

## **Geographical and Spatial Distribution of Wheat and Barley Crops in Tuzkhurmato District**

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### **Abstract**

*Spatial analysis is considered the core of contemporary geography's work to investigate and understand the spatial behavior of geographical phenomena using modern geographical techniques capable of revealing patterns of geographical distribution and spatial relationships to geographical factors, given that technical progress in the field of informatics has been a reason for its application in the field of geographical studies, including agricultural geography studies, to keep pace with Geography and other applied sciences.*

*The study area was chosen due to its agricultural importance, as it possesses the elements of agricultural production, in terms of climate, soil, and abundance of water resources. It is one of the areas included in the Kirkuk irrigation project, and the region also has a topography suitable for agriculture. The study of the thesis right (Spatial analysis of wheat and barley crop production in Tuz Khurmatu and Amerli districts) aims to reveal the distribution of productivity of wheat and barley crops and to know the natural and human factors affecting the uses of agricultural land, as well as to identify the problems facing these uses in the study area in order to reduce their danger, as well as to reach a conclusion. A number of conclusions and proposals, which will benefit planners and decision makers in preparing appropriate development plans and programs necessary to improve the reality of agricultural land uses.*

**Keywords:** *Geographic distribution, Spatial variance analysis, Spatial statistics analysis.*

### **Introduction**

Tuz Khurmatu and Amerli districts are considered among the prominent districts in Salah al-Din Governorate in terms of agricultural production. Wheat and barley are important field crops as they are a food source because they contain protein, carbohydrates, mineral salts and vitamins, some of which contribute greatly to solving the grain crisis in poor communities and the animal protein deficiency crisis, in addition to Regarding its economic importance and its contribution to international trade, the relationship between climate characteristics and agricultural activity is close, as agriculture was and still is one of the activities most influenced by climate conditions (temperature, rain, and wind), as it controls the type of plants grown in any part of the world. The production of wheat and barley crops is of great importance in the districts of Tuz Khurmatu and Amerli, but the

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study area is currently facing a very important food challenge, which prompted the researcher to move towards studying the reality of the region and its capabilities to produce wheat and barley crops and sustainable agricultural requirements in order to find the best solutions to address the problems and imbalances. This study aims to diagnose the extent of the continuous decline and fluctuation that the study area suffers from, and to find out the reasons for this decline and fluctuation, in order to find the best ways to increase and improve production, which is one of the important issues that deserves study and propose appropriate solutions to treat it.

Firstly: the study Problem:

(There is a discrepancy in the production of wheat and barley crops in the districts of Tuz Khurmatu and Amerli, which led to a defect in their distribution and spatial organization, especially since these two crops are among the most important agricultural crops in Iraq.) From this main problem the following questions arise:

1. What is the geographical distribution of wheat and barley crop production in Tuz Khurmatu and Amerli districts?

Second: Study hypothesis:

1. The production of wheat and barley crops can be distributed at the district level in the study area, and the differences between the two districts under study can also be detected.

Third: Boundaries of the study area:

Tuz Khurmatu and Amerli districts are located in the northeastern part of Iraq and the eastern part of Saladin Governorate, and they are considered a linking area between northern and central Iraq, as shown in map (1). They are administratively linked to Salah al-Din Governorate. They are bordered to the north by Daquq District, administratively affiliated with Kirkuk Governorate, to the south by Kifri District, administratively affiliated to Diyala Governorate, to the east by Qadir Karam District, affiliated to Chamchamal District in Sulaymaniyah Governorate, and to the west by al-Dur District, administratively affiliated to Salah al-Din Governorate. They are located coordinately between the longitude lines ( $11, 26^{\circ}, 44^{\circ} - 6^{\circ}, 58^{\circ}, 44^{\circ}$ ) to the east, and between two latitudes ( $22^{\circ}, 30^{\circ}, 34^{\circ} - 12^{\circ}, 15^{\circ}, 35^{\circ}$ ) to the north. The total area of Tuz Khurmatu district constitutes approximately (362015) ( $\text{km}^2$ ), and the total area of Suleiman Bey district, which is administratively affiliated to it. To Tuz Khurmatu district, it amounts to (250,958) while the total area of Amerli district is (399,939). It is clear from tables (1-1) (1-2) (1-3) that the study area includes (83) districts, where Tuz Khurmatu district includes (32). Suleiman Bey District and District includes (26) districts, while Amerli District includes (25) districts. As in map (1).

