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The Influence of Global Climate Alteration on Nourishment Security in I.R. Iran

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Abstract

Climate change, disturbed various dimensions of national security within numerous countries. In the interim, declining the rainfall pattern in those countries which are positioned on the world desert strip, has had the greatest consequence and incidence on their food security sectors. This study objective is to investigate the impact of global climate change on nourishment security. The field study zone of this research is based upon analysis and data which had gathered from Iran. Due to the immensity of the study area, 6 provinces were selected by random sampling technique. To obtain the affiliation between climate change and the current food security complications, the rainfall data and the area under crop cultivation with rain fed planting method, the area under irrigated crops and the number of goats which have raised between 2004-2018 were applied within this research study. The Data which had accumulated was analyzed for variance in the R script environment. The conclusion of analyses of the researched variance showed that the amount of rainfall ratio had a positive and significant result; simultaneously, on the area under cultivation of rain- fed crops as well as the area under cultivation of irrigated crops system. The ratio of rainfall to the number of goats raised, except for the Chaharmahal and Bakhtiari Province, in the remaining states the outcomes were momentous. Henceforth, by generalizing the sample to the statistical population, it can be expressed that the climate change has had a positive and substantial consequence on food security in Iran.

Key words: Climate change, Food Management, Global Warning, R Software

1. Introduction

The current climate change is considered as one of the foremost threats for achieving the adequate sustainable development (Krishnamurthy, 2012; Diallo et al., 2020). These fluctuations are essentially due to the increase in the concentration of greenhouse gases effect in the atmosphere, which is produced mainly by increased human activities around the world; furthermore, has led to an increase in global air temperature of approximately 1 ° C compared to the previous years (Dibike and Coulibaly, 2005; VijayaVenkataRaman et al., 2012; Feng et al., 2014; Bekele et al., 2019).

The climate change can have various consequences. Perhaps, the climate change is predictable to have a direct impact on migration flow patterns and lead to longstanding migration flows in some countries (Constablem, 2017; Bwalya, 2013). Considering that many countries rely on agriculture industry and rain- fed production, a sharp decline in annual rainfall can affect agricultural production volume (Hjelm and Dasori, 2012). The current climate change causes complications at the national and transnational levels. The current climate change is essentially due to systematic procedures in the global capitalist structure (Ribot, 2014) that effect the global agricultural landscape in inefficient economic systems (Borras and Franco, 2018) In the present day, it can be obviously seen that the current climate change has a high impact on agricultural production and consequently food resources. The food depletion due to current

climate change can be examined in the form of national management size.

Having this in consideration, that many of these crises are interrelated; In contrast, the current climate change crisis is directly related to the administration of food products as well as food production systems. It can be considered in the context of food security and its consequences. (Alexander et al., 2019; Reed and Stringer, 2016). The nourishment security is defined as the ability of consuming sustainable and sufficient food resources for a fixed human population. Once, all the individuals have complete adequacy access to the food; physically, socially, culturally and economically and the accessible food meets the nutritional needs and preferences for the continuation of a healthy lifestyle for each individual, it can be summarized that this particular community has sufficient nourishment security (Tull, 2020).

The future demographic statistic of global population is projected to reach 9.7 billion by the year 2050. As the world population grows; unsurprisingly, we will face more problematic encounters for accessing the food resources (FAO, 2012). The current climate change has direct impact on rainfall ratio and temperature escalation; pointedly, has triggered weather change to be meticulously related to agriculture and nutrition resources (Phalkey et al., 2015). Increasing air temperature intensify the heat wave which upsurges the phenomenon of global drought, and similarly reduces agricultural products such as: fisheries, forestry, etc., which subsequently leads to nourishment insecurity. There are numerous ample evidences that climate change can effect on: food quality, nutrient diversity - density, and the most prominently the final food price for consumers (Vermeulen et al., 2012). In actual fact, the climate is the main determinant of agricultural productivity and its' production. The existing agricultural systems are harshly affected by this factor, and this dependency on weather conditions has become a foremost concern for the human civilizations around the globe. Hence, various researches have been conducted to study climate change and its' physical effects on crops as well as the economic significances of these variations in the potential yielding of the regions. The climate changes and their impact on agricultural production can have substantial effects on nourishment insecurity (Hossain et al., 2014). Alternatively, the current climate change can limit the transference of food/ goods and products to local markets which high- quality distribution methods will be deteriorate. The nutritional status with reduce resilience, exclusively deprived the communities (Springmann et al., 2016; Whitmore et al., 2015). The climate alteration can have dissimilar effects based upon wealth and the living standards (Grace et al., 2012). Therefore, the FAO put emphasis on nourishment security is exclusively depending more than anything else on the economy and economical environments. It is not acceptable to bank on national production to assess the potential effects of climate alteration on food security sectors.

