Effect of Three Operation Systems of Contour Furrow, Pitting and Enclousure on Rangeland Improvement (Case Study: Golestan Province, Iran)

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Abstract. In order to study the effects of three operations of rangelands on the properties of vegetation in rangelands, this research was conducted in Chaat Gonbad, Golestan province, Iran in 2004. Chaat area is located in 50 km of border road of Dashlibroun to Maravetappeh in North of Attract River (border of Iran and Turkmenistan). The Altitude is 70 m, annual rainfall is 170 mm and annual temperature is 8.16°C. Most of rains fall in spring. In this study, four operation systems including contour furrow, pitting, enclosures and control area (without any operations) were conducted. Samples of vegetation factors were done randomly in 20 plots of $1m^2$. Data were collected for the forage production, vegetation cover% and canopy height. Data were subjected to analyses of variance and comparisons were made using Duncan method. The results showed significant differences among four operation systems for all traits ($P<0.01$). The results showed that contour furrow had more efficiency for plant characteristics compared to other operation systems.

Key words: Vegetation, Reform the operation, Rangeland, Golestan province.

Introduction

Rangelands not only had important role in forage production, but also had some benefits as soil conservation, increased permeability, ground water supply, preventing the filling of dams, increasing reservoirs and reducing flood damage, producing oxygen, protecting plants and animal species. Therefore, it is essential to apply appropriate management for the preservation and proper utilization of this valuable resource of rangelands. In the management of rangelands, the vegetation elements, environmental factors, livestock. Moreover, the farmers' role should be considered as a decision making agent. In utilizing of rangeland in a case of ecosystem, there is no balance between production and utilization rates, and vegetation is gradually changed and eventually disappears. In this case, the rangeland improvement programs are essential. Based on vegetation situation and the area condition, one of the improvement methods can be selected (Azarnivand, 2009). One of operations systems for saving more rainfall in the soil of rangeland is making many holes in the soil surface for storage of rains in the holes, penetrate rain into the soil and prevent the flow of surface water (Bainbridge, 1997). Pitting operations are performed in a wide range of habitat and it plays an effective role in restoring and improving the surfaces and sealed and knocked soils. Pitting often takes soil moisture into the holes almost 2 times and will reduce the amount of runoff from heavy rainfall. In addition, pitting has appropriate places for the accumulation of litter and seeds are moved by wind. Forage production occasionally using such a method will be increased to 100% (Ansari, 2009). Contour furrow is the tracks or the shallow stream on the balance lines in rangelands made by agricultural instruments such as tractors and plow. The purpose of creating contour furrow is to control the surface runoffs and increase the vegetation. It is performed in areas with slopes less than 20%, medium depth and soil texture. This method is recommended in areas with rainfall from100 to 300 mm (Azarnivand and Zare Chahooki, 2008). Inclosure is a rangeland management to prevent the entering livestock for grazing with specific goals for a certain period. Rangeland inclosure is one of the most simple and effective method of restoration and improvement of rangeland, especially in rangelands that are to enhance the vegetation, seed production, soil conservation, protection and maintenance of other restoration projects and improved rangelands.