1. Geographical distribution of the wheat crop area in the Touz and Amerli districts for the year 2022:

The distribution aims to reveal variation in any geographical phenomenon. As for the area cultivated with wheat, a clear variation was recorded at the district level first, and then the provinces second. It is clear from Table (1) and Map (1) that the wheat crop recorded a cultivated area amounting to (33,343) dunams, in the Touz district, distributed among (50) districts, and at a rate of (8.39)% of the arable land in the entire district, which amounts to (397,388). Acres. As for the distribution according to the province, it was distributed in four levels, where the highest cultivated area of wheat was in (Chorau/1) province, with an area of (7470) dunams, and in second place was (Sancor/2) province, reaching (4640) dunams, while in third place. The two provinces (Shah Siwan/4, Bablan/8) came in, amounting to (2906, 1931) dunams, respectively, while the rest of the provinces came in fourth place, with an area ranging from (0 – 1867.5) dunams. Because of natural factors such as soil, surface nature, and water resources, as well as human

factors related to mechanization and others. While the percentage of land cultivated with wheat out of arable land was (8.39)%, the highest was in (Shah Siwan/4) province with (91.33)%, followed after that by (Koçek Bashtepe/65) with (79.86)%, and thirdly. The province of (Albu Sabah Al-Gharbiyya/3) came with a rate of (66.32)%, while the lowest percentage of cultivation of this crop was recorded in the provinces of (Kola Kani/4, Sheikh Hawazi/54, Talaw/62, Karmuk/71, Haidar Sur/71, and Balkana). Salem/50, Belkana Sada, 46), as these provinces were devoid of wheat cultivation due to the factor of desertification, as well as the slope, and their distance from water resources.

Table (1) Cultivated area for wheat and barley crops in Touz district by province, for the year 2022

Percentage of wheat area of arable land%	Cultivated area of wheat/dunam/2021-2022	Valid area/acre	County name	County number
3.00	276	9196	Qalkhano is great	1
35.28	7470	21174	Shurao	1
6.88	628	9130	Small Qalkhano	2
66.32	4640	6996	Sancor	2
8.44	1717	20334	Albu Sabah Al Gharbia	3
1.12	86	7670	Mel Nasser	3
91.33	2906	3182	Shah Siwan	4
0.00	0	5270	Call me Kanye	4
3.43	251	7319	Touz	5
6.35	279	4396	Bassas	6
3.83	291	7603	Yinjah	7
15.73	1931	12279	Bablan	8
11.89	1593	13403	Eastern sweets	16
5.40	349	6467	His little sweet	33
6.06	933	15408	Southern Heliwa	38
8.12	179	2205	Albu Sabah Al Sharqia	40
2.10	201	9578	Khadr and me	47
3.10	416	13424	Nogol	51
2.67	408	15267	For you and Qashlan	52
0.80	57	7089	Heap yea	53
0.00	0	9117	Sheikh Hawazi	54
12.10	519	4289	It's going to be great	60
3.36	279	8297	A scene	61
0.00	0	5412	Talao	62
0.37	4	1089	Omar Sufi	63
23.22	212	913	In front of Muhammad	64

			Rashid	
79.86	908	1137	Make sure you don't mind	65
43.82	1162	2652	Sefer Bayat	66
6.47	212	3277	Take care of it	67
1.03	72	7002	Lotfi Agha	68
0.00	0	13451	Your generosity	71
0.00	0	2191	Haider Sur	71
8.81	898	10198	cox	9
1.59	60	3766	Especially Darlie	10
1.21	276	22800	Suleiman Bey	14
1.61	184	11409	Fossil	15
3.56	220	6177	Brand new	23
2.14	92	4308	Nahrawan	28
1.63	167	10265	For people	36
0.00	0	2333	He has a plain accent	46
5.25	249	4745	spread	48
2.74	255	9306	Bangs	49
0.00	0	2839	He is safe	50
7.08	738	10423	fort	55
17.39	1354	7788	Repent of your crime	56
2.86	132	4611	Salehi is old	57
9.45	428	4531	Dragee	58
2.82	175	6207	Gory	59
1.63	53	3242	And see me below	69
0.51	83	16223	Zandana	70
8.39	33343	397388	the total	

Source: Organized by the researcher based on the Ministry of Agriculture/Saladin Agriculture Directorate - Tuz Agriculture Division (unpublished data), 2022.