Moderately, it should comprehensively examine the effects of climate alteration on foreign exchange revenues, determining the ability of countries that utilize food programs to increase their international exportations. It also used the income of the poor populace which affected by climate change and nourishment insecurity (FAO, 2003). Presently, the average annual temperature in Iran has amplified by approximately 0.3 ° C in this decade; and in the intervening time, the average rainfall has decreased nearby 7 mm over the past 50 years (Rahimi et al., 2019 and 2020).

Due to the positioning in Iran in the arid and semi- arid region next to the tropics area, which their annual national rainfall is much lesser than the global average, the climate alteration in this region is anticipated to be more momentous (IPCC, 2014). The results illustrate that the annual temperature in I.R. of Iran will increase by 0.5 ° C in 2020; moreover, nearby 1.5 ° C by end of the decade 2029 (Jamshidi et al., 2020). The Iran's Weather Research Institute also forecasts that the annual rainfall will decrease by 9% in the period of 2013-2030 and the following decades to come. The outcomes of this research study also confirm that I.R. of Iran is facing the phenomenon of climate alteration in general and in the not-too- distant future, climate transformation will have a direct and indirect

influence on country's natural ecosystems (Wang, 2012) over and above human ecosystems (Feola et al., 2015).

Nevertheless, the agricultural industry within this country is sturdily influenced by climate conditions and resulting the vicissitudes (Feng et al., 2017; Sima et al., 2015). Iran is fronting the delinquency of water resources deficit, so it is very vulnerable to the effects of climate transformation (Nassiri et al., 2006). According to the governmental official statistics, from the annual 415 billion cubic meters of rainfall in Iran, approximately 70% is evaporated. With The yearly inflow of 12 billion cubic meters of water entering the country from its international borders, the total renewable water resources are only around 135 billion cubic meters, which until 10 years ago only 95 billion cubic meters have been harvested.

Nonetheless: in addition to restricted water resources, extraction costs and limited financial resources, modernization of water expansion projects have faced complications. In a very informative World Bank Report, the reduction of extractable water per capita and the loss of its quality and inefficiency of water consumption in: the agricultural industry, industrial sectors, urban segments and utilizing very restricted financial resources are among the most imperative challenges facing this country. The water deficit dilemma within this country needs immediate attention of: the national government and politicians. (Karimi et al., 2018).

Subsequently, the agriculture and nourishment security and to achieve self-sufficiency in order to reduce food and goods importations from other countries in a way that can maintain the independence and integrity of the country's products are profoundly affected by this aspect (Karimi et al., 2018). The main aim of this research study is to examine the affiliation between climate alteration and food production regimes from a nourishment security perspective. The article commences with the interactions of climate on agricultural and food production and then examines the nature and extent of climate transformation and its indicators in Iran.

In this research, first, six provinces out of 31 provinces of Iran were randomly selected as the case studies. The selected provinces are Golestan, Sistan and Baluchestan, Isfahan, Chaharmahal and Bakhtiari, Kohgiluyeh and Boyer-Ahmad and South Khorasan. The database of this research includes the annual rainfall data of the studied provinces in the period of 2004-2018, which was requested from the central meteorology office. The periods of annual data rainfall in Excel software was calculated by Mann-Kendall test. The Mann- Kendall nonparametric test is based on the order of the data in a time series, this test is used to check the randomness of the data against the existence of hydrological and meteorological time series periods (Zhang et al., 2000). Annual data on under plantation water crops and rain-fed crops and the number of goats were collected from the ministry of Agriculture- Jahad (https://maj.ir). Finally, the researcher used from R scripts for analysis. The R scripts are taken from www.r-project.org on this site, packages "book" and "magazines" related to R scripts can be retrieved also explanations about these scripts and its capabilities are given (Arabpoor et al., 2017).

