	**149**	**344**	**1131**

2-9- Scientific Working Groups

The number of plant species in Iran is estimated to be 8-10 thousands which about 600 are woody plants. About 124000 plant speicimens are kept in the Institute's National Herbarium which woody plants (trees and shrubs) are about 9000 specimens. Also the Institute's National Botanical Garden was established in an area of 150 ha. including 2000 plant species, from which 300 are woody plants, 100 native and 200 exotic.

Forest Research Division activities are run by six different Working Groups.

The topics of Working Groups are as follows:

a)Silviculture

b)Afforestation

c)Utilization

d)Management

e)Policy & economy

f)Ecology and phytosociology

2-10- Research projects

Table 4. shows the number of research projects in different research divisions.

Table 4: Distribution of Research projects in different research divisions (1997).

Research Divisions	Head Office	Research Centres	Total
Forest	28	168	196
Poplar & Fast Growing Trees	8	32	40
Wood & Paper Science	18	6	26
Botany	25	53	78
F & R Protection*	8	54	62
Genetic & Plant Physiology	40	30	70
Medicinal Plants & By Products	18	78	96
Rangeland	18	158	176
Desertification	7	29	36
Total	**170**	**610**	**780**

In 1995 Forest and range protection Research Division was acted as independent Research Institute, entitled: Forest and Range pest management Research Institute.

-Trail of exotic species

Over 300 exotic and indigenous tree species including a large number of Eucalypt species (193) and conifers (37) were examined in various climatic zones of Iran.

-Poplar and fast growing trees species

A great number of indigenous and exotic species and clones (150) were tested.

-Tissue culture and micropropagation

Eventhough Research Division of Genetic and Plant Physiology is not too old but micropropagation study under controlled conditions for important tree species is going on and acceptable results were obtained.

-Seed and seedling

A young natural resources genebank, for conservation of germplasm has been established. About 1318 indigenous and 1935 exotic species have already been preserved by the genebank.

Forests and Rangelands Organization in 1991 implemented a joint project with FAO to establish the Caspian Tree Seed Production and Improvement Centre under main objective of high quality seed collection and process.

2-11- Other forestry organizations in I.R. of Iran

A)Educational:

- College of Natural Resources. Karaj, University of Tehran.
- College of Natural Resources. Noor, Tarbiat Modarres University
- Agriculture and Natural Resources Gorgan University.
- College of Agricultural sciences, Gilan University.

B)Executive:

- Forests and Rangelands Organization, Ministry of Jihad-e-Sazandegy.
- Parks and Green Environment Organization (branch of Municipalities)

2-12- Monitoring and Evaluating

One of the most important activities of RIFR is to evaluate and control the under going research projects. Five groups of the high level and experienced scientists have been organized for monitoring and evaluating the projects, using 16 criteria, at National level. In 1993 more than 300 research projects were visited by 3000 person /day and their reports were published. In 1994 the number of evaluated projects increased to 400 and in 1996 the number of evaluated projects increased to 481. Monitoring and Evaluating is undergoing annualy.

2-13- List of Projects

The Institute has close relationship with the universities and 50 post graduate topic theses were specified according to Institute, priorities which 21 of them are directly related to Forestry Research Division. Our Institute tried to run national projects to solve regional or national problems. Details of the completed and undergoing projects in Forestry in our Institute are displayed in Appendixes 1 and 2 respectively.

2-14- Publications

Institute has published 220 title book which 61 of them are directly related to the forestry. List of some of forestry publications are given in Appendix 3.

2-15- References

1. Fattahi, M. (1994). Assessment of Zagross Oak Forests. Technical publication No. 101, Research Institute of Forests and Rangelands, pp. 63.
2. Jafari, M. and Hosseinzadeh, A. (1994). present Status of Afforestation Research in I.R. of Iran, Presented at Making the Grade, International Symposium on Planting Stock Performance and Quality Assessment, Sep. 11-15 1994, Sault Ste. Marie, Ontario,

Canada, pp. 14.

3. Khial, B.; Afsharpour, F.; Adeli, E. (1975). The Oak Tree Pest "Leucoma wiltshirei Collen" in Iran. Technical publication. No. 18, Research Institute of Forests, and Rangelands, pp. 18.
4. Personal comunication with Forest and Range Organization 1995.

Appendix 1. The executed projects and their beginning and final years

1. Comprehensive research on coastal mangrove forests of Persian Gulf and Oman Sea, First Stage: natural distribution.
2. Effect of drip irrigation on economizing water usage in *Pinus eldarica* afforestation, 1970-1972.
3. Table volume preparation in Caspian Forests of Iran, 1968-1973
4. Preparing site index for Caspian Forests, 1971-1973
5. Mulch and water shortage in afforestation, 1969-1973.
6. Identification of poplar diseases and pests in four provinces of Iran, 1970-1973.
7. Effect of prunning amount on water uptake of *Pinus eldarica*, 1969-1974
8. Effect of prunning on different clones of poplar in irrigated plantation, 1969-1974
9. Study of economical use of water for forest plantation, 1969-1974
10. Effect of prunning on different clones of poplar in non-irrigated plantation (2 projects in 2 provinces), 1969-1974.
11. Effect of prunning on growth rate and water uptake of few conifer species (2 projects), 1969-1974.
12. Species trials of *populus tremula* in Kalardasht and Liresar (Mazandaran province of Iran), 1970-1975.
13. Effect of chmeical fertilizers on *Pinus eldarica* growth rate, 1976-1975.
14. Species and pilot trials, using 230 species mainly Eucalyptus and Pinus, under 36 research projects in Nine provinces of Iran,

(1968-1971) - (1973-1976).

15. Seedlings age planting of poplars in Safra-basteh (Gilan province), 1969-1979.
16. Afforestation trial, using poplar cuttings in safra-Basteh (Gilan province) 1969-1979.
17. Reforestation of Caspian degraded forests of Iran with poplar seedling, 1970-1980
18. Effect of chemical Fertilizers on Populus nigra in Gorgan province, 1971-1981.
19. Natural regeneration of Alnus species under poplar under-story, 1970-1982.
20. Hybridization between *Pinus eldarica* and *P. taeda*, 1972-1982.
21. Spacing trials of native and exotic poplars in three provinces of Iran (7 projects). (1969-1971)- (1989-1986)
22. Nursery selection of poplars and Willows in three provinces of Iran, 1968-1988.
23. Study of Juniper seedlings rehabilitation on south slopes of Alborz Mountains, 1983-1988.
24. Determination the most suitable transfer age of Juniper seedlings, 1984-1989.
25. Collection of poplar mother stock in three provinces of Iran, 19 65-1969, 1985-1989.
26. Investigation on introduction of *Taxodium distichum* in relation to different depths of water tables (1985-1990).
27. Determining the seed production cycle of *Fagus orientalis* in Caspian Forests of Iran by analysis and study the trank and regeneration

groups (1990).

28. Appointment of harvesting rate in seed felling operation in bech forests of Asalem and Veisar (Caspian Forests), 1970-1990.
29. Rehabilitation of the Iran west Forest by direct seed sowing of different Oak species (1987-1992).
30. Investigation on desirability of natural habitates of Alnus species at Forest regions of Mazandaran (1990-1992).
31. Investigating the best time and method of seedlings transfer of *Cupressus sempervirens var. horizontalis* in Gorgan (1990-1992).
32. Anivestigation on growth parameters of conifer Forests plantations by trunk analysis, 1990-1992.
33. Evalluating forest plantation in Fars province and its problems, 1991-1992.
34. Investigating the best planting space of *Quercus castaneifolia* (1993)
35. Investigation on direct seed sowing techniques of oak different species to reclaim the western forests of Iran (1981-1993).
36. Species trial with species likely suitable for pencil manufacturing (1983-1993).
37. Investigation on the effect of different thinning intensities on increasing wood quality of *Pinus taeda* forest plantations (1988-1993).
38. Determining the existing problems facing natural regeneration of wild Pistacia species in western forests of Iran (1988-1993).
39. Investigating the problems facing the annual afforestations of Fars province (1992-1993).
40. Species trials of most important species of world coniferus (1989-1994).

41. Study of the effects of thinning on quality and quantity of loblolly pine (*Pinus taeda* L.) Plantation (1989-1994).
42. Collection, Identification and conservation of genetic resources of qualified varieties of *Juglans regia* at Yassoj (1991-1994).
43. Collection, Identification and conservation of genetic resources of qualified varities of *Juglans regia* at Fars province (1991-1994).
44. Identification of best supplementary irrigation periods for primary rehabilitation of four eucalypt provenances (1991-1994).
45. Taxonomy, Pheonology and ecology of Acacia species of Hormozgan province (1991-1994).
46. Investigation on the depth of direct seed sowing of oak in Kermanshah province (1992-1994).
47. Study of desirability and classification of natural sites of Alnus species in Forests of Mazandaran, 1990-1994.
48. Introduction the promising and tolerant species for afforestation in dryland conditions of Koredestan province (1975-1995).
49. Pilot trial of tree species at Sanandaj (1975-1995).
50. Pilot trial of tree species in Sanandag (1975-1995).
51. Investigating the rehabiliation methods of west Oak Forests without using fences (1976-1995).
52. Investigating the rehabilitation methods of west Oak Forests, using fences (1976-1995).
53. Selecting the most appropriate varietites of *Juglans regia* by adaptation trials (1985-1995).
54. Determination the seed production cycle of *Fagus orientalis* in Caspian forests of Iran by analysis and regeneration groups study

(1990-1995).

55. Investigation on desirability of natural habitates of Alnus species at forest regions of Mazandaran (1990-1995).
56. Investigation on multi-purpose tree species plantation, using run-off rain waters at pyroieh Baft, Kerman province (1990-1995).
57. Investigation on taxonomical, phenological and ecological aspects of Acacia in Hormozgan province (1990-1995).
58. Investigation the current regeneration of *Fagus orientalis* at the coastal forest of Ziarat forest management project of Gorgan province (1992-1995).
59. Investigating the existence regeneration of *Fagus orientalis* at the beech forests of Ziarat Forest Management Project in Gorgan (1992-1995).
60. Investigation and Study the fona of insects producing galls on Oak trees of Lorestan province and the potential of gall collection (1993-1995).
61. Investigation on the best transformation time and method of *Cupressus sempervirens var. horizontalis* seedling in Gorgan province (1993-1995).
62. Investigation on the depth of direct seed sowing of oak (in Kohgilawieh and Boweir Ahmad Province) (1993-1995).
63. The effects of *Taxus baccata* sex status and its cuttings heel on its rooting development (1993-1995).
64. Investigation on Almond plantation problems and the economical effects of its wide distribution in Hamadan province and Iran (1994-1995).

65. Investigation on chemical weed control method at Ghorogh forest nursery (1994-1995).

66. Elementary investigation on *Pistacia vera* stands of Khorasan province (1993-1996).

67. Investigation on the problems facing seedlings production of *Capparis decidua* in Forests and rangelands of Iranshahr located at east of Jazmoorian. (1994-1996).

68. Identification the maximum wood production of a populus *Eura-American* Clone per hectar at different spacings (1983-1996).

69. Rehabilitation of Iran west Forests by different dephths of seed sowing of different Oak species (1991-1996).

70. Investigation on the seed sowing depth of different species of Quercus (National project) (1992-1996).

71. Appropriate Forest management at a water catchment of Caspian Forests in Iran. First stage: Fundamental studies. (1992-1996).

72. Determining the effective parameters on Zagross natural resources management at Bakhtaran province (1992-1996).

. Investigating the vegetative parameters of forest plantations of Gorgan & Gonbad region by tree cutting and trunk analysis (annual growth rings) (1993-1996).

