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Reclamation of Vegetation with Introduction of Adaptable Species in the Western Rangelands of Salt Lake at Fars Province, Iran

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Research Article

Abstract

These Rangelands located on 18 km East of Shiraz city. This research aim to investigate the vegetation of these rangelands by compatible species. First, geographical location, geology, geomorphology, vegetation, water table depth, hydrogeology, pedology and climatology information were investigated. The typology was done by geomorphological data. Then, soil sampling was done through one meter depth in each type randomly and was tested by experiments involving saturated percentage, electrical conductivity, pH and Texture. Then within each vegetation type, sampling the vegetation was done completely and randomly using transect method and a transect of 30 m and three transect per each type were performed. Water table depth was obtained by total station camera, topographical maps and wells in the area and field studies. Finally according to data obtained from these studies and data obtained from relative resources, appropriate species for reclamation of these rangelands were introduced.

Keywords: Salt Lake; Reclamation of vegetation; Compatible species.

1. Introduction

The vegetation has not formed and developed randomly in natural systems and all vegetation develops in appropriate site according to their nature and needs. Each vegetation has a special genera with defined limits by virtue of their tolerance, adaptation, ecologic field harmony and development potential and ability and in fact, it reflects the ecologic conditions and evolution process.

Reasonable and stable maintenance, management and exploitation concerning the vegetation and rangelands depend on comprehensive, scientific knowledge. Lack of such knowledge leads to inappropriate exploitation of the vegetation and imbalance among natural ecosystems' elements and the environment depending on the vegetation changes; then the plants may not protect themselves and survive and gradually the low quality plants replace the high quality and useful ones and finally new ecosystem elements change leads to new vegetation replacing the previous one [1].

Non-systematic use of plants as forage or otherwise, would jeopardize the their survival in various ways; however, to prevent the destruction of this species and in order to protect them, the first step is to fully understand the relevant ecosystems in terms of ecological, edaphic and botanical.

Iran has many Rangelands on one hand, it is necessary to protect their vegetation and on the other hand, such lands may be used to protect and improve regional soil, water and vegetation and if such site are ignored and destroyed, the salinity of the soil and water increases and harmful factors such as wind corrosion, etc., appear so considering considerable development of such regions it is necessary to study and examine them to know their potentials to benefit from them essentially and vastly.

The basin of Salt Lake is within the geographical area 52°14' to 53°28' East and 29° to 29°57' North and from the northwest to the southeast it stretches the length of it along the width of up to 160 kilometers along the Sarvestan plain and the maximum region is about 43 km. The Rangeland area is 4,272 km^2 (Program and Budget Organization, 1992) of which 2,323 ones are high lands and 1,949 ones are plains [2,3].

The highest place is Gorr about 3,720 m height and the lowest part is in northwest center with 1,460 m height.

The present paper was carried out in order to reclamation of vegetation in these rangelands to propose reasonable solutions in the field of natural resources development by understanding the relationship and generalize the findings in the same areas (Figure 1).

2. Methodology

General processes of the studies are as follows:

Figure 1. Salt lake location in Iran.

2.1 First step

Collecting information, necessary data, deeds, documents, maps, previous reports and studies: Such as climatology, hydrology, geology, geomorphology and pedology information, of course, some of them which had been confirmed were used. Meanwhile, the Topographic maps with the scale of 1:50,000 including the region and the aerial photographs in the scale of 1:55,000 were used and the mosaics were also taken from them.

2.2 Second step

Field operations to complete necessary data

Topographic maps are considered as the basic ones in this step; we went to the region identified and distinguished the lands limits by altimeter and compass. The regional plants were classified by virtue of regional geomorphology. These units should be separable in aerial photographs and have gradual slope changes and approximately the same soil and be directed by an independent department [4].