Study of vegetation and protection facilities will be done and in each case, different factors will be involved in the enclosure area. Inclosure with the aim of increasing vegetation and forage production on rangeland is performed in which there is a considerable percent of palatable species in composition of plants (Mesdaghi, 1999). Long-term inclosure in Arizona after 72 years increased the plant density and canopy cover (Deborah and Turner, 1986). Few pitting studies had been done by Bainbridge (1997) in the California desert with predominant winter rain and very dry summers. However, from limited field experience and trials, it seems that it is the most effective low cost method to recovery the degraded dry lands. Enclosure of semi steppe warm rangelands in Khouzestan province, Iran increased 40% total density of plants in the inclosure and increased the forage production 3 times compared to the control (Hoveizeh *et al*., 2006). Stanley (1978) suggested the creation of plains with synthetic bushes using the pitting method on harsh lands in Western Australia. Hessary and Gifford (1970) using contour furrow and pitting on Sagebrush plains, USA, showed that in the areas under the operation of contour furrow, annual production was increased but pitting reduced the production in clay soils. Studies in other areas of the West have found similar results. Barnes (1950) found that pitting was superior to all other treatments for improving short grass range. Soil pitting allowed 32% more sheep production per acre with a 50% increase in perennial grass left at the end of year. The effects of mechanical treatments such as contour furrowing, pitting and ripping on forage production and water storage were evaluated by Branson *et al*. (1966) in USA. From seven kinds of their evaluation method, contour furrowing at 3 to 5 foot intervals and broad base furrowing were the most effective. The greatest beneficial responses were occurred on medium to fine-textured soils. Also, their results showed that soils with medium to tiny medium texture had the most appropriate conditions for contour furrow, pitting and ripping treatments. Babakhanlou (1985) showed that vegetation cover was the best means to avoid wasting water flows from the surface. His study shows that pitting minimized the water flow in soil surface and in addition to the storage of snow in the winter, it led to the storage of about 4.5 to 15 mm of extra water in the soil. Khodagholi and Chavoshi (2002) studied the effect of pitting and contour furrow on establishing a few important species in the rangelands around Esfahan province, Iran. Their results showed that they had positive impact on plant establishment, but depending on the species type, the type of reform operation was also different. Jafari *et al*. (2009) for improving the rangelands, studied the effects of different operations system on some soil factors and vegetation. They found that reform operations had a positive effect on soil properties and vegetation of Sirjan, Iran, rangelands and increased the coverage, production and density percentage of vegetation in three classes. Habibzadeh *et al*. (2007) in the study of reform operations for the storage of moisture and increased vegetation in Khajeh station, West Azerbaijan, Iran have concluded that in the lands with heavy texture, contour furrow and pitting will led to the precipitation storage, soil conservation and improve vegetation.

The purpose of this research was to study and evaluation of the effects of aquifer management operations on quantitative changes in vegetation including forage production, canopy percentage and plant height in salty and alkaline rangelands of Gonbad Chaat, Iran.

Materials and Methods

Chaat area is located in 50 km of border road of Dashlibroun to Maravetappeh and 2 km North of Attract River (border of Iran and Turkmenistan) with the geographical coordinates are 55°40' eastern longitude and 37°57' northern latitude. Altitude of 70 m, annual rainfall of 170 mm, the average surface evaporation of 1900 mm, the minimum, maximum and average annual temperature were -1°C, 36.6°C and 16.8°C, respectively. Most of the rains fall in spring. Dry season according to the amberotermic curve (Fig. 1) is from mid-August to early December. The region slope was 2%. Land of this region has high salinity and alkalinity and weak internal and external drainage a lot of erosion. Soil of the area is silty loam to silty clay loam, yellowish brown to grayish brown with small amount of lime and gypsum spots (Karimidoost *et al*., 2003).

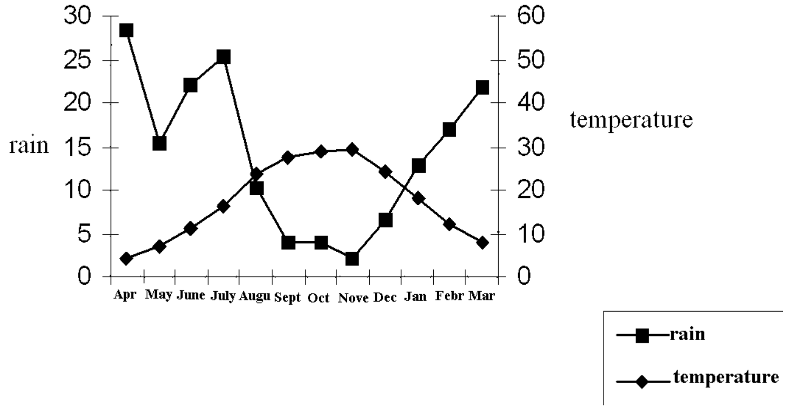

Fig. 1. Amberotermic curve of Gonbad chaat area

For this research, three types of reform operations were conducted including contour furrow, pitting, inclosure and control area (without any operations). Samples were collected randomly for vegetation factors. The size of plots, according to the vegetation structure, was $1m^2$. The number of plots was determined based on the required samples and the distribution variance of vegetation. In this research, four treatments were applied in five replications. For assessing of the vegetation percentage the canopy cover, litter, bare soil, stones and gravel% were recorded. Forage were cut, weighed and separated for perennial plants, annual plants, annual grasses and forbs. Samples were placed into separate envelopes to air dried then weight to determined forage dry matter. For species identification, one herbarium sample was taken and sent to the taxonomist. The palatability of species were classified into classes (I, II, III) based on the book code of rangeland plants (Range technical office, 1982). The height of plants within plots was measure in cm.