73. Determining the best method of seed sowing and scattering of *Quercus castaneifolia* as a suplementary regeneration in the regeneration area of Loveh Forest Management project (1993-1996).

74. Investigation on *Pistaca vera* stands of Iran (1994-1996).

75. Investigation and Identification the diameter growth rate of most important forest species of Mazandaran province (1995-1996).

76. Collection of native and exotic clones of populus species at Gilan Province (1990-1997).
77. Determination of different thinning intensity on wood quality and growth rate of *Pinus eldarica* in planted stands (1994-1999).

Appendix 2: List of undergoing projects and their beginning year

1. Appropriate density and combination of *Fraxinus excelsior* and *Acer velutinum* in forest plantation (1996).
2. Investigating the natural forests of *Pistacia vera* in Maraveh- Tappeh, quantitively and qualitively (1996).
3. Comparative study of ecological and genetical characteristics of *Pistacia atlantica* populations (families) in Kordestan province (1996).
4. Comparative study of growth and wood production of five promising eucalypt species on southeast coasts of Caspian Sea (pilot trial) (1996).
5. Definition and classification of mycorrhizal fungi symbiosis with *Haloxylon* species at Sabzevar (1996).
6. Ecolgoy of *Zelcova carpinifolia* in Gilan province (1996).
7. Ecology and phenolgoy of *Betula pendula* in Tehran province (1996).
8. Ecology of *Sorbus torminalis* at Sangdeh Forest (1996).
9. Growth and wood produciton of the mixed plantation of Alnus species with Populus species in Gilan province (1996).
10. Identification the mycorrhizal fungi and their popultion on *Pistacia vera* roots and root area of Khorasan Pistacia Forest (1996).
11. Investigating the effect of rain chemical parameters on forest plant communities of Vaz Experimental Forest (1996).
12. Investigating the appropriate depth of Oak seed sowing at Arasbaran (1996).
13. Investigating the ecological characteristics of *Tecomella undulata* and

its economical value in Booshehr province (1996).

14. Investigating the effect of 12 year conservation of a site at Chahar-Tagh-Ardal in Chahar-mahale Bakhtiary on plant development, soil improvement and forest trees regeneration (1996).
15. Investigating the soil physical and chemical factors causing wilting and growth limitation in prosopis tree species (1996).
16. National project of pilot Forest plantation at Persian Gulf and Aman Sea coasts of Iran (1996).
17. Phenolgoy of *Pistacia* and *Quercus species* at Ilam Forests (1996).
18. Phenology of *Quercus persica* in Fars province (1996).
19. Study, planning and manufacturing new tree diameter and height measurer apparatus (1996).
20. Investigating the natural distribution and ecologoy of *Amygdalus* species at Ilam province (1996).
21. Investigation and identifying the diameter growth of *Pistacia* and *Fraxinus* species in Chahar-Mahal Bakhtiary province (1996).
22. Specification the role of forest typology as a criteria for silviculture (the study area is located in Neak-Zalemrood forest Management project) (1996).
23. Comprehensive project of *Pistacia experimental* (1995).
24. Defining the best distance of *Pinus taeda* for plantation (1995).
25. Identification the seed production cycle of *Quercus castaneifolia* by trank and regeneration groups study and analysis at Loveh Forests (1995).
26. Investigating the effect of different levels of *Haloxylon* forest plantation density on the other native plants (1995).

27. Investigating the factors influencing the natural the distribution of *Pistacia* species in Iran. A national project including eight sub projects conducted in eight provinces and regions (1995).
28. Investigation and identification the diameter growth rate of most important forest species in Kerman province (1995).
29. Investigation on the effects of different levels of thinning on the quality and quantity of wood production of the Picea forest plantations (1995).
30. Investigating the different methods of tree and shrub planting in dryland conditions and their adaptability on south slopes of own-ebane-Ali mountain of Tabriz (1995).
31. Investigating the effect of thinning on the plantations of *Acer velutinum* at Imamzadeh- Abdollah Amol (1995).
32. Investigating the rehabilitation of different Oak species in seedling and seedling systems (1995).
33. Seed orchard establishment of *Pistacia mutica* and *Amygdalus scoparia* in Kerman province (1995).
34. Study and determination the diameter growth rate of *Quercus brantii* in Chaharmahal province (1995).
35. The optimal management of Arasbaran natural resources (Experimental Forest of Sotanchai) (1995).
36. Typology of Kerman Province Forests (1995).
37. Phenological studies on *Pistacia mutica* in Kerman province (1995)
38. Comparative study of two silvicultural systems to achieve the best regeneration of Caspian *Fagus orientalis* Forests (1994).
39. Comparative study of plantation of four native Acacia species with

different irrigation periods at Hormozagan province (1994).

40. Determination the best nursery seed sowing density of most important Caspian forest tree species of Iran (1994).
41. Determining the best appropriate distance of *Cupressus sempervirens* var. horizontalis in a spacing trials (1994).
42. Determining the best root prunning depth of *Quercus castaneifolia* (1994).
43. Determining the most appropriate planting date of *Quercus castaneifolia* in Asalem forest plantation area (1994).
44. Dryland forest plantation trial at Yassoj (1994).
45. Investigating the effects of *Prosopis Juliflora* plantation on the native species of Chah-Bahar area (1994).
46. Investigating and comparing the growth and wood production of the five adapted coniferous species at eastern costs of Caspian Sea (pilot trial) (1994).
47. Investigation and Comparison the growth rate of the five most promising coniferous species at eastern coasts of Caspian Sea (1994).
48. Investigation on ecological conditions of habitates of *Tilia begonifolia* in Caspian Forests of Iran (1994).
49. Investigating and identificating the diameter growth of the most important forest tree species of Iran (1994).
50. Investigating and comparing the pure and mixed plantation of *Quercus castaneifolia* with six native species of Mazandaran Forest (natural habitat of Oak at Noor region) (1994).
51. National project for establishing seed orchard of *Fraxinus excelsior* and *Tilia begonifolia* in Chamestan Experimental Station (Noor) by

seed and graft (1994).

52. National project for establishing seed orchard of most important commercial and industrial species of Iran (1994).
53. National project for publication of silvicultural characteristics of trees and shrubs of Iran (1994).
854. Study on the best spcaing of *Sequoia semervirens* (1994).
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provinces of Iran (1993).

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70. Investigation on the effect of spacing trials on wood quantitative and qualitative characteristics of *Juglans regia* at Chamestan-e-Noor (1993).
71. Investigation on appropriate seed sowing time in nursery for quantitive and qualive peoduction of *Cedrus deodara* seedlings (1993).
72. National project for wide application of eucalypt's species in Iran (1993).
73. National Forest plantation trial, using multi-purpose trees and shrubs in different parts of Iran. Conducted in 17 provinces and regions (including 17 sub-projects) (1993).
74. Phenological investigation on *Quercus castaneifolia* in Loveh Forest Management Project (1993).
75. Species trial of 30 eucalypt species at chamestan-e-Noor (1993).
76. Species trial of forest tree species on south Tehran wetlands (1993).
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99. Investigation on the effects of different methods of prunning on Haloxylon freshness and its wood and seed production (1990).
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102. Pilot trials of different native tree and shrub species at Jaizan-Ramhormoz region (1989).
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Present Status of Afforestation Research in I.R. of Iran

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Present Status of Afforestation Research in I.R. of Iran

Dr. M. Jafari* & A. Hosseinzadeh**

3-1- Abstract

The paper reviews the recent progress concerning afforestation and relevant research carried out in Iran, and describes the introduction of local and exotic tree species to both the low lands and to the upland areas of the Caspian zone as well as in un-irrigated plantations in the semi-arid zone of the country. The paper further summarizes current information on afforestation and seedling production having down in I. R. of Iran.

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3-2- Introduction

I.R. of Iran is located in the north temperate zone from 25 to 40 degrees latitude and 44 to 63 degrees longitude, with a total area of approximately 1,650,000 square kilometers. A large area of the country is covered with high mountain ranges which amounts to about 50% of total land area, and large sections of interior is characterized by arid basins. Elevations range from 26 meters below sea level on the shores of the Caspian Sea to 5860 meters above sea level at the Mt. Damavand.

Geologically, the Iranian Plateau dates from the Tertiary period, but older formation also exist in some certain areas. Sever orogenic uplift and folding produced much of this land from an enormous sea in the mid-Miocene. Due to the relatively young ages, the principal mountains are still settling which seems to be the causes of the earthquakes that rock the country frequently(1).

Climatic variations are also great in Iran. The main variation is between the dry, desert interior region and the humid Caspian coastal region. The Caspian region receives the larger part of the country's precipitation (2400 mm), while the central desert (Dasht-e-Lut) is faced with permanent drought. Mean January temperatures range from 20 degrees centigrade along the Persian Gulf region to minus 2 degrees in northwest of Iran. Extreme temperatures of over 50 degrees centigrade in the Persian Gulf region to minus 35 degrees centigrade in the northwest have been recorded.

The total forest area of Iran was estimated approximately 18 million hectares about three decades ago. Unfortunately, a tremendous

proportion of those forests has been destroyed. The main factors in this destructive trend have been shifting cultivation and heavy overgrazing. With respect to the vegetations association, five different regional types of forest may be distinguished in I. R. of Iran which are as follows:

3-2-1- The Caspian Zone Forests: These forests which also called the Hyrcanian forests-the most valuable forests in Iran-cover the northern slopes and foothills of the Alborz mountain. In 1958 these forests were estimated at 3.4 million hectares, but currently is estimated around 1.9 million hectares (10). The most common trees are oaks (especially *Quercus castanaeifolia)*, beech, hornbeam, ironwood, *Ulmus spp., Acer spp., Fraxinus spp.* and etc.

3-2-2- Arasbaran Zone Forests: These forests are located in the extreme western corner of Caspian forests, the elevations there provide some of the last expands of the Oak-Juniper forests of north western of the country. However, in most parts of these forests land conversion and wood cutting for fuel are responsible of the sever degradation of Arasbaran Forests. The following plant species have been found in this region; *Quercus macranthera, Carpinus betulus, C. schuschaensis , C. orientalis, Acer campestris, A. monspessulanum, Fraxinus rotundifolia , Ulmus spp.*, and etc.

3-2-3- Zagros Zone Forests: These forests cover a vast area throughout the length of the Zagros range, extending as far as Shiraz. These area once covered by dense forests (approximately 11300,000 ha.), but

presently subjected to severe degradation. Thus, trees of timber dimensions are extremely rare. The mountains, where they have not been completely degraded, carry a very open crop of scrub-oak *(Quercus infectoria and Q. libani)* in extreme northwest along the Turkish and Iraqi frontiers, and *Q. persica* farther south around Shiraz. There are certain small trees and shrubs in varing parts in these scrub-oak forests such as: *Celtis transcaucasia , Amygdalus spartioides ,* and *A. orientalis , Daphne acuminata , Acer cinerascens, Pistacia khinjuk.*

Zagros Zone Forest

3-2-4- Pistacia Forests: They include scattered patches of open degraded forests, in the region of low rainfall (100 to 150 mm) of the

central and southern parts of Iran (The Irano-Turanian region of arid and semi-arid part, approximately 3.1 million hectares) and on the eastern hills along the Afghanistan border. It has a few plant species mainly, *Pistacia mutica , Amygdalus spp.*, and *Berberis spp.*

3-2-5- Forests of the Subtropical Region: These forests are situated in the south, along the coast of the Persian Gulf, and Sea of Oman and the border of Baluchistan province, where the annual precipitation is about 125 mm or less, and very high summer temperatures exist. They consist of Mangrove forest (about 0.5 million hectares) along the coasts. Other parts include chiefly of open, low thorn scrub with small trees such as *Tamarix articulata, Acacia spp. Prosopis spicigera, Zizyphus spina-christi,* and *Ficus spp.*

There are some sever difficulties in respect to afforestation and reforestation in arid and semi-arid zones of Iran. This country is very short of adequate water resources. Thus, wherever, there is some water available, drinking water and industries get the first priority. Even, in these area, if the water is available, afforestation is very costly, because of the cost of lands, preparation and establishment of irrigation facilities. For this reason and because of the need for establishing green areas around the cities, conservation of soils, production of wood, and dry afforestation has been one of the most important tasks of the Research Institute of Forests and Rangelands and since, the establishment of this Institute, extensive research and detailed investigations have been conducted in these regards and some significant and usefull results have been obtained.

