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# A study of salinity variation (EC & SAR) in agricultural lands, Kermanshah province

M. Jafari[a*], M. Souri[b], H. Azarnivand[c], M. Makhdom[a], V. Etemad[c], M. Aghayi[d]

[a] *Professor, Faculty of Natural Resources, University of Tehran, Iran*
[b] *Ph.D. Student of Range Management, Faculty of Natural Resources, University of Tehran, Iran*
[c] *Assistant Proessor, Faculty of Natural Resources, University of Tehran, Iran*
[d] *Chief, Jihad Agriculture Dpt., Kermanshah Province, Iran*

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**Abstract**

Soil salinity is one of the problems threatening agricultural lands. Parts of this phenomenon are related to geologic formations and saltpans, while some major factors are resulted from irrelevant agricultural activities, issue of irrigation, and improper cultivation systems which lead to increase in soil salinity. To avoid such consequences that would end up with ecosystem degradation, suitable management of these lands is indispensable. A research was conducted in agricultural lands as well as in rangelands of Kermanshah province (in split plots with three replications) to analyze EC and SAR in the different layers of soil. The results indicated that there are significant differences among the treatments. Duncan analysis showed that the highest EC and SAR are related to deeper layers of soils in steep slope rainfed lands of Paveh, not suitably treated, while from more the top soils of gentle slope rainfed lands of Kermanshah benefit suitable treatment and management.

*Keywords:* Electrical Conductivity (EC); Sodium Adsorption Ration (SAR); Agricultural lands; Split plots; Topsoil; Subsoil

## 1. Introduction

Attending to soil salinity issue, considered from different facets, is of high recommendation. Destruction of some ancient civilizations such as Mecedonian was actually accompanied with saline becoming of irrigated lands. Also, nowadays, soil salinity is one of the most important elements that restrict crop cultivation, so that about fifty percent of irrigated lands in the world suffer from this problem (Demaria et al., 1999). A well estimation and understanding of soil salinity can be assessed through electric conductivity because on the one hand it is significant to examine plants in the damp zones of an area, and on the other hand it is evident that the effect of variations in various ions of salts are reflected in the electric conductivity. Soil salinity has always been a source of trouble for agricultural activities for man through out history. Agricultural performances can either directly cause soil salinity or indirectly, and because of some natural causes, which keep on doing a weak reclamining process. Soil salinity through the interference of incorrect agricultural practices will eventually end up in the form of a critical problem (Jafari, M. 2000). Therefore, it is quite essential to regularly and consistently inspect soil salinity in various susceptible areas. Undoubtedly, it should not be imagined that soil salinity is a problem in places where it is already prevailent and abundant. It should be taken into consideration that any kind of performance which adds to soil salinity is a step

* Corresponding author. Tel.: +98 261 2223044;
fax: +98 261 2239313
E-mail address: jafary@ut.ac.ir

towards gradually destroying land and making it barren. Thus, factors determining their variation and processes should precisely be evaluated and analyzed. Kuda and his colleagues, in their studies, have summed up the major paths of salts entering into soil as follows:

1- The increase of salts in underground water due to intense evaporation.

2- Entrance of salts through irrigation water in irrigated lands.

3- Entrance of salts into soil through precipitations (Demaria et al., 1999). Balantin (1979) believes that the main and significant cause of increasing salts in soil in Saskachewan lands is underground water, topography, or ascent and descent pattern of soil in a region.

Asadian (1989) studied Asadabad plain in Hamedan province, and concluded that the main reason for salinity and alkalinity of agricultural lands is the poor quality of irrigation and the weak drainage system of irrigated lands (Amiri, B. 2003). Jamshidi (1999) studied the agricultural influence on making lands barren with due attention to region, soil, and water conditions. He pointed out that the paucity of surface water underground water being saline, alkalinity and salinity of soil, the scarcity of land suitable for cultivation, and a lack of farmers' awareness, have led to the destruction of lands. (Jamshidi, A. 1999)

Torabi (2002) studied Moghan plain and announced the main reason for salinity of agricultural lands as improper land preparation, incorrect methods of irrigation, leaving lands abandoned, and unsuitable cultivation.

Sohrabi (2004) studied a region in Taleghan and came to the conclusion that among treated lands, graized lands are in a better and more quality condition in comparison with the others as indicated by the two factors of: EC and SAR.