The pitting was done by a tractor, the holes were dig up with the length of 1 m, width of 30 cm and depth of 20 cm so that the holes occupied 10 to 20% of pasture level. The contour furrow was made by the tractor on the alignment lines and the perpendicular to the dominant slope in length of 40 to 60 meters in depth of 10 to 20 cm and width of 30 cm. After the control of normality of data, they were analyzed using SPSS software and the means of treatments were compared using Duncan's multiple range test method.

Results

In this study, four treatments (contour furrow, pitting, enclosure and control) at five replications were studied in Chaat rangelands. Results showed significant differences for all treatments ($P<0.01$) (Table 1 and Figs. 2, 3 & 4). For the biomass production, the contour furrow had higher values than the other treatments. There was no difference between pitting and enclosure for forage production. The lowest value of production was obtained for control treatment (Fig. 2). Data analysis for the vegetation cover showed a significant difference among four treatments ($P<0.01$) indicating that contour furrow had higher values for coverage percentage and the lowest value for this factor was related to the control treatment (Fig. 3). For the plant height, there were significant differences among four treatments ($P<0.01$). For plant height, contour furrow had higher values than other treatments. The lowest value for plant height was for control (Table 1 and Fig. 4). The list of plants used in the current study area is shown in Table 2 in terms of family; palatability class and growth form (Table 2). Class I is the plants that have a low speed in heavy grazing. These plants are perennial and very palatable and make up much of the composition of plant community climax. Class II refers to the plants that under heavy grazing are decreased. Class III is the plants that are rapidly increased in heavy grazing and usually are annual, woody and non palatable (Moghaddam, 2001).

Table 1. Variance analysis forage production (gr/m^2) between the four treatments

S.O.V	DF	MS		
		Forage Production (gr/m^2)	Vegetation Cover%	Plant Height (cm)
Treatment	3	8282.68**	1111.25**	490.98**
Error	16	192.30	47.50	25.97

**= Significant at 1% level

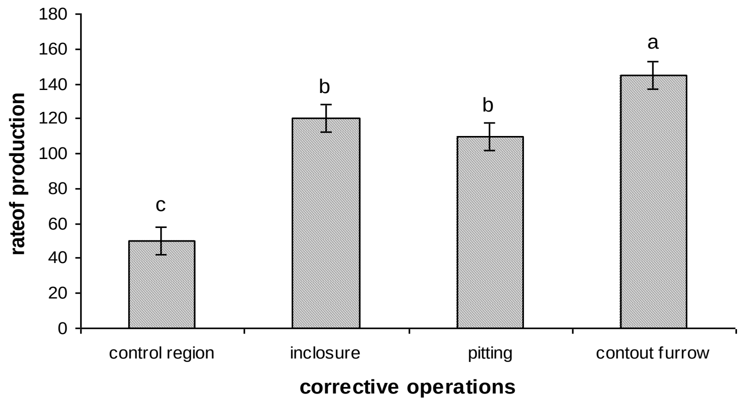

Fig. 2. Forage production (gr/m^2) in four treatments

The column with the same letter had no differences based on Duncan method.

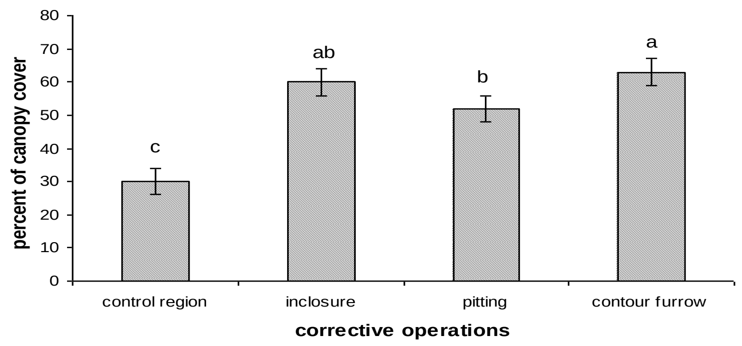

Fig. 3. Percentage of canopy cover in four treatments

The column with the same letter had no differences based on Duncan method.