This paper outline the afforestation strategy used and some results of researches which obtained. It consists of different approaches which vary according to the soils, climate, and lands capability.

3-3- Research activities

3-3-1- The Trial of Exotic Species

Since the establishment of the Research Institute of Forests and Rangelands in 1968, a continued attempt has been made to increase the value of the country's tree coverage through afforstation, regenaration of deteriorated forests (reforestation). Thus the first specific action was taken to establish research centers, research stations and standardized nurseries throughout the country. Over 300 exotic and indigenous tree species including a large number of Eucalyptus species and conifers were grown in numbers of specialized research nurseries in various climatic zones.

Since, the selection of species and provenances for planting under certain environmental conditions is the most important decision, the selection of species for trial has been finalized after a very careful study of the range of climatic and edaphic factors encountered in different climatic zones of the country.

3-3-1-1- The system of trials employed consists of three stages:

a) Species Elimination Trials; b) Species Growth Trials followed by c) Species Plantation Trials. The basic plan for the trials was one of

the replicated randomly allocated plots, using four replication to allow statistical analysis. This procedure was adopted from the method used by Kemp (4).

3-3-1-1-1- Species Trials in the Humid Caspian Region:

Since 1968, the following species have been produced in the specialized research nurseries and planted in the trial areas at different elevations of Caspian forests by the Forest Research Division of this Institute in cooperation with the Forest and Range Organization:

3-3-1-1-2- Low lands of Caspian Forest (i.e. up to 100 meter above sea level):

Pinus elliotii , P. halepensis , P. pinaster , P. radiata , P. taeda , P. longifolia , Sequoia sempervirens , Taxodium distichum and Cryptomeria japonica.

3-3-1-1-3- Above 1000 meter:

Abies alba , A. bornmuelleriana , A. cilicica , A. nordmanniana , A. cephalonica , A. grandis , A. procera , Cedrus brevifolia , C. libani , C. deodara , Larix decidua , L. kaempferi , Picea abies , P. orientalis , Pinus nigra , P. sylvestris , P. roxburghii , P. contorta , Pseudotsuga , Thuya plicata.

For those species which planted in recent years it is far too early to draw any conclusion but, it would appear that on the low lying plain, *Pinus elliotii, P. taeda* and *P. radiata* showed to be valuable species and in the higher altitudes, *Pinus sylvestris* and *P. nigra* are showing promise

in the early plantation stages (2). At the present, several projects of this type with more species at different elevations of three parts of the Caspian forests are under investigations.

3-3-1-1-4- The trial of Exotic Species in the Semi-Arid Zone:

The semi-arid zone was defined as the area of the country excluding the humid Caspian area, receiving a mean annual precipitation of 250 mm or more. This corresponds with the southern and western slopes of the Zagros mountain range which runs in a north-west to south-east direction from the Turkish border to the Persian Gulf. Altitudes range from 200 to 2000 meter above sea level. The study area was estimated to cover some 17 million hectares. The rainfall in these semi-arid zones occurs only during the winter and spring with severe and prolonged summer drought up to eight mounths duration. Summer temperatures are high, often exceeding 40^{o} C. By contrast, winter cold on the high elevation is intense with over 60 days of the frost per year, minimum temperature of -20^{o} C, and a large parts of the precipitation occuring as snow.

The soils of the study area are all of limestone origin. They are uniformly alkaline with pH values of 7.5 to 8.5 level of organic matter and available phosphate are generally very low, while, potassium is adequate.

The long term objective of the study was to investigate the introduction of exotic tree species into the semi-arid zone of the country and test their ability and tolerate the un-irrigated plantation conditions. However, The short term object of the study was to identify suitable,

exotic tree species which can be employed for ;

a) the establishment of afforestation projects on sites capable of economic wood production and in the creation of farm or village wood lots throughout the area.

b) protection purposes on such sites.

c) soil conservation and watershed management planting on the hilly sites.

Species selection has been governed by the tolerance of three major factors: aridity, winter cold, and the alkaline soil conditions. Resistance to winter cold is generally only required for high elevation sites. The study area thus, had been divided into two major climatic zones; The cold winter, and the temperate winter zones, the boundary between these two regions not clear-cut, roughly corresponds to the 1000 meter contour (9).

This project had covered a total of 33 experiments on 19 different sites. Among species, there have been 37 conifers and 193 eucalypts and some other hardwood species.

The statistical analysis of the results obtained in term of survival, growth and form together with an estimate of species utility, indicated that the most promising species are :

Temperate winter zone	Cold winter zone
Acacia acuminata	*Cupressus arizonica*
A. salicina	*Eleagnus angustifolia*
A. victoria	*Fraxinus rotundifolia*
Eucalyptus camaldulensis	*F. xanthoxyloides*
E. microtheca	*Robinia pseudoacacia*
E. striaticalyx	
E. sideroxylon	

3-3-1-2- Poplar Research:

In this programme a great number of clones (over 150) from the following exotic and indigenous species have been investigated:

Poplar Research

3-3-1-2-1- Indigenous species

Populus nigra
P. alba
P. caspica
P. euphratica

2-3-2-3-1- Exotic species

Populus euramericana
P. deltoides
P. trichocarpa
P. simonii
P. yunanensis
P. maximowiczii
P. generosa
P. suaueolens
Populus beroliennsis
P. jacki
P. fremonti
P. grandis
P. candicans
P. szchuanica
P. ciliata

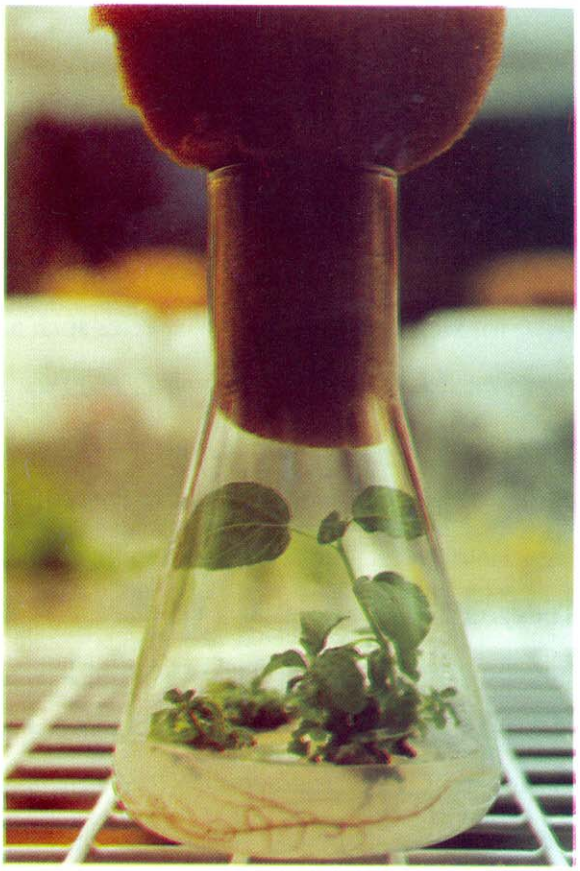
In recent years, studies have been conducted on different aspects of growth rate, pest and disease resistance, response to the spacing, double cropping etc. of populus species in depleted low land forests of caspian region and in 14 different other parts of the country, and the results of some research projects are as follows:

- Introduciton of 14 exotic improved clones for planting in low lands of the Caspian region.
- Preparing volume table for two improved clones in Mazandaran Province.
- Grafting of two species including *Populus alba* and *Populus euphratica* has been done successfully.

2-3-1-4- Genetics and Plant Physiology Research:

With the current establishment of the genetics and plant physiology laboratories at the RIFR, it is now possible to study

this regard, studies have been conducted on production of seedlings of species that we have had difficulties to grow them in the nurseries, being destroyed or those having difficulty of sexual propagation by the mean of tissue culture. Presently, *Populus tremula* and *Prunus avium* have been successfully micropropagated and some other species like *Populus caspica,* and *Juglans regia,*are in prolifration stage furthermore, a genebank which is responsible to focus on conservation of germplasm has been considered as one of the priorities and some preliminary works have been conducted. This genebank has been already preserved about 1318 indigenous and 1935 exotic species. However, because of large variability of Iranian geographical zones, there is a great need to support this young natural resources genebank.



Gentics and Plant Physiology Research

3-4- Afforestation activities

3-4-1- Plantation activities

Since 1965, the Forest and Range Organization has undertaken a considerable programme of irrigated and un-irrigated plantations in the vicinity of large towns. The objective of this programme is to establish green belt and forest parks providing recreational areas for the urban population.

The species planted are generally limited to indigenous or well established exotic species such as *Acer negundo , Cupressus arizonica , Fraxinus rotundifolia , Pinus eldarica , Robinia pseudoacacia , Eucalyptus camaldulensis Ailanthus glandulosa, Prosopis juliflora , Albizzia lebbek , Terminalia spp., Melia indica , Parkinsoni aculeata L., Ficus benghalensis* for southern part of Iran, species such as *Pinus nigra, Pinus sylvestris , P. brutia , P. taeda , P. elliottii , P. pinea , Cryptomeria japonica , Cedrus spp. , Cupressus arizonica, Abies nordmanniana , Larix europea , Taxodium distichum , Pseudatsuga spp.* and etc. for the Caspian zone and Haloxylon , Tamarix and Zygophyllum species for the desert zone. Today (1994), the total area of more than 466197 ha. of plantation have been estimated (unofficial estimation). This total is made up of 189328 ha. planted in Caspian region including the provinces of Gilan, Mazandaran, and Gorgan, and about 276869 ha. planted in other provinces specially Fars, Esfahan, East and West Azarbaidjan,

Khuzistan, Kerman, Khorrasan, Sistan-Baluchestan, Ilam, Semnan, etc. Table 5 shows the trend of progress and significance of afforestation activities after revolution.

Table 5. Afforestation Activities In Iran During Period of 1965-1993.

(hectares)

Years	Caspian regions	Other parts of the country	Total area planted
Before Islamic Revolution of Iran (1979)	29 400	13 300	42 700
After Revolution up to first year of socio-economical plan	60 008	20 162	80 170
During the 4 years of the first 5 years socio-economical plan (1989-1992)	83 420	169 409	252 829
1993	16 500	73 998	90498
Total	**189 328**	**276 869**	**466 197**

In respect to afforestation, the Government of I. R. of Iran gives various assistances to promote planting the private lands. One of this assistances is encouraging land owners, as well as governmental agencies, municipalities, and cooperatives to plant trees by providing free seedlings and necessary instructions. Furthermore, every year on certain day, individuals who planted more trees in their lands are awarded by the government.