## 2. Materials and Methods

### *2.1. Kermanshah City*

Kermanshah city with an area of 5282.6 kilometer square kilometers is located on the eastern side of the province. It is located between 33° 37′ - 34° 45′ N, and 46° 37′ - 47° 22′ E. The altitude of the region is 1420 meters above sea level. The average annual temperature of the region is approximately 14.2 °C. The hottest month of the year is August, with an approximate temperature of 27.6 °C, and the coldest month February, with an approximate temperature of 2.2 °C. The annual rainfall is 450.9 millimeters.

The soil type in the region is vertisol, (Makhdoom, M. 1998). In terms of geology, the region is principally composed of Shahbazan, Asmari formations.

By studying the plant coverage map of the province, it has become evident that the dominant plant types of the studied region are: *Amygdalus orientalis*, *Festuca ovina*, *Astragalus sp*. Besides these dominant types, other kinds can be observed more or less scattered in various parts of the region. The followings can be mentioned among them: *Agropyron trichophorum, Stipa barbata, Hordum bulbosum*.

According to ambrothermic graph of Kermanshah, the number of dry months of the year is five.

### *2.2. Paveh County*

Paveh, with an area of 1260 square kilometers, is located on the northwestern side of kermanshah province. This region is located between 34° 47′-35° 17′ N, and 45° 51′-46° 33′ E. The altitude of the region from sea level is 1540 meters.

The average annual temperature of the region is reported to be about 14.9°C. The hottest month of the year is August, with an approximate temperature of 29.4°C, and the coldest January, with an approximate temperature of 1.28 °C. The annual rainfall is about 56.7 millimeters. The dominant soils of the region is Lithosol (Makhdoom, M. 1998). Geologically speaking, the region is mainly composed of Bakhterian formation. A study of the plant cover map of the province indicates the dominant types of plants belonging to: *Prangos ferulacea*, *Bromus tomentellus*, and *Hordeum bulbousm.* Apart from these dominant types, other kinds of plants can frequently be seen scattered in various parts, from among which the following can be highlighted: *Daphne mucronata*, *Cerasus microcarpa*, and *Salsola rigida*. Ambrothermic graph of paveh, shows the number of dry months as five.

### *2.3. Javanrood County*

This county, with an area of approximately 2624.1 square kilometers, is located on the northwestern side of Kermanshah. This region is placed between 34° 33′ - 34° 46′ N and 45° 46′ - 46° 50′ E. The altitude of the region above sea level is 1280 meters. It has been reported that the average annual temperature of the region is 14.9 °C. The hottest month of the year is July, with an approximate temperature of 29.6

°C and the coldest February with an approximate temperature of 2 °C.

The annual rainfall is 537.4 reported to be 537.4 millimeters.

The dominant soil of the region is of Regosol type (Makhdoom, M. 1998). From the view point of geology, this region is primarily composed of Gurpi formations. Having studied the plant coverage map of the province, it has become clear that the dominant plant types in this region belong to *Stipa barbata, Poa bulbusa*,and *Astragalus hohenacheri*. Apart from these domineering types, some other plants can more or less be observed dispersed in various places, some of which can be mentioned as: *Noaea mucronata, Atriplex leucoclada*,and *Prosopis farcta*. It is to be mentioned that the current utility of lands in these studied regions is as indicated on land resources, and land use maps of these areas. They include agricultural lands, forested lands, pastures, inhabitable lands, and left out non-irrigated lands. Among these, most sections are particularly dedicated to agriculture, especially dry land farming, water for which is supplied through rainfall (Souri, M. 2005).

Considering the ambrothermic chart of Ravansar, the number of dry months during a year is five.

### *2.4. Research Procedure*

In order to analyze the variations in the considered factors in Kermanshah province, the research was carried out in four steps.

The first step included the collection of available data and statistical information in the region concerning soil, as well as providing the basic maps of the region and eventually choosing an appropriate statistical design. These were gathered for three depths of: 0-30, 30-60, and 60-90 because it was needed to clarify the variations in different layers of soil. This research was carried out in the form of split split plots, and based on completely randomized blocks.

The second step consisted of field operations, and soil sample takings. The sampled region was identified on the available pedological map and transferred to topographical map of the region by using numerical desk and the software programs of: Arc-info, and Idrisi.

The samples were taken from three regions of: high non-irrigated lands gently sloping non-irrigated lands, as well as from pastured lands.