The geomorphologic and aerial photographs were used for such classification. Then each part representative was defined and sampled randomly by line transect method. In each type three lines transects with 30 m length and range condition in each type obtained by American forestry organization and range trend obtained by trend balance method [5]. By virtue of the map indicating lands' potential each soil type was sampled randomly in the depths of 0-50 cm and 50-100 cm.

As it was said the sampled soil was sent to the pedology lab for physical and chemical analysis. All related tests concerning the texture, electrical conductivity, saturation percent and soil acidity of the samples were conducted in the lab and usual and appropriate methods were used for each factor in a way that hydrometery method was used to define the soil texture, the electrical conductivity meter was used to define electrical conductivity of the saturation extract and following formula was used to define the saturation percent:

(The absorbed water weight/Dry soil weight) × 100

Also the soil acidity was defined by electrometric method or pH meter [6]. The approximate depth of the underground waters is defined by topographic maps in each type, the wells in the field studies and Total Station camera.

2.3 Third step

This includes headquarter operations and setting information.

3. Results

3.1 Weather and climate

The nearest meteorology to the case study id Shiraz

Synoptic Meteorology station bureau in about 10 km from the lake and 37 years statistics of the bureau were examined [7].

3.2 Climate

By virtue of the bureau statistics the yearly rainfall (P) is 315.5 mm in the studied region according to Coppen classification system and the mean yearly weather (T) is 17.5°C and the rainfall is of Winter type in the region and considering T<P<2T it is in steppe region.

By virtue of De Martonne method the dryness coefficient (I) is 11.4 by virtue of the formula: I=P/T+10 because 'P' is 315.5 mm and 'T' is 17.5°C so the case study is in semi-arid region.

3.3 Temperature

The 37 year statistics confirm that the case study limits have moderate winter and temperate summer in a way that the maximum daily mean is 25.6°C and the minimum daily mean is 9.4°C and the maximal absolute daily temperature is 43°C and minimal is -14°C.

3.4 Rainfall

The southwest rainfalls of Iran are mostly from low pressure systems on northeast Africa and east of Mediterranean. The north Sudan system passes through central regions of Saudi Arabia and the system of east Mediterranean passes through Lebanon, Syria and southeast Iraq and influence Iran [8]. The most regional rainfall begins from late November, decreases in the late April and it is near zero in summer. The yearly rainfall rate is 315.5 mm and the maximal daily regional rate is 43.1 in thirty years.

3.5 Freezing weather

Freezing weather in exceptional and occurs rarely in cold months namely from October to March.

3.6 Wind

Generally the mean wind speed was low in the case study November and December and January are the calmest months with 56% calm weather and April and May and June are the most windy with 29% calm weather. The rapidest wind is 21 knot (Knot=0.5 m/s) April, May and June. The wind direction is mostly northwest and west in all months.

3.7 Geology

There are sediments of different geologic periods in the region. The salty dome in the east of Sarvestan is an example of Cambrian period and Goori in south of Maharloo village is an example from second period (Cretaceous) and there are all sediments from third period (From Eocene to Pliocene) everywhere in the limits.

Generally the regional geologic and petrologic formations are in view of their age as follows [2]:

Tarboor formation: In south of Sarvestan and in northeast near salty dome.

Sachoon formation: From Paleocene period in south of Sarvestan camp.

Jahrom formation: From Eocene with nomolite fossils.

Asmari formation: From Eocene-Miocene with crystalized limestone.

Fars group (Miocene): The formations of this group are divided into three subgroups: upper, middle and lower ones of which the middle one which is known as Moshan is not found in the region.

Razak formation: Containing silt greenish and greyish red marne, silt and colourful limestone.

Aghajari formation: Containing calcareous grit with gypsum layers, red marne and silt stones.

Bakhtiari Kanglomer: The Zagros mountains created in Kooh Ghaleh in late Miocene and Pliocene and contain Kanglomer and sandstone.