2. Material and Methods

2.1. Study area

Iran is located in the dry belt of the world due to its special geographical position in relation to the general circulation of the atmosphere. For its vicinity to subtropical high pressure, most parts of the country have an arid and semi-arid climate (Gholami et al., 2017). 2.7% of Iran is considered too dry, 64.7%dry, 29/4% semi-dry, 2/3% semi-wet, 0/3% wet and 0/5% very wet. In other words, 94.8% of the country is between arid and semi- arid regions. Accordingly, the need for water supply for agricultural purposes is one of the first priorities and usually ends in hot debates (Ghaffari et al., 2015).

Assessing the effects of climate change on water resources in Iran shows that climate change has reduced water resources in Iran. It also has a variety of consequences of endangering food security through changes in agricultural productivity. The relationship between climate change and food security presented as figure 1. Figure 2 also show the location of studied stations in Iran. Geographical and demographic characteristics of the study area are presented as table 1.

2.2. data related to rainfall

Since the study of rainfall changes is of particular importance for the adjustment of damage or adaptation to phenomenon of climate change (Akbari and Sayad, 2021), annual rainfall was selected as the key variable. The annual rainfall of the studied provinces was requested from the central meteorology office. Finally, the rainfall periods were calculated for each province in the statistical period of 2004-2018. The results are presented in table (2).

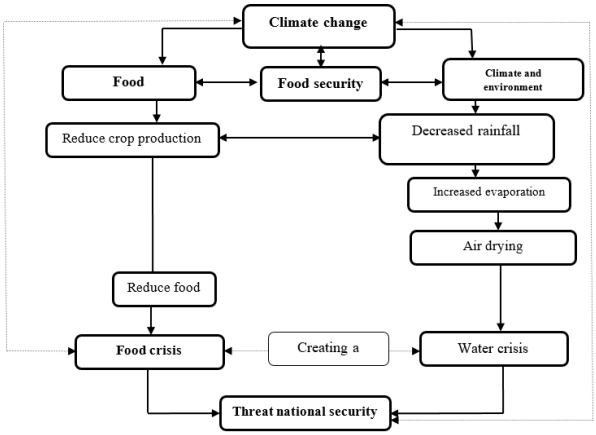

Fig. 1. The relationship between climate change and food security

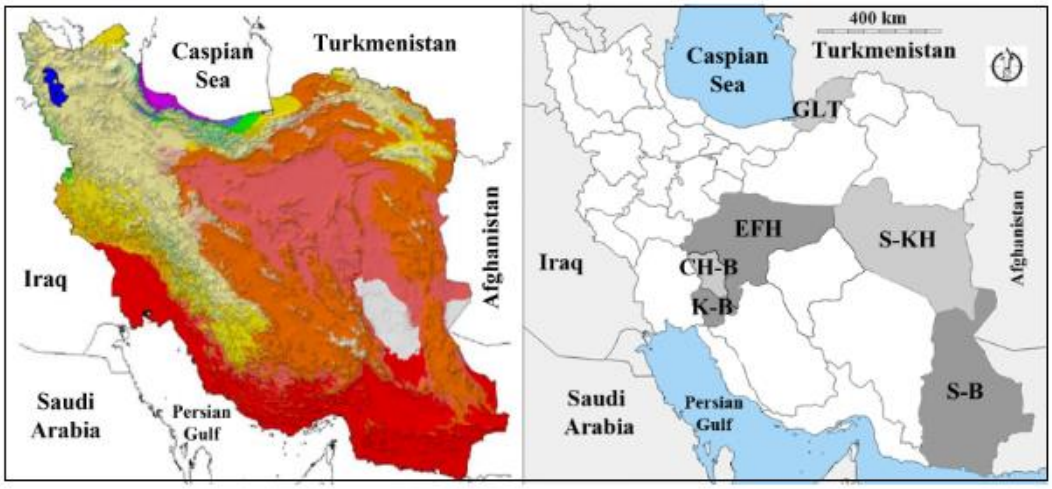

Fig. 2. The map on the left shows Agro-climatically zoning of Iran by UNESCO approach (Ghaffari et al., 2015). The map on the right shows the studied samples which includes GLT: Golestan, S-B: Sistan and Baluchestan, S-KH: South Khorasan, EFH: Isfahan, CH-B: Chaharmahal and Bakhtiari, K-B: Kohgiluyeh and Boyer-Ahmad provinces.