The third step also included experimenting the gathered samples to identify the chosen parameters, which was meticulously done.

Finally the diverse variations in variously considered treatments were statistically analzed, using software Mstatc in the signified format.

## 3. Results

The overall results of the research are presented in three stages as follows:

1- A determination of the normality of the various inputs concerning the investigated variations

2- Analysis of variance to determines the difference or lack of differences among treatments.

3- A comparison of means, based on Duncan comparative test.

### *3.1. Determination of the Normality of Data*

After sampling soil from various treatments, as mentioned and experimented, the amounts of the chosen factors were evaluated in the three levels of: 0-30, 30-60, 60-90.

For statistical analysis, Mstatc Software was used, and then the normality test of Kolmogorov-Smirnov-Ryan joiner with the help of the data, was preformed on the surface, middle, and bottom levels. The conclusion taken from the normality test indicates that all factors on the three regions have symmetrical variance and the data are normal.

Table 1. The overall data relating to variances

| Variant | Average | Variance | Deviation from criterion |
|---|---|---|---|
| EC | 1.23 | 0.0069 | 0.083 |
| SAR | 0.11 | 0.017 | 0.013 |

-Analysis of the data for determining the difference or lack of differences in treatments

-The most significant functions of agricultural lands:

Non-irrigated lands of steep slopes, gently sloped non-irrigated lands, and pastures, regarding agricultural treatments were investigated in three regions and in three depths (81 samples for each factor).

A sketch of split split plots was applied to the data with the extracted conclusions examined. They are introduced for the chosen variances as follows:

A comparison of the treatments to determine the difference or lack of differences indicated that there were huge differences observed among various regions, agricultural treatments, as well as among different layers of soil.

Table 2. Analysis of variance for Electrical Conductivity

| Variation Source | Degree of Freedom | Sum of squares | Mean squares | F | Pr>F |
|---|---|---|---|---|---|
| Replication R | 2 | 0.0034 | 0.0016 | 1.47 | 0.2430 |
| Factor A (Soil layer) | 2 | 0.3043 | 0.1521 | ** 129.87 | 0.0001 |
| Error A | 4 | 0.0010 | 0.0002 | | |
| Main plots | 8 | | | | |
| Factor B (Agricultural Treatments) | 2 | 0.0093 | 0.0046 | * 3.99 | 0.272 |
| Mutual effect (AB) | 4 | 0.0042 | 0.0010 | 0.91 | 0.4713 |
| Error B | 12 | 0.0120 | 0.0010 | | |
| Minor plots | 18 | | | | |
| Factor C (Region) | 2 | 0.0391 | 0.0195 | ** 16.69 | 0.0001 |
| Mutual Effect (AC) | 4 | 0.0664 | 0.0166 | 14.18 | 0.0001 |
| Mutual Effect (BC) | 4 | 0.0277 | 0.0069 | 5.93 | 0.0009 |
| Mutual Effect (ABC) | 8 | 0.0065 | 0.0008 | 0.70 | 0.6908 |
| Error C | 36 | 0.0421 | 0.0011 | | |
| Complete Minor plots | 54 | | | | |
| Total | 80 | 0.5164 | | | |

** Vast Differences Observed Among Treatments (P<0.01)
* Differences Observed Among Treatments (P<0.05)

Table 3. Analysis of variance for SAR

| Variation Source | Degree of Freedom | Sum of squares | Mean squares | F | Pr>F |
|---|---|---|---|---|---|
| Replication R | 2 | 0.0001 | 0.0009 | 0.39 | 0.6775 |
| Factor A (Soil layer) | 2 | 1.4088 | 0.7044 | ** 30.89 | 0.0001 |
| Error A | 4 | 0.0005 | 0.0001 | | |
| Main plots | 8 | | | | |
| Factor B (Agricultural Treatments) | 2 | 0.0009 | 0.0004 | 2.04 | 0.1444 |
| Mutual Effect (AB) | 4 | 0.0041 | 0.0010 | 4.58 | 0.0043 |
| Error B | 12 | 0.0037 | 0.0003 | | |
| Minor plots | 18 | | | | |
| Factor C (Region) | 2 | 0.0383 | 0.0191 | ** 83.68 | 0.0001 |
| Mutual Effect (AC) | 4 | 0.0054 | 0.0013 | 5.97 | 0.0009 |
| Mutual Effect (BC) | 4 | 0.0039 | 0.0009 | 4.36 | 0.0056 |
| Significant Effect (ABC) | 8 | 0.0038 | 0.0004 | 2.09 | 0.0625 |
| Error C | 36 | 0.0082 | 0.0002 | | |
| Complete Minor plots | 54 | | | | |
| Total | 80 | 1.4782 | | | |