3-4-2- Seeds and Seedlings Activities

Seedlings in Iran are produced mainly in the government nurseries

and some by the private seedlings producers. The number of seedlings produced annually by the afforestation and Park Bareu of Forest and Range Organization and the trend of progress in this regard is shown in table 6.

Table 6. Number of Seedlings Production During Period of 1962-1993. (1000)

years	Caspian regions	Other parts of the country	Total seedlings produced
Before Islamic Revolution of Iran (1979)	190 100	32 800	222 900
After Revolution up to first year of socio-economical plan	183 200	135 900	319 100
During the 4 years of the first 5 years socio-economical plan (1989-1992)	220 555	175 679	396 234
1993	55 000	61 734	116 734
Total	**648 855**	**406 113**	**1 054 968**

In order to succeed promptly in the afforestation programmes first of all, the best seed and seedlings are needed. Therefore, until recent years, most of the seeds were imported from other countries around the world. However, in 1991 the Forest and Range Organization had implemented a joint project with the FAO to establish Caspian Tree Seed Production and Improvement Centre. The main objective of this

project was to collect and process seed of high quality. This centre has now existed for almost four years and has achieved a great deal in this regard.

3-5- Conclusions

1. This comparison of research and practice reveals that in spite of all the work have been done and progress made, there is still more work remains to be done for successful establishment and management of plantations on different sites of the country.
2. We should continue our efforts to test more exotic species, seed sources, spacing, thinning and rotation trials by using pilot size experiment and different methods of moisture conservation.
3. Forestry Research is so important and must be considered as integrated part of any implementing activities.
4. Experimental sites and stations for trials and testing adaptability of species should be selected on the same ecological conditions.
5. There is also a need for international co-operation to make the results of our study more effective and useful. We believe that IUFRO could examine the possibility of supplying information,technical assistance and more co-operation with our institute.

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Site preparation And Seedling Plantation For Afforestation In Semi-arid Zone With Climatical Limitation

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Site preparation And Seedling Plantation For Afforestation In Semi-arid Zone With Climatical Limitation

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4-1- Abstract

There are about 30 millions km^2 desert in the world and about 300 millions people living in these areas, which half of them are villagers, about 17 millions ha. is under desertification processes (Bankok conference's documents, 1986).

Iran is generally classified into semi-arid or arid climate, although there is a narrow line of temperate forest around Caspian Sea.

The annual rainfall in Iran varies between about 50 mm in central part and 2000 mm in Caspian Sea.

This paper is considering sites peraperation and seed or seedling plantation for afforestation in areas which have climatical limitation as follows:

a)Oan-nebn ali Mountain in Tabriz, north west of Iran

b)Albagi sand dune in Ahvaz, south west of Iran

c)Sand dune in Kashan, central part of Iran

d)Gareh Bygone in Fasa, south of Iran

Materials and methods wich were used in different sites are varied based on environmental and ecological conditions.

In most parts establishment of trees and plantation were successful.

Some recomended species are as follow:

1- Calligonum bungei
2- Calligonum comosum
3- Calligonum crinitum
4- Calligonum turkestanicum
5- Eucalyptus camaludensis
6- Hallooxylon aphylum
7- Populus euphratica
8- Salsola turkmanica
9- Smimovia iranica

4-2 Introduction

Iran's surface area is about 165 m.ha. and its' climate is generaly classified as semi-arid or arid. Although, there is a narrow line of temperate forest in northern slop of Albourz Mountain's chain south of Caspian sea with annual rainfall up to 2000 mm. Most part of Iran are dry with scare of vegetation. Zagros mountain-chain in western part of Iran with medium rainfall and cold to warm weather are coverd with especial tree species, mainly oak. About 50% of total land area of Iran is covered with high mountain ranges.

There are about 30 millions Km^2 desert in the world, and about 300 millions people living in these areas, which half of them are rural villagers, and about 17 millions ha. is under desertification processes (Bankok conference's documents, 1986). There are about 12 million

hectar sand dune in Iran which about 5 Million hectars is active.

(Fig.3 Topography map of Iran)

(Fig.4 Rainfall map of Iran)

(Fig.5 Isotermic map of Iran)

(Fig.6 Vegetation map of Iran)

Work and plantation in such areas with different climatical limitations are very common and difficult.

4-2-1- Site description

In this work several regions, described as follow, have been investigated:

(Fig.7 Experiment Sites in general maps of Iran)