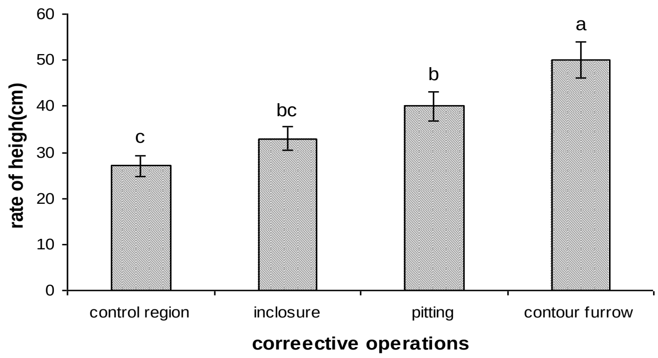

Fig. 4. Plant height (cm) in four treatments
The column with the same letter had no differences based on Duncan method.

Table 2. List of species in the region Chaat (inclosure and outclosure) (Karimidoost *et al*, 2003).

Growth Form	Palatability class	*Family*	*Species name*	No.
Perennial Grass	II	Gramineae	*Aeluropus lagopoides*	1
Perennial Grass	II	Gramineae	*Aeluropus littoralis*	2
Annual Forb	III	Aizoaceae	*Aizoon hispanicum*	3
Perennial Forb	III	Popilionaceae	*Alhagi camelorum*	4
Perennial Forb	III	Liliaceae	*Allium rubellum*	5
Bush	II	Compositae	*Artemisia sieberi*	6
Annual Forb	II	Popilionaceae	*Astragalus angustatus*	7
Annual Forb	II	Popilionaceae	*Astragalus crenatus*	8
Annual Forb	I	Popilionaceae	*Astragalus tribuloides*	9
Annual Grass	III	Gramineae	*Avena fatua*	10
Annual Grass	III	Gramineae	*Bromus japonicus*	11
Annual Grass	III	Gramineae	*Bromus scoparius*	12
Annual Forb	II	Umbelliferae	*Bupleurum semicompositum*	13
Annual Forb	III	Compositae	*Calendula persica*	14
Annual Forb	III	Compositae	*Centaurea virgata*	15
Annual Forb	III	Ranunculaceae	*Ceratocephalus falcatus*	16
Annual Grass	III	Gramineae	*Eremopyrum confusum*	17
Annual Forb	III	Cruciferae	*Eruca sativa*	18
Annual Forb	III	Compositae	*Filago arvensis*	19
Annual Grass	III	Gramineae	*Hordeum glaucum*	20
Perennial Forb	III	Ixioliriaceae	*Ixiolirion tataricum*	21
Annual Forb	III	Compositae	*Koelpinia linearis*	22
Annual Forb	III	Compositae	*Lapsana communis*	23
Annual Forb	III	Cruciferae	*Lepidium draba*	24
Annual Grass	III	Gramineae	*Lolium rigidum*	25
Annual Grass	III	Gramineae	*Lophochloa phleoides*	26
Shrub	III	Solanaceae	*Lycium depressum*	27
Annual Forb	III	Malvaceae	*Malva neglecta*	28
Annual Forb	I	Popilionaceae	*Medicago minima*	29
Annual Forb	I	Popilionaceae	*Medicago orbicularis*	30
Annual Forb	I	Popilionaceae	*Medicago polymorpha*	31
Annual Forb	I	Popilionaceae	*Medicago rigidula*	32
Annual Forb	III	Popilionaceae	*Melilotus officinalis*	33
Annual Forb	III	Papaveraceae	*Papaver orientalis*	34
Perennial Forb	III	Zygophyllaceae	*Peganum harmala*	35
Annual Grass	III	Compositae	*Phalaris minor*	36
Perennial Grass	II	Compositae	*Poa bulbosa*	37
Annual Forb	II	Plumbaginaceae	*Psyllostachys spicata*	38
Annual Forb	III	Chenopodiaceae	*Salsola dendroides*	39
Annual Forb	III	Chenopodiaceae	*Salsola incanescens*	40
Annual Forb	III	Chenopodiaceae	*Salsola sclerantha*	41
Annual Forb	III	Chenopodiaceae	*Salsola turcomanica*	42
Annual Forb	III	Compositae	*Scorzonera cinera*	43
Annual Forb	III	Caryophyllaceae	*Spergularia diandra*	44
Annual Forb	III	Chenopodiaceae	*Suaeda microphylla*	45
Annual Forb	III	Compositae	*Taraxacum officinale*	46
Annual Forb	III	Zygophyllaceae	*Tetradiclis tenella*	47
Perennial Forb	III	Compositae	*Tripleurospermum disciforme*	48
Perennial Forb	III	Liliaceae	*Tulipa hoogiana*	49
Annual Grass	III	Gramineae	*Zingeria trichopoda*	50