** Vast Differences Observed Among Treatments (P<0.01)
* Vast Differences Observed Among Treatments (P<0.05)

Table 4. Probability of differences among various regions

| Factor | EC | SAR |
|---|---|---|
| Probability | 0.99 | 0.99 |

Table 5. Probability of differences among various agricultural treatments

| Factor | EC | SAR |
|---|---|---|
| Probability | 0.95 | --- |

Table 6. Probability of differences among various layers of soil

| Factor | EC | SAR |
|---|---|---|
| Probability | 0.99 | 0.99 |

### *3.2. Comparing the Treatments Means Based upon Comparative Duncan Test*

Following statistical inspection and analysis of variance of the data, for an indication of the available differences among treatments, it should be clarified which treatment has an obvious difference as compared with others. Therefore, for a comparison of treatments, the comparative test of Duncan was employed and the results shown in the following figures.

### *3.3. Salinity*

Having inspected the data on salinity in various treatments and their replications, the average figure for each treatment has been extracted, inserted and then compared. Figures 1-3.

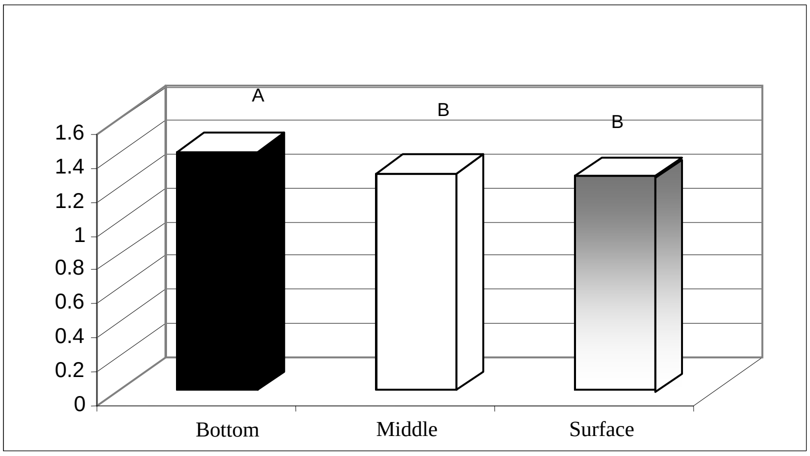


Fig. 1. Average salinity of various layers

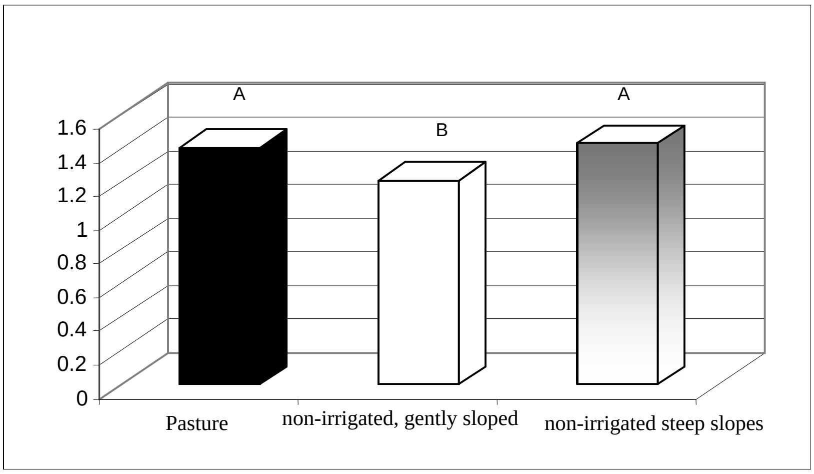


Fig. 2. Average salinity of various agricultural treatments

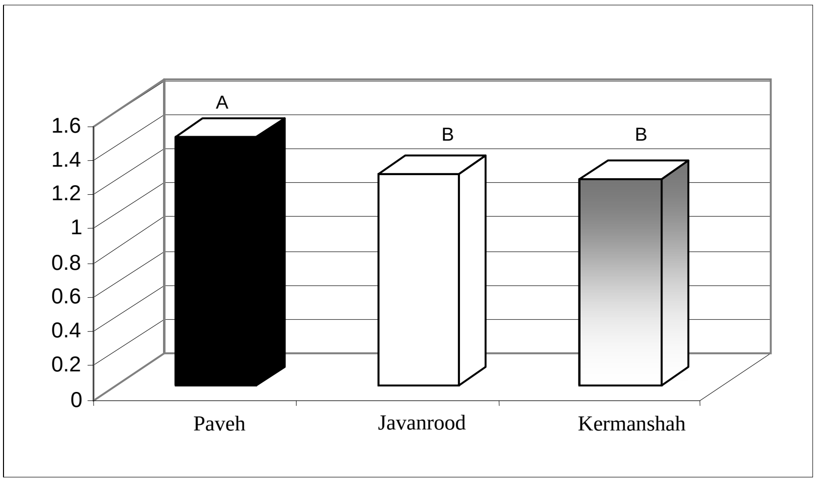


Fig.3. Average salinity of various regions

Having considered the degree of salinity in various treatments with an application of Duncan test, it has been clarified that there are vast differences existing among various regions. It has been figured out that Paveh soils have the highest Electrical conductivity while Kermanshah the lowest. Besides, there are various variations existing among different agricultural treatments.

Maximum EC belongs to highly steep lands and the minimum to gently sloped lands. Among various layers of soil, some differences can obviously be detected. The bottom layer has the most and the surface layer least amount of EC.

*3.4. Sodium Absorption Ratio (SAR)*

By examining the figures 4-6 which are connected with SAR, it is indicated that there are not a lot of significant differences observed among agricultural lands. However, in these regions and in their various layers of soil, some great differences can be seen. The highest SAR is observed in Paveh region while the lowest in Kermanshah. Furthermore, among layers of soil, the bottom soil has the maximum SAR, while the surface soil the minimum.