3.8 Geomorphology

This rangeland is located in moderate stratums of Zagros along northwest – southeast heights. There are log fissures along north-south heights made the Sarvestan plain in form of a cavity. The prominent syncline Kooh Ghaleh is seen in northwest of the plain. The salty dome in northeast of Sarvestan made some water resources saline. There is a long fissure along the dome towards south [2].

Generally the geomorphologic types around the lake are as follows [8]:

Lowlands: With high humidity created because of the lake withdrawal or because of heavy rains in the parts near the lake.

Gravelly piedmont deposits: Usually in the end of fan lands and with medium depth soil.

Highly denudated bed rocks: Formed of different parts according to the corrosion rate and superficial soil depth. The regional climatic condition is the same so it is possible to relate directly the corrosion to the materials.

Colluvial fans: Made of cones beside each other with variable moderate to great slopes and there are usually gravel and rubble stones on them.

Piedmont deposits: They are in the middle of the plain with low slope and approximately smooth and deep soil of tiny texture used for agriculture.

3.9 Hydrogeology

The Salt lake water mean is as follows [2]:

Input water: Generally there is water flowing from eastern, northern and southern heights and the underground flows are 18 million m^3 per year according to Darcy relationship.

Output water: The output water in towards Salt lake; some underground water enters into the lake yearly and it is 3.3 million m^3 per year according to Darcy relationship.

Plain aquifer feeding: The plain water supply is only from the floodways from surrounding heights in east to west direction towards Salt Lake. The water permeability becomes less when we go towards the center and around the lake in a way that a large part of the plain to the lake the water is superficial and evaporated and that is why there are marshes. Generally the aquifer receives water in three forms as follows:

By the rainfalls: The mean rainfall is about 300 mm creating 150 million m^3 water and considering five percent coefficient the rainfall permeability is 13 million m^3.

By the floodways: The floodway of Nazarabad, Sarvestan is 100 km^2, begins from the east and southeast 2,500 m heights, pass through Sarveatan plain and joins Salt lake in south, but we do not know the rate because there is no bureau there to measure the floods.

The returned water from agriculture: Some underground water from different resources to be used for agriculture is penetrated again into the aquifer and considering the soil texture, the type of the plants and agricultural and irrigation method was 15% of total water used in the farms including Sarvestan and Salt lake namely 4.5 million m^3 in 1971 became twice because of benefiting from the underground water namely 9 million m^3.

Drainage: It may be 3 million m^3; as we told before it includes Salt lake region, too.

Evaporation from the aquifer: Considering the basin is in arid and semi-arid region the water is evaporated in the parts near the earth level and the evaporation rate is different because of the type of the self-growing field plants; the regional rate is estimated about 3.5 million m^3 per year.

Benefiting from the yield: It includes:

Benefiting from the wells: By virtue of the 1983 statistics there were 362 deep and semi-deep wells in the region with 40 million m^3 yields per year.

Benefiting from aqueduct: By virtue of the last statistics there were twenty aqueducts in the region with 10 million m^3 yield per year.

Benefiting from the springs: By virtue of the 1983 statistics there were eight springs in the region with about 9 million m^3 yield per year.