a) Oan-nebn-ali mountain in Tabriz, north west of Iran

b) Albagi sand dune in Ahvaz (55 km), south west of Iran

c) Sand dune in Kashan, central part of Iran

d) Gareh Bygone plain in Fasa, 200 km to the south-east of Shiraz, south of Iran

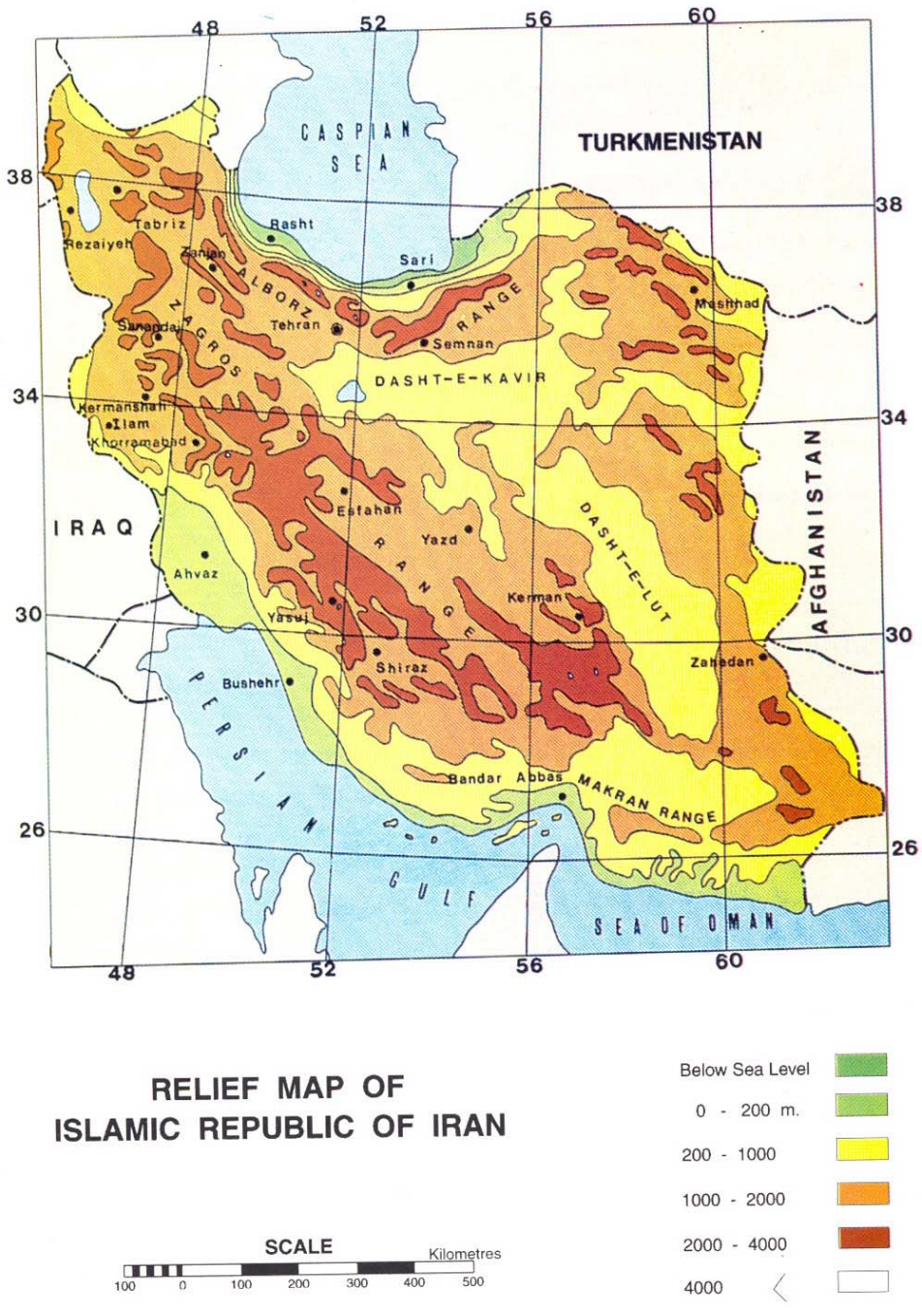

Fig.3 Topography map of Iran

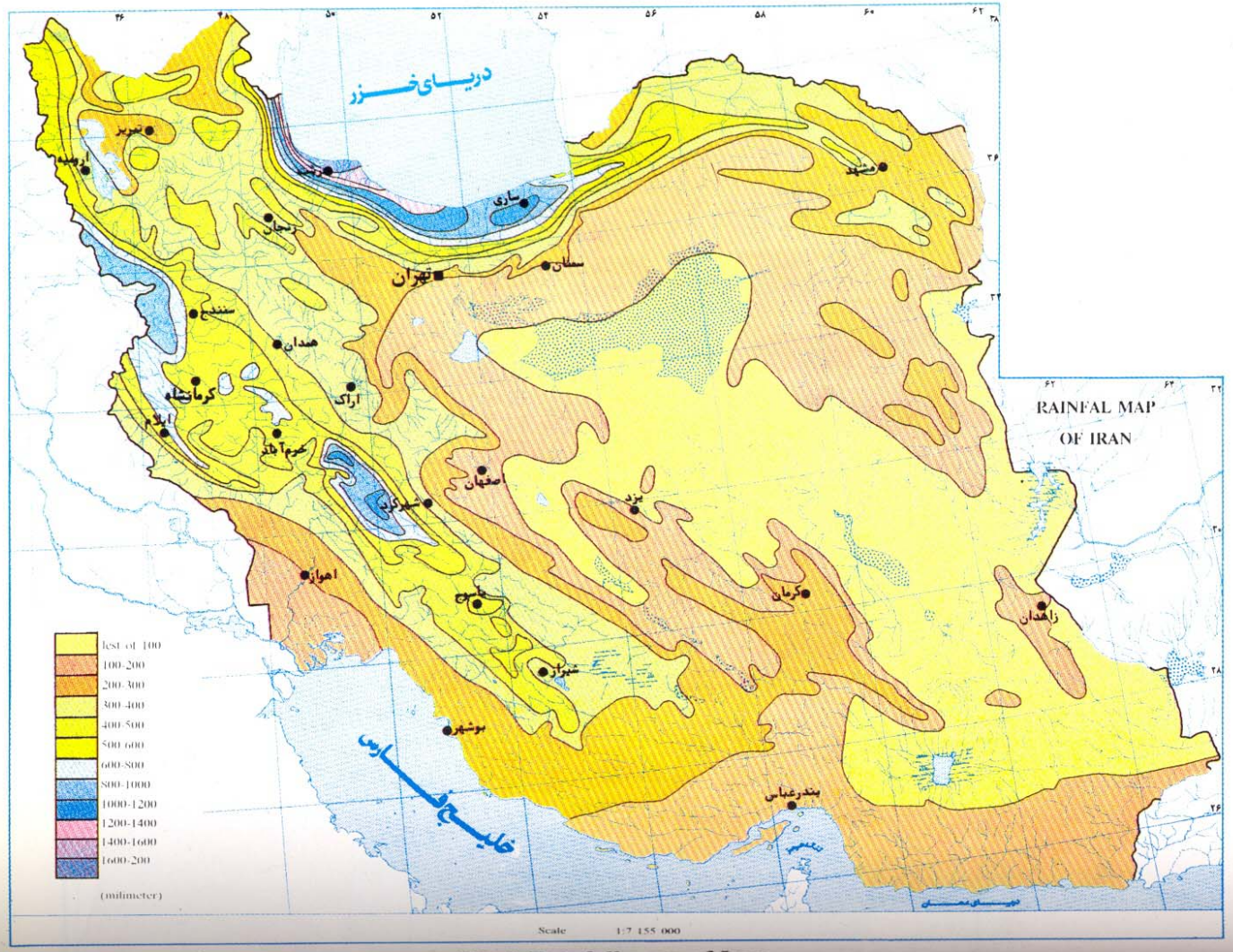

Fig.4 Rainfall map of Iran

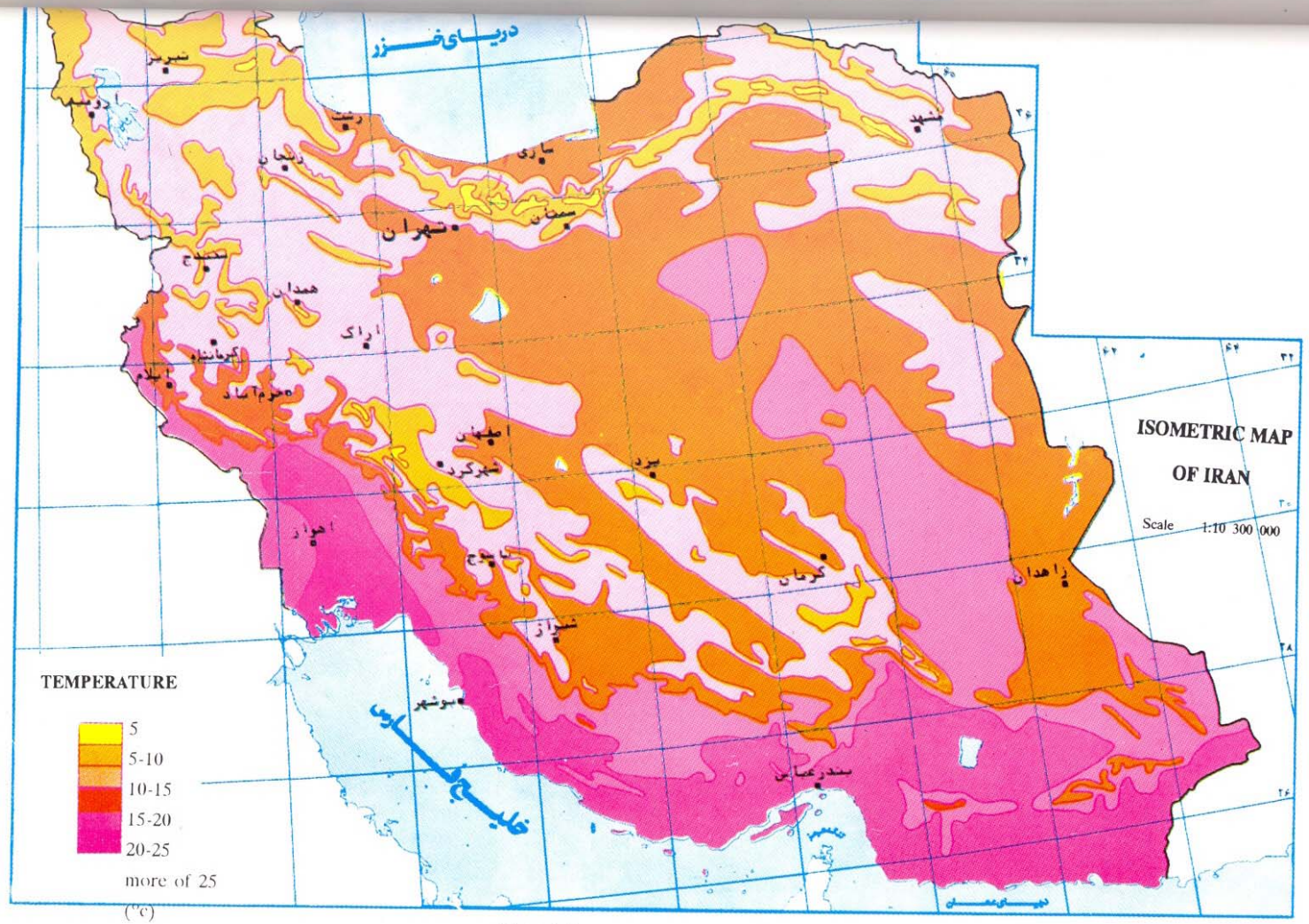

Fig.5 Isotermic map of Iran

Fig.6 Vegetation map of Iran

Fig. 7: Location of Experimental Stations.

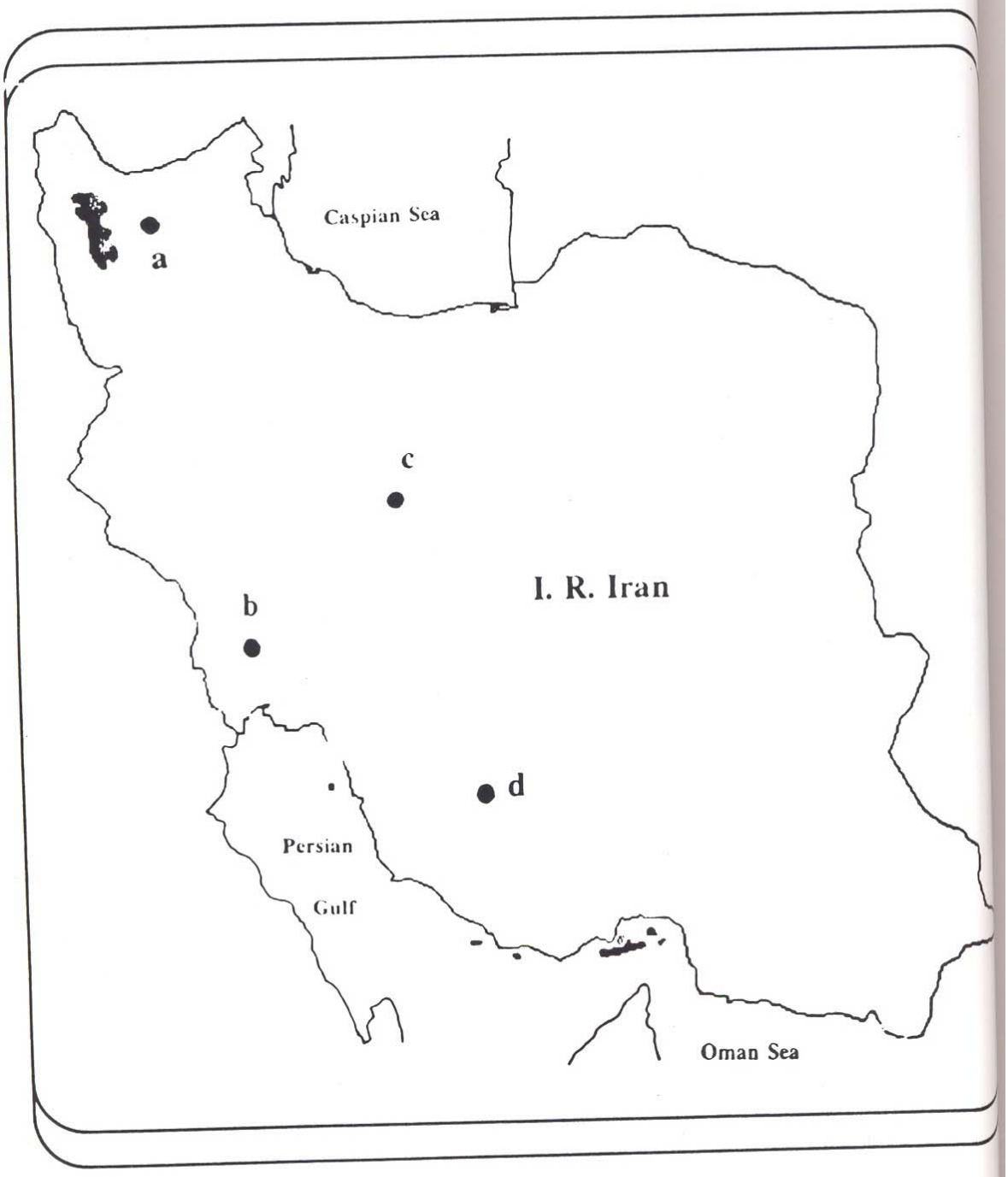

Table 7: Information on working sites.

Site Row	Site Name	Place	Lat. °	Alt. °	Temp.°C min./max.	Rainfall mm	General feture	Elevation m(sea level)	Climatical limitation
a)	Oan-nebn-ali	N.W.	38.50	46.17	-12.34	300	Mountain	1750	bare rock, high wind, water deficit
b)	Albagi	S.W.	31.15	48.37	5.54	253	Hot-Sand dune	12	water deficit, high temperature
c)	Kashan	Central	34.00	51.30	12.47	110	Sand dune	950	water deficit
d)	Gareh Bygone	S.	28.35	53.53	-7.43	150	Dry floodey land	1140	bare land, poor soil, water deficit

4-3- Site preparations

Sites have been prepared for different regions as follows:

a) Oan-nebn-ali Mountain:

Cresent form banquette been digged on contour lines with 5m diameter for trees with water harvesting areas about 15-20 m^2 and 2.5m diameter for shrubs with water harvesting areas about 10 m^2 All diameters for seed plantation was about 2.5m

b) Sand dune plantation in Ahvaz:

i) collecting suitable *Eucalyptus* seeds

ii) producing seedlings in 25x15 plastic bags, using river sediment light soil (2/3) mixed with animal durg(1/3).

iii) transplanting seedlings to the site in autumn and spring

c) Sand dune stabilization in Kashan:

i-studies of native plant communities

ii-collecting seeds from native plants

iii-producing seedlings

iv-transplanting seedling to the site

v-conservation of planted seedling up to establishment

vi-grazing control in planted areas

d) Gareh Bygone Plain:

A 6000 ha. sand-covered debris cone was selected in Jan. 1983 with

the main objective of utilizing flood-waters to stabilize the moving sands by sedimentation of the suspended load while rechrging an empty aquifer with a potential volume of 100 million m3. Eight floodwater spreading systems, covering an areas of 1365 ha. were designed and constructed in the 1983-1986 period according to the procedure suggested by Phillips (1957), Newman (1963), Quilty (1972 a,b) and with modification of Dr. Kowsar (1991) project director.

4-4- Species used

Species used for plantation in different regions are as follow:

a) Oan-nebn-ali Mountain:

seed sowing	**seedling plantation**
Amygdalus orientalis	*Amygdalus communis*
A. scoparia	*A. orientalis*
Berberis integerrima	*Amygdalus scoparia*
Haloxylon persicum	*Berberis integerimma*
Pistacia atlantica	*Haloxylon persicum*
Prunus andersowii	*Juniperus sp*
Purshia tridentata	*Pinus ponderosa*
Pyrus sp	*Pistacia atlantica*
Zygophyllum atriplicoides	*Prunus fasiculata*
Purshia tridentata	*Rosa sp*
Robinia pseudacacia	*Vitis vinefera*

b) species used in sand dune of Ahvaz:

Eucalyptus camaldulensis *E. camaldulensis 9616*

E. Microtheca *E. sargenti*

c) Species used in sand dune of Kashan:

i-*Halloxylon aphylum,*

- direct seeding (with at least 90 mm rainfall-without irrigation),
- seedling (with irrigation in dry spring and summer with 20 litre water per time per seedling),
- cutting

ii-*Calligonum sp.*

C. comosum *C. Turkestanicum*

C. crinitum *C.bungei*

- Seedling (with irrigation in dry spring and summer with 20 litre water per seedling 15 days intervals)
- cutting (// //)
- direct seeding (in area with at least 120 mm rainfal)

iii-*Smirnovia Iranica*

seedling (irrigation seeds in nersary with 3 days intervals) coppies

iv-*Populus euphratica*

rooted cutting (in wet sand dune with about 5 m depth of water table and research showed cutting from 3 years old is much better than younger)

v-*Salsola Turkemanica*

seeding (in salt land)

d) *Gareh Bygone Plain:*

Some fast-growing Australian species has been introduced into Gareh Bygone plain. The seeds were sown in a polythene bag, then transplanted when the seedlings reached their nine month age.