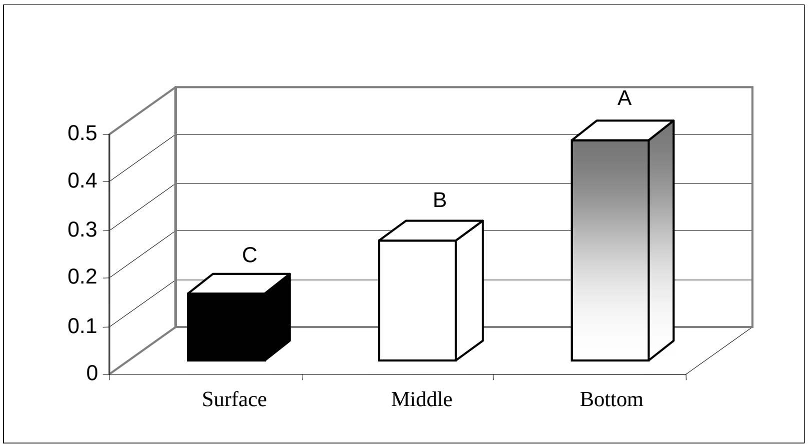


Fig. 4. Mean of Sodium Absorption Ratio in Various Soil Layers

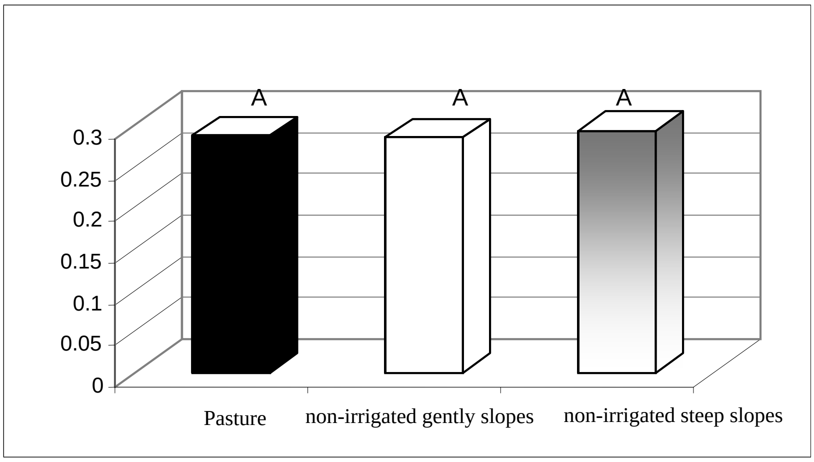


Fig. 5. Mean of Sodium Absorption Ratio in Various Treatments

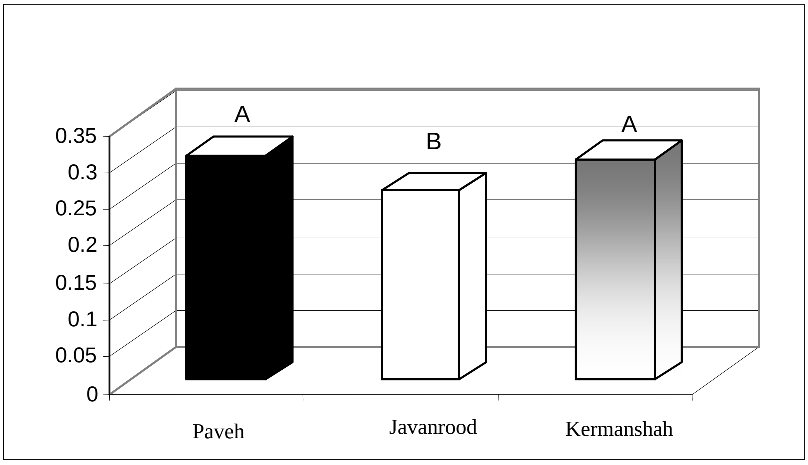


Fig. 6. Mean of Sodium Absorption Ratio in Various Regions

## 4. Conclusions

Further investigation of the initial data indicates that the soil of the region, with the concluded classification, can be categorized as non-saline considering EC and sodium absorption ratio factors, so there does not exist any problem from this point of view.

Nevertheless, among the chosen treatments, the treatment in which these factors are lower than the others is an ideal case, and the treatment in which these factors exceed those of the others can be considered as non-ideal.

Such a conclusion will make one familiar with the treatments that are on the threshold of being salinized and abandoned in the near future. It should be taken into consideration that the treatment of pastures is the main indicator, and the other treatments, with their functions in soil, should be evaluated in comparison with them. However, it does not mean that the treatment of the proved and evidenced as proper land should be considered as permanently ideal. Even that proved ideal land should be constantly examined in order to understand its condition as compared with other suitable treatments (cases).

With the afore-mentioned inspection for each chosen treatment concerned with variances, it can be comprehended that they absolutely influence soil destruction, reformation, and cultivation. Chart 7 indicates perfect (ideal) and imperfect (non-ideal) treatments for each variance.

Table 7: Regions, treatments and their perfect (ideal) and imperfect (non-ideal) layers