Table 1. Geographical and demographic characteristics of the study area

State	Geographical coordinates	Area km^2	Population (2016)	The center of the province	Number of cities
Golestan	54/4444° E 36/8393° N	20367	1868819	Gorgan	14
Sistan and Baluchestan	60/8669° E 29/4924° N	180726	2775014	Zahedan	14
Isfahan	51/6692° E 32/6577° N	107028	5120850	Isfahan	23
Chaharmahal and Bakhtiari	50/8546° E 32/3275° N	16421	947763	Shahr-e Kord	10
Kohgiluyeh and Boyer-Ahmad	51/60° E 30/67° N	16264	713052	Yasuj	7
South Khorasan	59/2164° E 32/8653° N	151193	768/898	Berjand	11

Source: statistical center of IRAN, google, researchers

Z statistics of Mann-Kendall shows statistical significance and trend changes in the time series. According to table (2), the changes in the rain fall trend of all studied provinces in 2004-2018 have been decreasing and significan at the 95% confidence interval. Among the provinces under study, Chaharmahal and Bakhtiari province had the

highest rainfall decrease with -2.07 and Sistan and Baluchestan province, Kohgiluyeh and Boyer-Ahmad and Isfahan with -1.88, -1.58 and -1.088 are in the next stage. South Khorasan and Golestan provinces with -0.98 and -0.59 are in the next row.

Table 2. Rainfall situation in selected provinces of Iran in period of 2004-2018

Time series	Long- term average annual rainfall[1](Mm)	Z statistics of Mann-Kendall	Sen's slope
Golestan	471	-0.59	-4.19
Sistan and Baluchestan	106	-1.88	-5.33
Isfahan	138	-1.08	-4.38
Chaharmahal and Bakhtiari	592	-2.07	-18.86
Kohgiluyeh and Boyer-Ahmad	654	-1.58	-16.40
South Khorasan	113	-0.98	-1.83

Source: researcher's calculations in Excel software (According to the Meteorological Department)

2.3. Data on the area under cultivation

Crops include cereals (wheat, rice and etc.), legumes, vegetables and etc., considered as the main food in Iran and play an important role in food security in this country, were selected as variables. Data related to the area under annual crop cultivation in rain-fed and water units per hectare were prepared from the ministry of Agriculture- Jahad (https://maj.ir). This data can be seen in table 3 and 4.

Table 3. The amount of the area under cultivation of crops in the form of rain-fed (Hectares)

Province	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Golestan	357600	357149	355594	372485	352112	346057	307325	327905	274151	296574	299314	327615	317711	306357	328728
Sistan and Baluchestan	1849	3321	2333	9302	5561	3873	2425	2272	149952	4518	21431	17945	1441	2100	0
Isfahan	31524	33617	31579	36997	18496	29174	27693	17661	18430	25427	39367	26303	25633	20809	19677
Chaharmahal and Bakhtiari	69230	55150	62822	62612	43027	60420	56364	58532	59900	61674	61566	63530	58561	55159	55429
Kohgiluyeh and Boyer-Ahmad	145922	140346	166733	132136	89198	108323	119710	105173	114797	111191	113926	138067	127086	115823	81200
South Khorasan	[2]	53571	31719	41504	643	37561	21807	13988	23073	16456	6631	6881	4677	2474	1259

Source: Ministry of Agriculture- Jahad (https://maj.ir)

Table 4. The amount of area under cultivation of water crops (Hectares)

Province	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Golestan	329892	222529	334511	331107	320450	338778	350901	359251	313105	362240	347141	340835	358483	334970	355879
Sistsn and Baluchestan	104912	158156	128283	169287	117397	142925	173335	168901	145764	157284	193918	184573	189851	173156	140521
Isfahan	307635	323532	332494	323184	267026	216555	241276	169091	188065	219896	204756	207481	211249	215858	178402
Chaharmahal and Bakhtiari	83818	83883	85760	80570	74051	74274	75299	71998	76246	78097	74263	76068	75036	73205	75536
Kohgiluyeh and Boyer-Ahmad	55061	51712	7660	56474	27675	45009	37437	79475	36939	35958	42168	40129	40842	47647	43464
South Khorasan	-	53571	31719	41504	643	37561	21807	13988	23073	67665	67878	70797	72545	67672	67422

Source: Ministry of Agriculture- Jahad (https://maj.ir)

[1]- Average total annual long- term precipitation(Millimeter), source Iran water resources management company
[2]- In 2004 south Khorasan province was a subdivision of Khorasan province

Table 5. Estimation of goat population (a thousand heads)