The following species which have been successfully tried in the more element environment of southwestern Iran :

Eucalyptus camaldulensis
E. microtheca
A. salicina
Acacia cyanophylla
A. victoria

4-5- Plantation

Methods used for plantation varied for different regions and described as follow: *a) Oan-nebn-ali Mountain:*

Seedling and seeds been planted in deepest point in cresent form banquette.

Seed sowing:

- Seeds been soaked before seeding
- Digged holes been filled with 1/3 decomposed animal dung and 2/3 soil
- Seeding few soaked seeds in middle of hole
- Covering seeds with fine soils and irrigated (10 litres)
- Covering hole with plastic after germination to avoid evaporation
- Irrigation during late spring and summer with 10 l. water and 20 days intervals (five times-total of 50 l.)

Seedling Plantation:

- Seedlings were planted at the same way as the seed sowing method and with the same irrigation system (totally 50 L. of water by five times).
- The experiment were run using five main plots of water harvesting treatments and two sub-plots for species (10 shrub and 5 tree species).

b) Ahvaze Sand Dune Plantation:

seedling were produced in plastic bags have been transplanted to the mulch stabilized sand dune in autumn and spring (which is better), Experiment designe was based on completly randomized block with three replicates. Area of each treatment plot was 15x27m, and seedlings planted 3x3m, in digged 50x40cm hols. Experiment was rainfed and no irrigation at all.

c) Kashan Sand Dune:

The native seed plants were collected then sow in plastic bags to produce seedlings, and after that the seedlings were transplanted to the field.

d) Gareh Baygon Plain:

Seedling of different species were planted in Feb. and March 1983, adjacent to the upslop toe of the banks of the channels, along the waterline of the diversion canal, and by the inside toe of the end banks. The planting lines were ripped to a depth of 35 cm.

4-6- Results

a) Oan-nebn-ali Mountain:

Results obtained from this experiment showd that in mountainous area with hard environmental conditions, it is possible to plant trees and shrubs by selecting tolerant and adapted species and using suitable and applicable methods of site preparation and plantation.

b) Sand Dune of Ahvaz:

The six years old of *Eucalypt* trees have reached a height and diameter breast height of 12 m and 20 cm without irrigation respectively. Rather than using an experimental design for Eucalyptus, some adapted species planted in wide areas for observation trail and the survival estimated to be 95%. The sand dune area in Khuzestan province is estimated to be 35000 ha. which 20% of this has been stabilized by mulching or wind-breaker.

c) Sand Dune of Kashan:

About 91 000 ha. Kashan desert area and sand dune has been improved and stabilized by plantation.

d) Gareh Bygone Plain:

Flood spreading and forest plantation (by tree and shrub) have transformed a dryland into a verdant pasture. The carring capacity of the stabilized drifting sandland has increased to 10 fold. The height and diameter breast height of many eucalypt trees exceeded 16m and 25m respectively. Provision of irrigation for 1000 ha. of cropland through 40 "new" and 16 "old" wells has substantially raised the income of our farm communitites in the plain. Morover, the yield of 650 ha. of flood-irrigated barley has doubled.

Flood spreading and forest plantation
(Gareh Baygone)

4-7- Recomended species

Based on these researches, several species could be recomended for plantation and afforestation in similar areas by ecological point of views.

a) Oan-nebn-ali Mountain:

In direct seed sowing methods, some species showed more adaptation than the others.

- *Amygdalus scoparia*
- *Haloxylon persicum*
- *Zygophyllum atriplicoides*

In seedling experiments, trees showed more adaptability than the shrubs as follows:

- *Pistacia atalntica*
- *Robinia pseudocacacia*
- *Pinus ponderosa*
- *Amygdalus scoparia*
- *Pinus nigra var. austriaca*
- *Juniperus virginiana*

b) Sand Dune of Ahvaz:

Amoung four *Eucalyptus* species used in this experiment *E. camaldulensis* 9616 and *E. microtheca* were the best. although *E. ca.* 9616 was more significant in growth and vigor.

c) Sand dune of Kashan:

The following species showed good adaptation after long term experiment:

- *Haloxylon aphyllum*
- *Sminovia iranica*
- *Salsola turkemanica*
- *Populus euphratica*
- *Calligounum comosum*
- *Calligonum crinitum*
- *Calligounum bungei*
- *Calligounm turkestanicum*

d) Gareh-Baygone Plain:

The performance of Eucalyptus camadulensis planted in the harsh environment of Gareh Bygone plain has been out standing.

4-8- Conclusion

Understanding ecological limitation factors and preparing suitable and environmentaly sound project with using native or addapted plants could be used as very effective method to overcome the problems in similar areas.

a) Oan-nebn-ali Mountain:

About 50% of total land area of Iran is covered with high mountain ranges, and improvement of such places could have significant effect, environmentaly and economically.

For plantation in such area species with wide range of tolerance should be selected. Control of surface evaporation with using plastic sheet

could help for providing moisture and water use economy. Suitable method for plantation should be operate based on ecological and geographical situation.

b)Sand Dune of Ahvaz:

Based on results obtained from this experiment mulching establized sand dune could be planted by recomended species.

c) Sand Dune of Kashan:

About 16 percent of the total desert land of Iran located in Esfahan province.

Area like Massileh watershed (in central part of Iran, near Kashan) and Kavir plain with arid or semi-arid ecological climate could be recoverd as its ancient form of vegetation. For improvement degrading factors should be removed and scientific method should be used.

d) Gareh Bygone Plain:

Controling flood and water management for plantation could be used as very strong tool for improvement of arid land and dry areas.

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4-10- Acknowledgements

Many thanks to Dr. A. Kowsar for his kind letting me to use his data and paper related to Greh Bygone project in this manuscript.

Also thanks to Eng. H.Loghman for his information and help related to Kashan sand dune stabilization project.

I would like to thank also East Azarbyjan Research Centre for their help and providing information related to Oan-nebn-ali mountain project, specially

to Eng. A.Najafi and Eng. A.Barzegar.

And also thanks to Eng. N. Najafi and his co-worker for imformation and data related to Ahvaz *Eucalyptus* adaptation project.

Renewable Natural Resources: Water Management and Sustainable Development

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Renewable Natural Resoureces:
Water Management and Sustainable Development

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5-1- Backgrounds

A survey carried out by International Commission on Large Dams (ICOLD) shows that around 300 large dams (height over 15 m) are commissioned each year and that construction begins on a similar number. In 1991 there were 1190 dams under construction, the average construcion time being about four years. During the decade this means roughly 3000 new large dams with an estimated watershed area of 500 km^2 per dam or about 1.5 Million km^2 being added to the upland areas situated directly upstream of dams.

5-2- Introduciton:

5-2-1- Natural Resources: Soil, Water, Plants, Oil, Mine, ...

5-2-2- Renewable Natural Resources: Plants (Forest, Rangeland, ...), Water, ...

5-2-3- Climatical Condition: Tropical, Temperate, Boreal, Arid and Semi-arid, ...

5-3- Role of Water:

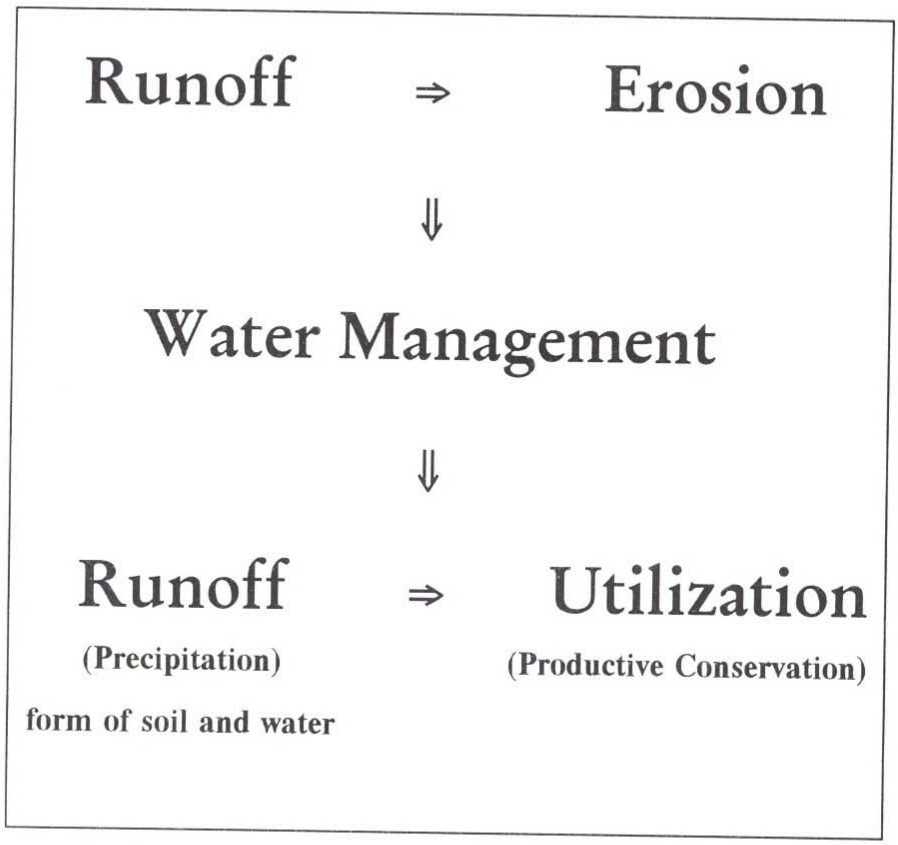
Water plays important role in mountainous areas mainly as its source and in arid land as its limitation.

The values of watershed protection can be categorized as those derived from water resources conservation and development (hydroelectric power, irrigation, municipal water supply, navigation, etc.) and those from protection against natural disasters (torrents, avalanches, floods, mudflows, landslides, etc.)

5-3-1- Water Management:

Water harvesting is the collection of runoff for productive purposes. Instead of runoff being left to cause erosion, it is harvested and utilized.

In the semi- arid dorught- prone areas where it is already practiced, water harvesting is a directly productive form of soil and water conservation. Both yields and reliability of production can be significantly improved with this method.



The water harvesting techniques could be described under three basic categories:

a) Microcatchments (Rainwater Harvesing) (within- Field catchment system)

b) External catchment systems (Rainwater Harvesting) (Long slope catchment Technique)

c) Floodwater farming (Floodwater Harvesting) (Water/spreading) (Spate Irrigation)

The objective of water management could be categorized as follows:

a) For reducing erosion

b) For increasing productivity and vegetation cover

Water management → Watershed Management → Watershed approach → Watershed Management practices

① ② ③

1- Natural, Agricultural and Human Resources
   - Social, economic and institutional factors operating within and outside the watersehd.
2- Planning and implementation of resource development.
3- Changes in land use, vegeatation cover, and other nonstructural and structural actions.