Discussion

Rangeland ecosystems in arid and semiarid regions of the world constituting a remarkable part of our country located in their territory in all ecosystems are sensitive and fragile. Precipitation is the most important factors limiting qualitative and quantitative growth of rangeland plants in arid and semi arid areas. Lack of rainfall, its inadequate distribution and non influence of rainfall on soil of rangelands due to trampling soil caused by excessive movement of livestock are the reasons for not enough water available for plants growth, Therefore, density of vegetation and forage production are reducing from year to year. In such circumstances, implementation a series of mechanical operations in rangelands is necessary including pitting, contour furrow, etc. Improving rangeland is a series of operations to increase productivity. Reform and restoration of rangeland led to enhance the quality and quantity of produced forage and the maximum amount of livestock products. The main purpose of the operation is to reform the rangelands and achieve a particular plant community of which its plants are nutritious for livestock grazing and keep the soil surface away from the wind and water erosion. Working with nature and its elements such as soil and vegetation is very delicate and requires accuracy perfection and attention. Therefore, unreasonable interference can affect all organs and strings of this huge network (Salehi and Loghman, 1999). When forage sources of rangeland are used without any scientific programs, vegetation will need attention. With reduction of vegetation, litter becomes too low. Reduced canopy cover and litter caused a direct impact on raindrops to wash the soil and intensify the erosion. Increasing flow of surface water causes soil washing and due to the influence of low-water, plants actually growth in the drier microenvironment. So, rangelands become poor and weak and in this case, it should be attempted to correct the soil level (Moghaddam, 2001). Studies showed that the rangelands of Gonbad Chaat considering the geological formations of clay with silty sandstones and limestone and soilogy have semi-heavy to heavy texture. Low soil permeability, low region precipitation and formation of runoff are more observed. Therefore, these areas need to consider the necessary measures for the soil conservation and optimum use of atmospheric precipitation in order to make vegetation cover and forage production. These strategies can be considered for correcting various operations such as contour furrow, pitting, etc. Performed studies in rangelands of Gonbad Chaat and obtained results showed that among treatments of contour furrow, pitting and enclosure, significant differences were obtained for forage productione and plant height. For contour furrow, forage production, percent cover and plant height were increased. The present study indicated that for heavy soils in areas such as Gonbad Chaat, contour furrow has higher efficiency rather than pitting. Neff (1976) studying the hydrological properties of soils and vegetation in Montana, USA showed that production of plants had increased by contour furrow. Stern *et al*. (1992) at South Africa on a silty clay loam showed that pitting was effective in reducing the surface runoff and maintaining higher plant evapotranspiration rates and yields compared to the control treatment. Wight *et al*. (1978) reported that over an 8-year period, contour furrow increased the average annual herbage production about 165% (527 kg/ha), increased available soil water 107% and reduced total basal cover 73%. On a saline-upland site, contour furrowing increased available water but had no effect on total herbage production and basal cover. Higher yield of furrow plots are due primarily to the increased soil water resulting from increased overwinter recharge and reduced summer runoff. Rich (2005) in the study of mechanical treatments such as contour furrow in Northern Great Plains of USA obtained that this treatment increases the vegetation of area. Mohammadian *et al*. (2007) studying the effect of corrective operations on status, trends and changes of vegetation in some research stations of Lorestan, Iran found that the corrective operations increase the forage production about 3.2 times and the amount of harvested forage and the capacity for grazing has been equivalent to 3 times compared to the control areas. In general, results of these studies were in agreement with present research. Jahantigh (2007) concluded that contour furrow and pitting were the most important corrective actions considered in the rangelands. The major limitations in developing the vegetation of rangelands are little rainfall and soil moisture, some operations for storing precipitation can help to increase the soil permeability and supplying aquifers for groundwater increases the vegetation density leading to increasi the production and capacity of rangelands.

References

Ansari, V., 2009. Technical principles and operational of improvement projects and restoration rangelands. Pooneh press. First edition. Iran. 152 p. (In Persian).

Azarnivand, H., 2009. Improved rangelands, obstacles and solutions. Abstracts fourth national conference on range and range management. Tehran. Iran. 364 p. (In Persian).