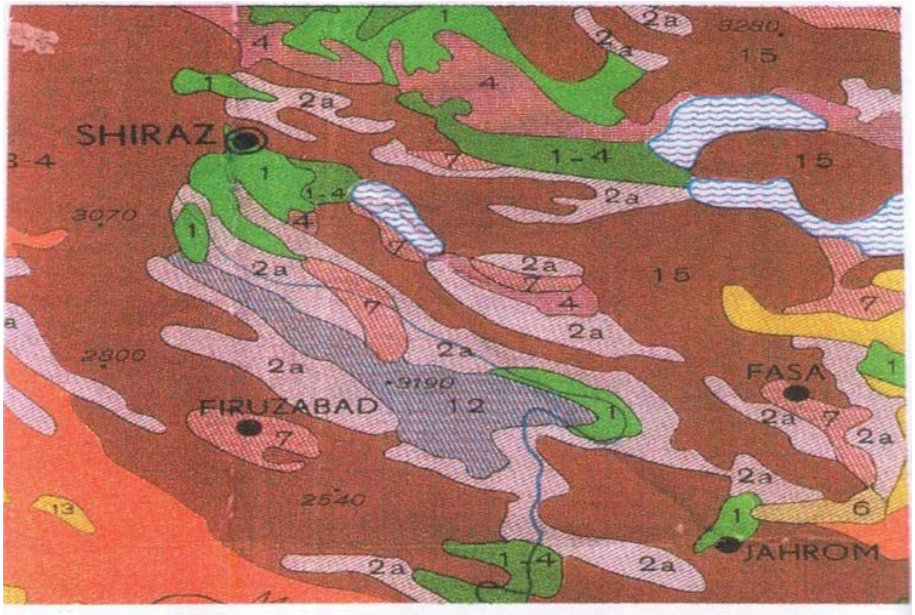
Changes of the reservoir capacity: Generally the underground water usage is more than the supply in Sarvestan basin and that is why the reservoir decreases.

3.10 Pedology and the lands potential

The regional soils are mostly sediments due to the lake withdrawal covered under the alluvial sediments from the surrounding mountains' water [8]. Generally by virtue of the Figure 2 it is possible to divide the lake surroundings as follows [9]:

Saline alluvial soils with code 1-4

They were seen in northwest of the lake in length of 7.5 km along it; the superficial soil usually changes from



1-4: Saline alluvial soils; 7: Brown soils; 4: Solonchak and Solonetz soils; 15: Calcareaus lithosols soils

Figure 2. Regional soils map [9].

silty to clay loam and silty clay and the underground soil has usually a stratum of very silty clay. The drainage is weak and permeability is low or very low.

Brown soils with code 7

The west brown side of the lake is equal to 25 km under it there is a calcareous layer with one percent organic materials; these soils had evolved under grassy plants' influence in semi-arid climate and sustained intense dryness in Summer; they have usually moderate to heavy tissue in a way that the deeper tissues are heavier. The natural drainage of the soils is medium to good made of old alluvial sediments; they are usually used as pasture , but it is possible to farm dryly wheat and barley in low slope lands with yearly product from medium to good. Fruit trees, beet, cotton, vegetables and wheat are cultivated in irrigated farming form in these regions, too. It is possible to cultivate wheat and barley in these lands. Also it is possible to cultivate cotton and beet when there is water enough for farming.

If the underground water is not saline, it is possible to use it for irrigation by pumping which is an effective method for drainage and reforming the soils completely and when the underground water is saline the drainage network may be effective to lower its level. Some of these soils are pasture or lying fallow.

Solonchak and Solonetz soils with code 4

It includes 2.7 kilometers of the south coast of the lake and it is permanently or alternatively exposed to humidity and is visible in low and plane regions. The internal drainage is little to very little and the natural drainage is weak. Such soils have been created because of sediments. The underground water level of the soils is very high and is even in the level of earth and it remains under water for days and weeks during the floods.

Calcareous lithosols soils with code 15

It includes 31.4 km of the west coast and generally is visible in the west of the lake. Such soils develop and evolve little because most of them have been transferred to other places because of corrosion and only the underground part is remained and the lands have slopes and some parts with deep and appropriate soil are useful for dry farming; such deep parts are brown or are as a strip of alluvial soils; a thin layer of soil is visible in such parts. They have an intense outer drainage and their internal drainage is medium to good; they are often of calcareous stone or other stones with lime. They are not good for farming and are used only for grazing notwithstanding their low capacity for it; it can be said that they are influenced highly by grazing.

The findings concerning the tests conducted on different regional genera are as follows (Table 1):

In type No. 1: The soil texture is clay loam, alkali reaction of the soil is poor (pH=7.8), electrical conductivity is less than 0.5 decisiemens/m and saturation percent 61.