5-3-2- Irrigation:

In arid zones, irrigated for plantations can be achieved by different ways:

a) A permanent water supply

a-1) Gravity systems

a-1-1) Surface flooding

a-1-2) Border check

a-1-3) Basin irrigation

a-1-4) Furrow irrigation

a-2) Sprinkler systems

a-3) Localized systems (trickle, drip, drop or sip/irrigation methods)

b) An intermittent water supply (Rainwater Harvesting)

b-1) Runoff farming

b-2) Desert strip-farming

b-3) Contour terrace farming

b-4) Flood water spreading

c) Waste water

c-1) Untreated waste water

c-2) Partially treated waste water

c-3) Completely treated waste water

5-4- Sustainable development

5-4-1- Development:

Development could be considered in different dimensions including Economic and financial, Environmental and Social.

5-4-2- Sustainability:

Development without sustainability does not have clear meaning. Sustainable development should be realized as one word in a integerated system. Sustainability in each dimension has got some indicators which could be define for each subject.

5-4-2-1- Role of vegetation cover in sustainability

All different types of vegetation cover including arid zone vegetation like desert, semidesert, low rainfall woodlands, savana and evergreen scrub, in one way or another can play important role in soil stability and water conserving and ultilization, which are key factors of sustainability. In this respest forest could be considered in more details.

Common effects of forestry investment project could be divided into three main categories as follows:

a- Economic and financial

b- Environmental

c- Social

5-4-2-1-1 Role of forests in sustainability

a- Forests and Climate:

- The influence of forests on rainfall

- The cooling effects of forests

- The reception of rainfall

b- Forests and water availability:

c- Flood control by Forests (even in Tropical):

- Most of the main Himalayan slopes receive from 2m to 5m of rainfall in six months.

- Study of 200 000 km^2 tropical watershed showed the average flow is 2 800 m^3/sec.

- Saturated forest effects on average annual peak flow by 46 times.

d- Forests and Erosion:

1) Surface (sheetwash and rills)

2) Gully

3) Mass wasting (Landslips, Slumps, debris flows, etc.)

e- Forests and sediment:

Figures 8 and 9 show increasing productivity or time of sedimentation and capacity of a reservoir which resulted by watershed management practices that could be considered as inportant factors of sustainability.

5-4-2-1-2- Role of Water Mangement on Vegetation Cover:

Water requirements of plants is very important factor for their establishment, growth and regeneration. There are, however, apart from sunshine and temperature, other climatic factors like humidity and wind speed which could influenced the plant water needs.

The following formula shows effect of precipitation on availability of water and moisture:

$$P=Q+E\pm S\pm G$$

P= Precipitation

Q= Stream flow

E= Evapotranspiration

±= Changes in storage of soil moisture and ground water

The hydrologic cycle shows in figure 10.

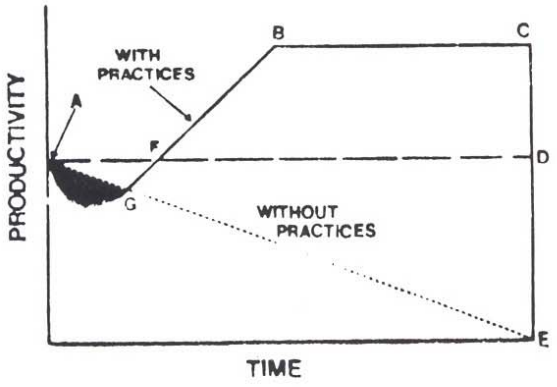


Figure 8. Hypothetical relationship between productivity and time for conditions of "with" and "without" watershed management practices.

Source: FAO, No 16(1987)

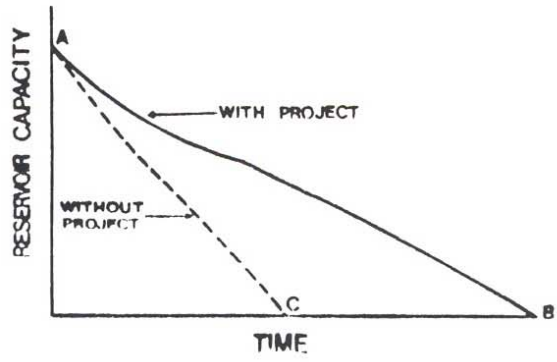


Figure 9. Example of effects of watershed project on sedimentation and storage capacity of a reservoir.

Source: FAO, No 16(1987)

THE HYDROLOGIC CYCLE

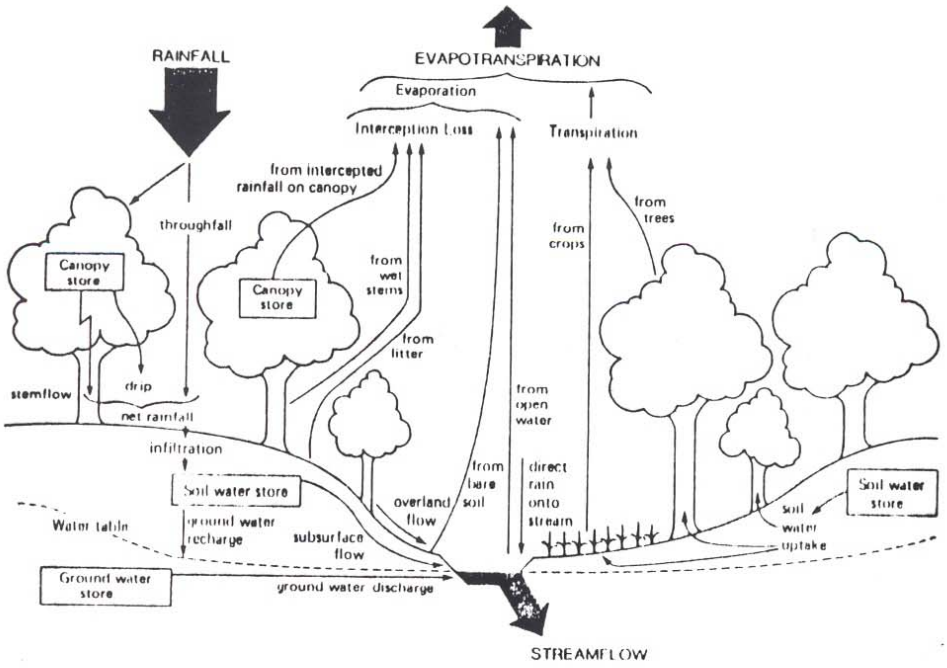


Figure 10. The hydrologic cycle.

Source: Hamilton and Pearce, 1986.

- Relation and size of catchment and plants like crop, fodder, rangelands and trees could scientifically be estimated. For example total size of the microcatchment systems for trees can be calculated by following formula:

$$MC = RA \times \frac{WR - DR}{DR \times K \times EFF}$$

MC= total size of microcatchment (m^2)

RA= area exploited by root system (m^2) (area of camopy of the tree)

WR= water requirement (annual) (mm)

DR= design rainfall (annual) (mm)

K= runoff coeflicient (annual) (# 0.5, in semi-arid)

EFF= efficiency factor (# 0.5 in semi-arid)

An example of change in frequency curve that may be expected in upland watersheds due to forest clearing is illustrated in Figure 11.

5-5- World scope and objectives:

5-5-1- World conditions

Almost one-third of the total area of the world (about 31%) is aridland. The hyper-arid zone with arid index ($\frac{P}{ETP}$) of 0.03 about 4.2%, the arid zone with arid index of 0.03-0.20 about 14.6% and the semi-arid

zone with arid index of 0.20-0.50 about 12.2%.

There are about 30 million Km^2 desert in the world, and about 300 million people living in these areas, which half of them are villagers. An area about 17 million ha. is under desertification process.

Population increases in many mountainous countries are taking placed at a rate of between 2 and 3 percent annually. Deforestation rates in the 1980s are estimated to be 35 percent above the, already alarming, rates of the 1970s. Poverty, unemployment, poor health and bad sanitation are widespread.

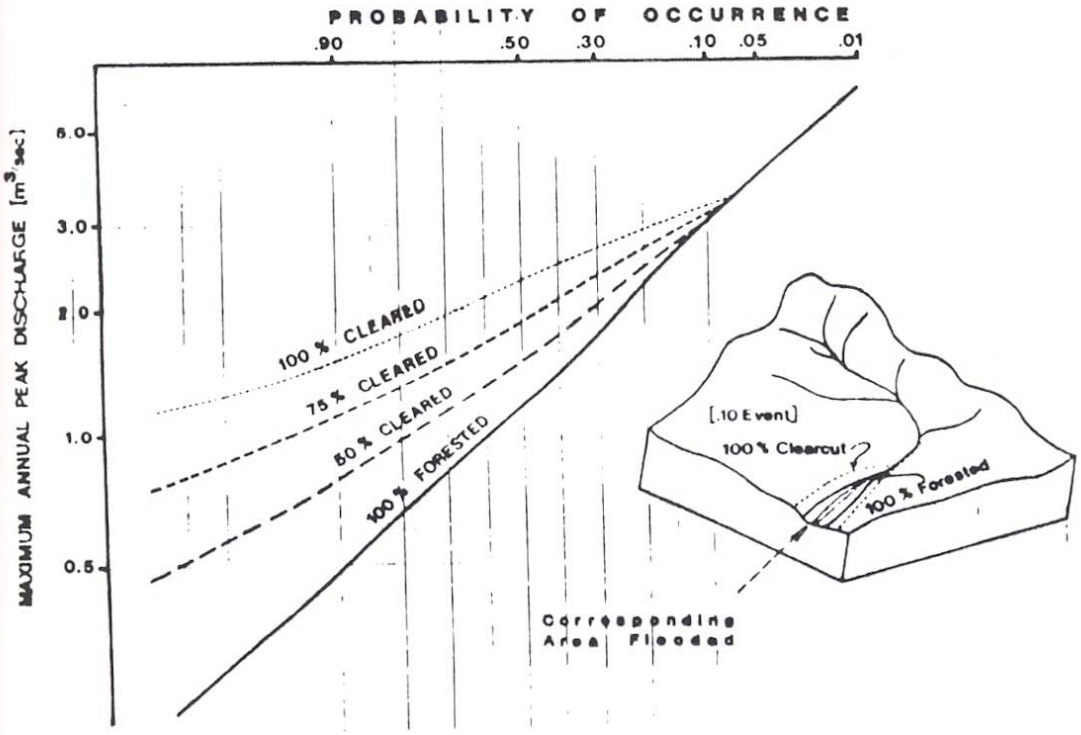


Figure 11. Effects of forest removal on annual peak discharge frequency curve and associated stages for a particular watershed.