Province	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Golestan	148.30	148.69	148.84	148.84	110.83	107.6	106.37	105.31	104.25	102.18	158.344	155.96	164.2	191.5	187.5
Sistsn and Baluchestan	1217.35	1219.7	1220.99	1220.99	1060.87	1029.95	1018.17	1008	997.937	978.08	941.395	1216.794	1008.7	1836.6	1798.05
Isfahan	1039.36	1041.4	1042.47	1042.47	576.84	560.02	553.62	548.09	542.614	531.82	649.22	639.460	501.4	505	۴۴۴۴۹۴.۴
Chaharmahal and Bakhtiari	1081.46	1083.6	1084.69	1084.69	920.9	894.05	883.83	875	866.262	849.03	452.775	455.971	402.5	398.4	390.1
Kohgiluyeh and Boyer-Ahmad	842.27	843.94	844.79	844.79	882.81	857.07	847.28	838.81	830.432	813.91	829.319	826.858	937.8	928.4	908.9
South Khorasan	-	1503.4	1503.98	1503.98	1285.99	1248.5	1234.22	12221.9	1209.699	1185.6	786.031	877.502	967.8	957.8	937.7

Source: Ministry of Agriculture- Jahad (https://maj.ir)

Table (3) shows: the area under rain-fed crops is declining from 2004-2018. This amount reaches zero in Sistan and Baluchestan province. Table (4) shows: the area under cultivation of crops in different years is associated with many fluctuations and in three provinces of Isfahan, Chaharmahal and Bakhtiari and Kohgiluyeh and Boyer- Ahmad has had a decreasing period.

Since the number of goats plays an important role in the production of dairy products and protein, it was chosen as a variable. Table (5) shows: the estimation of goat population in different years is associated with many fluctuations. In three provinces of Isfahan, Chaharmahal and Bakhtiari and south Khorasan has had a decreasing period.

3. Results and discussion

3.1. Data analysis

To test the research hypothesis, the data collected in the statistical R scripts were analyzed for variance. The variance of annual rainfall and annual area under rain-fed and irrigated crops and the number of goats raised in one year in the period 2004-2018 were analyzed. The results are presented in table 6, 7, 8, 9, 10 and 11.

Table 6. Result of analysis of variance between rainfall and area under rain fed crops.

Province	**DR**	**SUM sq.**	**Mean sq.**	**F value**	**PR (>F)**
Golestan	1	8.068e+11	8.068e+11	2038	2e-16***
Sistan and Baluchestan	1	157485174	157485174	7.914	0.00891**
Isfahan	1	5.327e+09	5.327e+09	222	7.72e-15***
Chaharmahal and Bakhtiari	1	2.558e+10	2.558e+10	1509	2e-16***
Kohgiluyeh and Boyer-Ahmad	1	1.083e+11	1.083e+11	448.6	2e-16***
South Khorasan	1	2.432e+9	2.432e+9	17.12	0.000326***

Table 6 shows the results of analysis of variance between annual rainfall and the area under annual rain- fed crops in R script. As can be seen, this ratio was confirmed in: Golestan, Kohgiluyeh and Boyer-Ahmad, Chaharmahal and Bakhtiari, South Khorasan and Isfahan provinces with a significance level of 99% accurateness. In Sistan and Baluchestan province, this ratio was confirmed with a significance level of 95% exactness.

Table 7 shows the results of analysis of variance between annual rainfall and annual crop area of irrigated crops in R script. As you can see the results of researched analysis of variance for the ratio between rainfall and the area under crops were confirmed in: Golestan, Kohgiluyeh and Boyer-Ahmad, Chaharmahal and Bakhtiari, South Khorasan and Isfahan provinces with a significance level of 99% accurateness. In Sistan and Baluchestan province, this ratio was confirmed with a significance level of 95% exactness. Table 8 shows the ratio between rainfall and the number of goats during the 15-year period studied.as can be seen. The ratio among rainfall and number of grown goats was confirmed in: Golestan, Isfahan, Sistan and Baluchestan provinces with a significance level of 99% and for South Khorasan

province with a significance level of 95% accurateness. Although the number of grown goats in Chaharmahal and Bakhtiari province has been decreasing for about 15 years, however, the analysis of variance among the quantity of rainfall and the number of grown goats in this province was rejected.