In type No. 2: The soil texture is silty clay loam, alkali reaction of the soil is poor (pH=7.9), electrical conductivity is about 0.5 decisiemens/m and saturation percent 62.

In type No. 3: The soil texture is silty clay, alkali reaction of the soil is poor (pH=7.9), electrical conductivity is less than 0.5 decisimens/m and saturation percent 62.

In type No. 4: The soil texture is silty clay, alkali reaction of the soil is poor (pH=8.1), electrical conductivity is more than 0.5 decisimens/m and saturation percent 64.

In type No. 5: The soil texture is silty loam, alkali reaction of the soil is poor (pH=8.4), electrical conductivity is more than 0.5 decisimens/m and saturation percent 58.

3.11 Vegetation

By virtue of the studies done in the region are about five types as follows:

Plant type 1 (*Artemisia sieberi*)

The prominent type is *Artemisia sieberi* from Compositeae with several year life, grassy form and palatability II.

Some of the genera accompanying this type are:

Table 1. The lab results of soil samples in each vegetation types.

	Type Number	1			2			3			4			5		
First depth (0-50) cm	Transect nomber	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	Texture	Cl	Cl	Cl	Scl	Scl	Scl	Sc	Sc	Sc	Sc	Sc	Sc	Sl	Sl	Sl
	pH	7/86	7/82	7/85	7/91	7/88	7/88	7/99	7/96	7/95	8/16	8/18	8/19	8/41	8/44	8/41
	EC	0/37	0/34	0/35	0/52	0/52	0/50	0/35	0/34	0/36	0/62	0/62	0/61	0/65	0/67	0/66
	SP	61	62	61	62	61	63	62	63	62	64	62	63	58	57	58
Second depth (50-100) cm	Texture	Cl	Cl	Cl	Scl	Scl	Scl	Sc	Sc	Sc	Sc	Sc	Sc	Sc	Sc	Sc
	pH	7/86	7/82	7/86	7/94	7/85	7/86	7/97	7/95	7/94	8/18	8/17	8/18	8/42	8/41	8/42
	EC	0/37	0/35	0/35	0/51	0/5	0/51	0/35	0/35	0/36	0/62	0/62	0/62	0/65	0/65	0/66
	SP	61	61	60	61	60	62	61	63	62	64	63	62	59	57	57

Stipa barbata from Gramineae family with palatability III.

Astragalus arbusculinus from Leguminosae family with palatability III.

Echinops robustus from Compositeae family with palatability III.

Amygdalus scoparia from Rosaceae family with palatability III.

Ficus johannis is only in the first parts of the rocks; there is no farming and tree planting there often because of inappropriate slope immediately after the Lake Coast and ends to the rocks and precipices. Such type is 1.9 km of the west coast namely it is 8.5% of total west coast. The type condition is fair and its trend is upward. The fair slope of the type is about 31% in the mountain slopes.

Plant type 2 (*Astragalus arbusculinus-Eryngium bungei-Echinops robustus*)

The prominent genera of the type are as follows: *Astragalus arbusculinus* from Leguminosae family of several year ages in shrub form with palatability III.

Then is *Eryngium bungei* from umbelliferae family of several year ages in grass form with palatability III.

Also *Echinops robustus* from Compositeae family in grass form with palatability III and age of several years.

Of the genera accompanying it: *Artemisia sieberi* from Compositeae with palatability III.

Like *Ficus johannis* it is only in the first parts of the rocks. Sometimes there is *Amygdalus scoparia* in upper slopes. Farming and planting trees are not in the type because of intense slope and like the previous one it begins from the lake coast and ends to the rocks and precipices; it includes 5.1 km of the west coast namely 22.8% of total west coast. The type condition is fair and its trend is upward. The mean slope of the type is about 27% in the mountain slopes

Plant type 3 (*Echinops robustus-Astragalus arbusculinus*)

Echinops robustus from Compositeae family with grassy form and palatability III of several year ages.