Source: FAO, No.16, (1987)

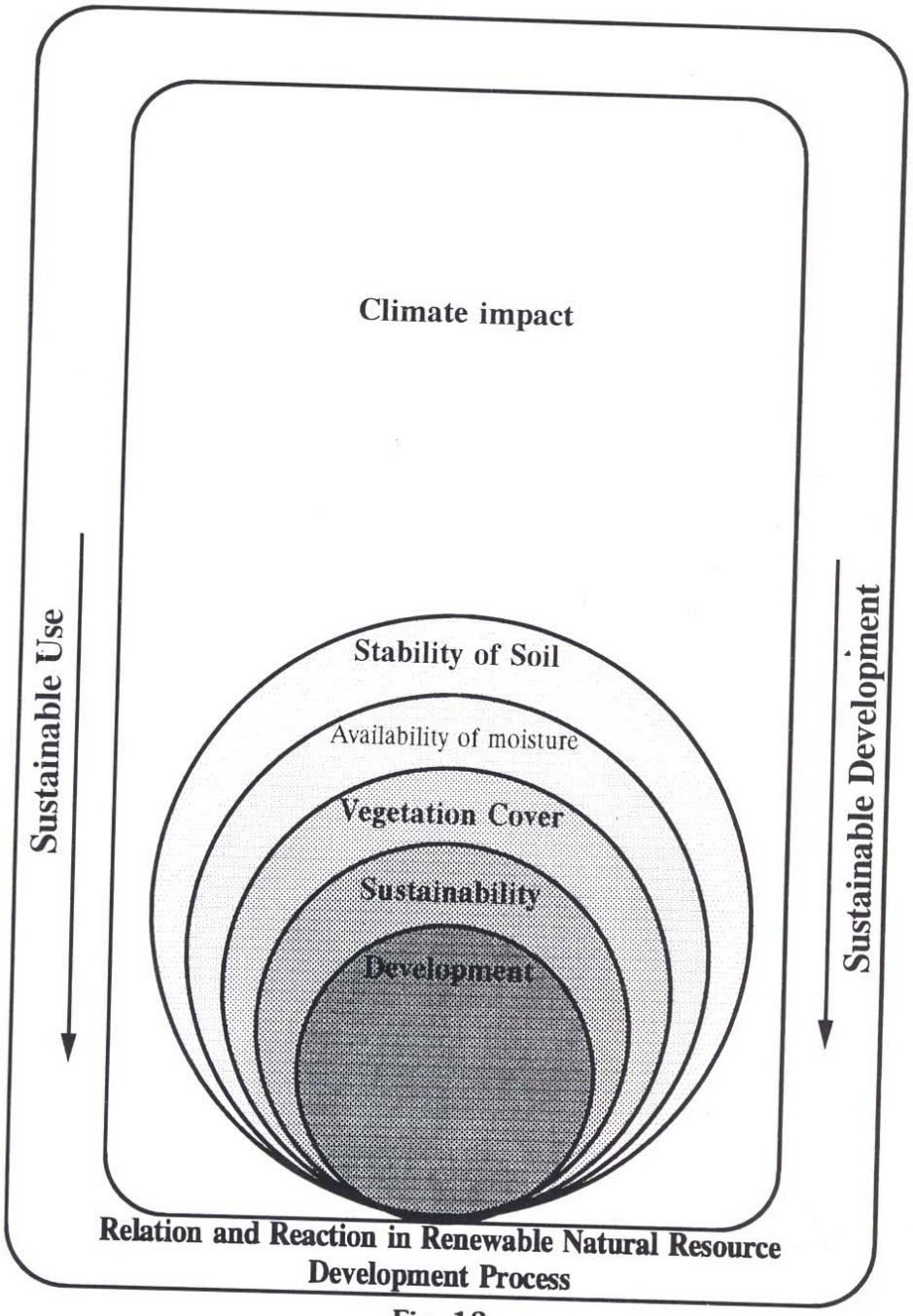

Climate impact
Sustainable Use
Sustainable Development
Stability of Soil
Availability of moisture
Vegetation Cover
Sustainability
Development
Relation and Reaction in Renewable Natural Resource
Development Process

Fig. 12

5-5-2- Global objectives:

A major objective of watershed management in mountains is to protect the natural resources such as soil, water and vegetation from degradation. Some overall objectives may be enunciated as:

1) Ensure the sustainable use of all the renewable natural resources

2) Achieve sound ecological balances

3) Maintain and improve water quality

4) Maintain and increase water yield.

5) Regulate the timing of streamflows

6) Control excessive runoff and reducing floods

7) Control flood's water

8) Control soil erosion and other harmful land degradation processes

5-5-3- UNCED and Agenda 21:

UNCED's Agenda 21, chapter 13 consider that "nearly half of the world's population is affected in various ways by mountian ecology and the degradation of watershed areas. About 10 per cent of the Earth's population lives in mountain areas, while about 40 per cent occupies the adjacent medium -and lower- watershed areas."

Objectives established by UNCED in Agenda 21 chapter 13:

"Promoting integrated watershed development and alternative livelihood oppourtunities."

a) to develop appropriate land use planning and management

b) to promote income- generating activities

c) to develop technical and institutional arrangement

5-6- Iranian scope and objectives:

I.R. of Iran is located in the north temperate from 25 to 40 degrees latitude and 44 to 66 degrees longitude, with a total area of approximately 1 650 000 square kilometers. A large area of the country is covered with high mountain ranges with amounts of about 50% of total land area, and large sections of interior is characterized by arid basins. Elevations range from 26 meters below see level on the shores of the Caspian Sea to 5 860 meters above sea level at the Damavand Mountain.

5-6-1- Climatical condition:

Climatic variations are also great in Iran. The main variation is between the dry, desert interior region and the humid Caspian coastal region. The Caspian region receives the larger part of the country's

precipitation (2 000 mm), while the central desert (Dasht-e-Lut) is faced with permanent drought. Mean January temperatures range from 20 degrees of centigrade alonge the Persian Gulf region to minus 2 degrees in northwest of Iran. Extreme temperatures of over 50 degrees of centigrade in the Persian Gulf region to minus 35 degrees of centigrade in the northwest have been recorded.

Tweleve million hectars of Iran lands is covered by sand dune, which about 5 million hectars are active.

5-6-1-1- Land Classification in Iran

There are significent climatic variations and differences, particularly in forest regions of Iran and this caused great diversity in species. Table 8, shows the land classification in I.R. Iran.

Table 8: Land Classificaiton in I.R. Iran.

	Forests	Ranges	Farm/Garden	Desert/Kavir	Urban	Total
Percent	7.51	54.54	14.30	20.96	2.66	100
Million hectars	12.4	90	23.6	34.6	4.4	165

5-6-1-2- Forest ecological zones in Iran

Forest eclogical zones in Iran could be categorised as presented in Table 9.

Tabel 9. Different Forest types in I.R.Iran

Type of Forests	Location	Annual Rainfall (mm)	Area	
			Million ha.	%
Caspian Forest	N.	600-2000	1.9	1.15
Arasbaran Forest	N.W.	400-700	0.2	0.12
Zagros Forest	W.	300-600	3.5	2.12
Central Forest	C.	100-150	5.5	3.33
Subtropical Forests:				
-Mangrove	S.	125	0.5	0.30
- Others	S.	-	0.8	0.48
Total Forest	-	-	**12.4**	**7.51**

5-6-2- Main problems:

Drought or water deficiency is one of the most critical climatical factor in Iran. About 50% of Iran can be classified as arid or semi-arid zone. Climatic parameters, partiularly precipitation varies significantly in different part of Iran.

Some soil properties like poor drinage, very light texture and high salt density when combine with low rainfall, make problem for plant growth in arid and semi-arid areas.

Social and economical problmes have serious effects on existing renewable natural resources.

5-6-3- Objectives

There are some severe difficulties in respect to afforestation and reforestation in arid and semi-arid zones of Iran. Because of shortage of adequate water resources, wherever, there is some water available, drinking water and industries get the first priorities.

Even, water is available, afforestation is very costly, because of the cost of land preparation and establishment of irrigation facilities. For this reason and because of the need for establishing green areas around the cities; conservation of soil, production of wood, and dry afforestation has been one of the most important tasks of the Research Institute of Forests and Rangelands and since the beginning, extensive research and detailed investigations have been conducted. In these

regards some significant and usefull results have been obtained.

Iranian objectives with regards to international and regional agreements and national climate and conditions have been identified. Some major Iranian objectives related to renewable natural resources could be listed as follows:

- Providing an Integrated System by planning a master plan for sustainable development of natural resources.
  - Management
  - Sustainable ecosystem
  - Exploitation
  - Rehabilitation

- Sustainable use of Natural Resources

- Erosion control and reducing land degradation
  - combat desertificaiton

- Increasing vegetation cover
  - afforestation, reforastation, range rehabilitation, fast grwoing species ...

■ Reducing vegetation removal

-control illegal exploitation

■ Reducing flood and water flows

■ Exploitation flood water and other water flows

- Flood water spreading

■ National coordination and International cooperation

■ Improving Technical Methods

- Silviculture, Seed quality, ...

■ Identifing Criteria and Indicators (C & I)

- for each subjects

■ Monitoring and Evaluation (M & E) of Research projects and implementation activities

- Based on provided guidlines

■ Distribution of Researh output by publishing results or other ways

■ Reserach, Training and Extention

-in all disiplines

- Research and Development (R & D)

5-7- Strategies:

Subdivision of watershed area could be divided into major types of land use, such as following, and for each type, suitable strategies, with attention to related criteria and indicators (C & I) should be developed:

- Agriculture

  Irrigated

  Rain-fed

- Grazing

- Agroforestry

- Forest

  Commercial

  Mixed-use

  Preservation

- Mining

- Transportation

- Urban

- Lakes, Reservoirs and Stream channels

To develop strategies, different directions with their priorities must be listed; for example as follows:

for water management

for afforestation

for combat desertification

for reforestation

for erosion control

and then in a integrated systems all details and overlapping should be considered.

To work on details of each individual subject, the causes of unstability or even factors effect on stability should be identified. For example, deforestation is a criterion of unstability for sustainable forest development and some indictors for it could be listed as follows:

- Over used and wood harvesting
- Over grazing
- Cultivation on Steep slopes
- Removal of vegetation
- Desertification

In combined production systems, agriculture, livestock production, forestry and combination there of are practised on the same piece of land, either in rotation, simultaneously, or spatially. Such combination,

also called "agroforestry". The basic aim of agroforestry is to attain ecological stability and, at the same time, to provide maximum short-term and long-term benefits to the user of the land.

Depending on the land use, three "types" of agroforestry can be distinguished in arid zones; namely:

- Agrisilviculture
- Silvipasture
- Agrosilvipasture

Agenda 21 proposes the following strategy: "Promoting integrated watershed development through effective participation of local people is a key to preventing further ecological imbalance. An integrated approach is needed for conserving, upgrading and using the natural resources base of land, water, plant, animal and human resources.

In addition, promoting alternative livelihood opportunities, particulary through development of employment schemes that increase the productive base, will have a significant role in improving the standard of living among the large rural population, living in mountian ecosystems."

The most common strategy is to use reforestation, to achieve this by:

1) The re-establishment of vegetation cover

2) The provision of common needs (fuelwood, fodder, timber and etc.)

3) The rehabilitation of existing natural forests and the development of appropriate exploitation guidelines.

5-8- Recommendation:

▣ Using Not or Less Renewable Natural Resources for Sustainable Development of Renewable Natural Resources

▣ Strengtheing Research bodies

- Establishing Research stations
- Training Researcher and End-users
- Trainin g, research , demonstration and technology pakages constitute important areas of action for a successful Watershed Management Program.

▣ Working on Criteria and Indicators (C & I)

▣ Working on Monitoring and Evaluation (M & E)

▣ Clear linkage between International Conventions

▣ Providing new and adequate Financial support, GEF, Capacity 21, World bank, ODA, and ...

▣ Facilitating Transfer of Technology

▣ A balance between population and the environmental carring

cappacity of upland watersheds must be achieved.

▣ Countries need to develop national conservation strategies and frameworks to achieve appropriate and comprehensive management of mountain watersheds.

▣ Watershed management practices should be implemented which solve soil and water degeradation problems but at the same time are socially and politically acceptable and economically feasible.

▣ Public awareness and the involvement of local communities are crucial for the successful and sustained management of mountain watershed.

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Book Identity:

Title: *Four Articles on Forests*

Author: *Dr. Mostafa Jafari*

Published by: *Forests and Rangelands Research Institute*

First Edition: *1997*

Lithography: *Toos*

Printing-house: *Pejvak*