Azarnivand, H., Zarechahooki, M.A., 2008, Range improvement, Tehran University of press. First edition. 335 p (In Persian).

Babakhanlou, B., 1985. Improved rangelands through storage precipitation. Organization of forests and rangelands. Technical office of rangeland. 60 p. (In Persian).

Bainbridge, D. A. 1997. Soil pitting; a technique to improve arid land revegetation. SDSU Soil Ecology and Restoration Group, 12 p. Alliant International University San Diego.

Barnes, O. K. 1950. Mechanical treatments on Wyoming rangeland. *Jour. Range Management* **3(3):** 198-203.

Branson, F. A., Miller, R. F., McQeen, I. S., 1966. Contour furrowing, pitting and ripping on rangelands of the western United States. *Jour. Range Management*. **4:** 182-190.

Deborah, G., Turner, R. M., 1986. Vegetation change and plant demography in permanent plots in the Sonoran desert. *Jour. ecology* **67:** 695-701.

Habibzadeh, A., Goodarzi, M., Mehrvarzmoghanloo, K., Javanshir, A, 2007. The effect of pitting and contour furrow in storage moisture and increased vegetation. *Jour. Natural Resources*. Iran. **60:** 397-410. (In Persian).

Hessary, L. K., Gifford, G. F. 1970. Impact of various range management practices on watershed protective cover and annual production within the Colorado. River basin. *Jour. Range Management*. **2:**134-140. (In Persian).

Hoveizeh, H., Malekpoor, B., Salehi, H., 2006. The effect in status and trends rangelands in Khuzestan. Second national conference rangeland and range management in Iran. 134-148p. (In Persian).

Jafari, M., Ebrahimi, M., Azarnivand, H., Maddahi, A., 2009. Study the effects of different operations the rangelands improvement on some of the factors in soil and vegetation (case study of rangelands Sirjan). *Jour. Range Management*. **3:** 371-384. (In Persian).

Jahantigh, M., 2007. Investigated of the most efficient method of storage precipitation and reducing deposition (contour furrow and pitting). Tenth national congress of Iranian soil science (In Persian).

Karimidoost, A., Mirkazemi, S. R., Alazmany, M., 2003. Investigated the establishment of 20 species of trees and shrubs in arid areas. Saline and alkali conditions with and without windbreak in the border area Gonbad Chaat. Publication of Research center of agriculture and natural resources Gorgan. 18 p. (In Persian).

Khodagholi, M., Chavoshi, S. A., 2002. Evaluating the effect of pitting and contour furrow on establishment of some important species of rangeland. *Journal research of rangeland and desert Iran*. **1(8):** 619-634. (In Persian).

Mesdaghi, M., 1999. Range management in Iran. Tehran university press. Third edition. Iran. 215 p. (In Persian).

Moghaddam, M., 2001. Rangeland and range management. Tehran university press. Second edition. Iran. 470 p. (In Persian).

Mohammedian, A., Abtahi, S. A., Siahmansouri, R., Karamian, R., 2007. The effect of aqifer management operation on status, trends and changes in vegetation in research stations Davood Rashid Lorestan. Fourth national conference sciences and engineering Iran's watershed. Watershed management. (In Persian).

Neff, E.L., 1976. Water storage capacity of contour furrows in Montana. *Jour. Range Management*. **26(4):** 298-301.

Range technical office, 1982. Code rangeland plants in Iran, publishing and advertising committee of forest and rangelands. (In Persian).

Rich Terrel, D., 2005. Effects of contour furrowing on soils, vegetation and grassland breeding birds in North Dakota, Agriculture forest service, p: 496-503.

Salehi, H., Loghman, H., 1999. Restoration and development of desert regions by desert plants. The second national conference on range management in the rangeland Iran. 280-290 p. Listen Read phonetically (In Persian).

Stanley, R. J., 1978. Establishment of chenopod shrub by the pitting on hard pan soils in western New South Wales. Australia. Proceedings of the first international rangeland congress. Denver. Colorado. USA. Pp. 639-642.

Stern, R., A. J. Van der Merwe, M. C. Laker and I. Shainberg. 1992. Effects of soil surface treatment on runoff and wheat yield under irrigation. *Agronomy Jour*. **84(1):** 114-119.

Wight, J., Ross, E. L. and Soiseth, R. J. 1978. Vegetation response to contour furrowing, *jour. Range Management*, **31(2):** 97-101.