Astragalus arbusculinus from Leguminosae family with shrubby form and palatability III of several year ages.

Of the accompanying genera is *Eryngium bungei* from umbelliferae family with palatability III.

Ficus johannis is only in the first parts of the rocks. Sometimes there is *Amygdalus scoparia* in upper slopes. Farming and planting trees are not possible in the type. It includes 3.8 km of west coast of the lake namely 17% of total west coast. The type condition is fair and the trend is upward. The fair slope of the type is about 15% in the mountain slopes

Plant type 4 (*Juncus* sp.)

The prominent genus of the type is *Juncus sp.* From Juncaceae family with grassy form and palatability II of several year age and its local title is 'Khong'. Of the accompanying genera is *Taraxacum seratinum* from Compositeae family with palatability I. In phonologic view there is a short time between the flowering and seeding in a way that it is possible to see it in both flowering with yellow flower and seeding like dandelion for a while. This type has most cover than others.

Its medium slope is about two percent created good condition for farming and planting trees. The most important gardens of the region are here as follows: almond, fig, pomegranate, citrus trees and pistachio. Some farming is seen in this type namely wheat and barley are the most important and then cotton, sunflower, cantaloupe and vegetables (Such as cucumber, squash, tomato and eggplant are planted. The farming lands have developed according to the regulations of Natural Resources Department from the mountain slopes to the lake coast. There are not mountainous fig and almond in this type because of little slope. This type includes 8.2% of total west coast namely 36.7% of the total coast. The type condition is good and the trend is upward.

Plant type 5 (*Astragalus arbusculinus*)

The prominent genus of this type is *Astragalus arbusculinus* from Leguminosae family with shrubby form and palatability III of several year ages.

Of accompanying genera *Echinops robustus* is from Compositeae family with palatability III and *Poa bulbosa* from Gramineae family with palatability III, *Atriplex leucoclada* from Chenopodiaceae family with palatability II and *Cressa cretica* genus from Convolvulaceae with palatability III; the *Poa bulbosa* genus is too much in fallow region far from the lake coast and *Cressa cretica* is seen a little in the fallow region near the lake. The mean slope of the region is about zero and water is visible on the earth and some special plants with high resistance in high humidity are visible. When we go up there are vast farming lands of wheat, sunflower, cotton, cantaloupe and vegetables to the region border. This type includes 3.3% of total west coast namely 14% of the total coast. The type condition is poor and the trend is upward (Tables 2-4).

4. Discussion

Generally the regional soils were examined and studies into five groups and they were from clay loam to silty clay with potential keeping humidity into them so the plants never suffer from lack of humidity. pH of all types are weak sodic. The regional soils electrical

Table 2. General information about vegetation types.

Type Number	The Dominant Species	The length on the West Coast for each Type(Kilometer)	Condition	Trend
1	*Artemisia sieberri*	1/9	Fair	Upward
2	*Astragalus arbusculinus – Eryngium bungei – Echinops robustus*	5/1	Fair	Upward
3	*Echinops robustus – Astragalus arbusculinus*	3/8	Fair	Upward
4	*Juncus sp*	8/2	Good	Upward
5	*Astragalus arbusculinus*	3/3	Poor	Upward

Table 3. General information about plant species of vegetation types.

No.	Species name	Family name	Plant life	Growth habit	Palatability
1	*Artemisia sieberi*	Compositeae	Perennial	Grass	∏
2	*Stipa barbata*	Gramineae	Perennial	Grass	III
3	*Astragalus arbusculinus*	Leguminosae	Perennial	Shrub	III
4	*Echinops robustus*	Compositeae	Perennial	Grass	III
5	*Amygdalus scoparia*	Rosaceae	Perennial	Bushy Tree	III
6	*Eryngium bungei*	Umbelliferae	Perennial	Grass	III
7	*Poa bulbosa*	Gramineae	Perennial	Grass	III
8	*Atriplex leucoclada*	Chenopodiaceae	Perennial	Grass	∏
9	*Juncus* sp.	Juncaceae	Perennial	Grass	∏
10	*Cressa cretica*	Convolvulaceae	Perennial	Shrub	III
11	*Taraxacum seratinum*	Compositeae	Perennial	Grass	I
12	*Ficus johannis*	Moraceae	Perennial	Tree	III

Table 4. Water table depth changes in each vegetation type.