Table 7. The result of analysis of variance is the ratio between rainfall and under cultivation area `of irrigated corps

Province	DR	SUM sq.	Mean sq.	F value	PR (>F)
Golestan	1	8.627e+11	8.627e+11	1119	<2e-16***
Sistan and Baluchestan	1	1.836e+11	1.836e+11	528.7	2e-16***<
Isfahan	1	4.329e+11	4.329e+11	275.8	4.98e-16***
Chaharmahal and Bakhtiari	1	4.407e+10	4.407e+10	4773	2e-16***<
Kohgiluyeh and Boyer-Ahmad	1	1.1367e+10	1.1367e+10	113.5	2.34e-11***
South Khorasan	1	1.488e+10	1.488e+10	47.12	2.75e-07***

Table 8. Result of analysis of variance between rainfall and goat (A thousand heads)

Province	DR	SUM sq.	Mean sq.	F value	PR (>F)
Golestan	1	758435	758435	124.6	8.06e-12***
Sistan and Baluchestan	1	8975861	8975861	229.5	5.11e-15***
Isfahan	1	1797145		66.2	7.39e-09***
Chaharmahal and Bakhtiari	1	1.894e+11	1.894e+11	2.662	0.114
Kohgiluyeh and Boyer-Ahmad	1	1.367e+10	1.367e+10	113.5	2.34e-11***
South Khorasan	1	49836912	49836912	6.014	0.0212*

Table 9. Tukey's test results to investigate the ratio between rainfall and rain- fed crops

Province	**B-A**	**Diff**	**Lwr**	**upr**	**P value**
Golestan	B-A	327989.2	313107.8	342870.6	0
Sistan and Baluchestan	B-A	4582.36	1243.576	7921144	0.0089077
Isfahan	B-A	26650.76	22986.74	30314.79	0
Chaharmahal and Bakhtiari	B-A	58395154	55316.17	61474.7	0
Kohgiluyeh and Boyer-Ahmad	B-A	120148.7	108528.9	131768.5	0
South Khorasan	B-A	18638.49	9379.494	27897.49	0.0003261

Table 10. Tukey's test for the ratio between the amount of rain and the area under irrigated crops

Province	B-A	Diff	Lwr	upr	P value
Golestan	B-A	332882.2	314942.5	350822	0
Sistan and Baluchestan	B-A	156459.9	142521.4	170398.4	o
Isfahan	B-A	240238.3	210608.4	269868	0
Chaharmahal and Bakhtiari	B-A	76653.6	74380	78926.32	0
Kohgiluyeh and Boyer-Ahmad	B-A	42698	34488.06	50909.22	0
South Khorasan	B-A	46110.14	32302.42	59917.8	3e-07

Table 11. Tukey's test for the ratio between rainfall and the number of goats

Province	B-A	Diff	Lwr	upr	P value
Golestan	B-A	-318.0011	376.3609	259.6412	0
Sistan and Baluchestan	B-A	1093.975	946.0397	1241.91	0
Isfahan	B-A	489.5093		366.2738	0
Chaharmahal and Bakhtiari	B-A	158927	-40597.11	358451.2	0.11
Kohgiluyeh and Boyer-Ahmad	B-A	42698.64	34488.06	50909.22	0
South Khorasan	B-A	2668.25	431.8058	4904.695	0.0212154

To ensure the result of analysis of variance between the studied data, Tukey's test was also calculated in R script. Results are presented below. As can be seen in tables 9, 10 and 11, the results of the Tukey's test in the R script confirm the results of analysis of variance.

4. Conclusion

Climate change in the form of reduced rainfall has threatened security and development in many parts of the world, especially in arid and semi-arid regions of the Middle East.

Iran is located in the desert strip of the world in the Middle East. The country has experienced a sharp decline in rainfall in Recent years, especially in 2008-2016(The researchers reached this conclusion by using the rainfall data of the studied station, and similar studies confirm this). The rainfall period in this country has been decreasing and in most areas it has been negative. With the decrease of annual rainfall, the area under annual cultivation of crops and the number of goats have decreased. If these case accompanied by population growth, food security in this country will be endangered. Endangering food security will jeopardize all aspects of security and national security in general, and will prevent the country from developing.

5. Suggestion

- It is suggested that the cultivation of crops that are the main food of the people (rice, wheat, legumes, etc.) be a priority and be reduced from the cultivation of crops that require lot of water and aren't a food priority.
- Cultivation of crops in all provinces should be done with the planning and coordination of the government.
- The reduction in area under cultivation can be partially compensated by seed modification. Therefore, fundamental investment should be made in the field of seed breading and livestock breading.

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7. Conflicts of Interest

No potential conflict of interest was reported by the authors

8. References

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