| No. | Factor | Perfect Region | Perfect (ideal) Treatment | Perfect (ideal) Layer | Imperfect (non-ideal) region | Imperfect (non-ideal) Treatment | Imperfect (non-ideal) Layer |
|---|---|---|---|---|---|---|---|
| 1 | EC | Kermanshah | non-irrigated gently sloped | surface layer | Paveh | Non-irrigated steep slopes | bottom layer |
| 2 | SAR | Kermanshah | non-irrigated gently sloped | surface layer | Paveh | Non-irrigated steep slopes | bottom layer |

With respect to the examination and determination of perfect and imperfect treatments for each factor, it can be concluded that the treatment of non-irrigated gently sloping lands of Kermanshah province, in comparison with the other cases (treatments) is in a more suitable condition. Also, the amount of their examined factors is less than those in the others, but in contrast with the treatment of non-irrigated steep sloping lands of Paveh country, SAR and EC show higher figures. The studied regions were particularly alfalfa fields in which SAR and EC in each depth are of the maximum amount, so the danger of being salinized for these lands, in this zone is higher than in the other treatments. Polinko (1986) believes that incorrect agricultural activities make soil saline and such activities are the main cause of soil degradation and destruction.

It is recommended to have such studies in various other regions so that suitable agricultural activities can be categorized and recommended. By such recognitions it would be possible to prevent soil degradation. Related to the issue, Amiri (2003) researched in Zanjan province, included SAR and EC factors, and concluded that single crop irrigated agricultural lands in Khodabandeh zone in Zanjan are non-ideal practices and lead to the destruction of the soil in the region.

Moreover, Jamshidi (1978) announced that the main reasons for land degradation and destructions were salinity and alkalinity.

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