Changes in Water Table Depth (HW) (m)	Type Number
Hw>14	1
Hw>14	2
Hw>14	3
7<Hw<15	4
0<Hw<14	5

conductivity is less than 1 decisiemens/m everywhere. The saturation percentage of all regional soils is 58-64. Generally considering the soil parameters changes in regional types and little changes of the vegetation in the types it may conclude that the soil parameters have not considerable effect.

On the other hand, the water table depth study indicated that there are little slope and zero only in two regional types and other lands have considerable slopes so the water table depth effect is visible on the regional vegetation specially it is considerable in the fifth type where the underground water level beside the lake is zero.

The regional slope was considerable in the first three types and was moderate and little in the two last ones.

The vegetation was examined in five types and the most cover belongs to *Juncus* sp. in fourth type. The least one is in the fifth type. The most species which has more dispersion is *Astragalus arbusculinus* prominent in three types and as accompanying species in one type. On the other hand, the least regional species in first step is *Cressa cretica* seen very few in fallow farming lands of fifth type not far from the lake. Only *Taraxacum seratinum* has the palatability I, of course, as it was said it is very few in fourth type and other types' palatability is II and III.

Most of the regional species have grassy form and all of them are permanent.

The regional types' conditions are poor-good and only the fourth type has good condition and the fifth one has poor condition and others have fair condition.

All regional types' trend is upward.

According to information obtained from the study of vegetation and soil and water table depth as well as data obtained from studies of the parameters of the climate, geology, geomorphology and hydrogeology, the following spices are introduced to reclamation of the vegetation of the region:

Agropyron aucheri–Agropyron elongatum–Bromus tomentellus–Secale montanum-Stipa barbata–Kochia prostrata–Artemisia sieberi–Salsola rigida-Cenchrus ciliaris–Eurotia ceratoides–Atriplex leucoclada–Juncus sp.

For the purpose of reclamation of the vegetation, however, some of the data should be preferred than other ones. For example, if the aim of reclamation of vegetation is improving animal feeding, so palatability parameter should also be noted here that are suitable for the following species:

Kochia prostrata–Atriplex leucoclada–Agropyron aucheri–Bromus tomentellus-Artemisia sieberi–Salsola rigida–Erotia ceratoides–Juncus sp.

If the purpose of reclamation of the vegetation is soil and water conservation that are suitable for the following species:

Kochia prostrata–Stipa barbata–Artemisia sieberi–Eurotia ceratoides

If the purpose of reclamation of the vegetation is soil and water conservation as well as animal feeding, following species can be used in the rangeland:

Artemisia sieberi–Eurotia ceratoides–Kochia prostrata

Of course, other important factors should also be considered such as type of cultivation. In these rangelands, all types have upward trend, and yet there are desirable rangeland species in composition of vegetation and meanwhile, complete cultivation may cause the loss of some of the vegetation and erosion; so the interseeding method is recommended which is also applicable to 25% slope [10]. Thus, this cultivation method is applicable in the most of regions of these rangelands.

Another point is that due to the fact that plant communities cannot be artificially created in a region, since a plant community is the reactions of all the factors such as edaphic, climatic, ecological, geomorphological and on the vegetation [11].

5. Conclusion

Therefore, should be careful in selecting appropriate species to reclamation of vegetation so the selected species are not causing ecological imbalance in the region. Hence, the selected species should be somehow present in the rangeland vegetation to reclamation of vegetation.

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