2. Geographical distribution of the barley crop area in the Touz and Amerli districts for the year 2022:

It is noted from Tables (3) (4) and Maps (3) (4) that there is also a discrepancy in the areas cultivated with barley at the level of the two districts and at the district level. As for the Touz District, the area of land cultivated with barley reached (4517) dunams, with a ratio of (1.14) % of arable land, while in Amerli District it amounted to (2625) dunams, representing (1.24)% of arable land.

Table (3) Cultivated area for wheat and barley crops for the year 2022, in Al-Touz District, by province

Percentage of barley area of arable land %	Area of cultivated barley/dunum/2021-2022	Valid area/acre	County name	County number
1.01	93	9196	Qalkhano is great	1
1.35	286	21174	Shurao	1
1.13	103	9130	Small Qalkhano	2
3.73	261	6996	Sancor	2
1.55	315	20334	Albu Sabah Al Gharbia	3
0.59	45	7670	Mel Nasser	3
8.93	284	3182	Shah Siwan	4
0.00	0	5270	Call me Kanye	4
0.55	40	7319	Touz	5
1.84	81	4396	Bassas	6
1.21	92	7603	Yinjah	7
0.70	86	12279	Bablan	8
2.66	356	13403	Eastern sweets	16
3.32	215	6467	His little sweet	33
0.81	125	15408	Southern Heliwa	38
2.77	61	2205	Albu Sabah Al Sharqia	40
0.87	83	9578	Khadr and me	47
0.50	67	13424	Nogol	51
0.49	75	15267	For you and Qashlan	52
0.00	0	7089	Heap yea	53
0.00	0	9117	Sheikh Hawazi	54
1.75	75	4289	It's going to be great	60
0.00	0	8297	A scene	61
0.31	17	5412	Talao	62
2.57	28	1089	Omar Sufi	63
4.49	41	913	In front of Muhammad Rashid	64
11.08	126	1137	Make sure you don't mind	65
8.11	215	2652	Sefer Bayat	66
1.40	46	3277	Take care of it	67
0.00	0	7002	Lotfi Agha	68

0.00	0	13451	Your generosity	71
0.00	0	2191	Haider Sur	71
1.25	127	10198	cox	9
2.79	105	3766	Especially Darlie	10
0.43	98	22800	Suleiman Bey	14
0.45	51	11409	Fossil	15
0.52	32	6177	Brand new	23
2.00	86	4308	Nahrawan	28
0.91	93	10265	For people	36
0.94	22	2333	He has a plain accent	46
0.99	47	4745	spread	48
1.02	95	9306	Bangs	49
0.49	14	2839	He is safe	50
0.92	96	10423	fort	55
1.94	151	7788	Repent of your crime	56
1.37	63	4611	Salehi is old	57
2.56	116	4531	Dragee	58
0.82	51	6207	Gory	59
0.99	32	3242	And see me below	69
0.14	22	16223	Zandana	70
1.14	4517	397388	the total	

Source: Organized by the researcher based on the Ministry of Agriculture/Saladin Agriculture Directorate - Tuz Agriculture Division (unpublished data), 2022.

In the district of Al-Touz, there is a difference at the district level. It was divided into four categories, each of which is ranked first: the district of (Haliwa Al-Sharqiya/16, Al-Bu Sabah Al-Gharbiyya/3, Shoraw/1, and Shah Siwan/4) with an area of (356, 315, 286, 284 dunums, respectively. In second place came each of the districts (Sankor/2, Safar Bayat/66, and Helwa al-Saghira/33), with areas of (261, 215, 215) dunums, respectively, and in third place came each of (Tape Jarmak). /56, Cox/9, Kojak Bash Tepe/65, Southern Halwa/38, Daraji/58, Khasa Darli/10, Qalkhano Saghir/2, Suleiman Bey/14, Qalaa/55, Gharra/49, Laqum/36, Qalkhano Kabir/1, Yengja/7) with areas reaching (151, 127, 126, 125, 116, 105, 103, 98, 96, 95, 93, 93, 92) dunums respectively, and in fourth place came the rest of the provinces, and this discrepancy It results from the nature of the soil in the base grade and the availability of water resources, as the area is semi-arid, and its rain is not guaranteed.

As for the percentage of barley area among the arable areas, with regard to the Touz district, there is a variation in the percentages of the area exploited for the cultivation of barley crops. At the district level, the district of (Koçek Bashtepe/65) came in first place with a percentage of (11.08)%, followed by the district. (Shah Siwan/4) with a rate of (8.93)%, and then (Safar Bayat/66) county, with a rate of (8.11)%. As for the lowest counties that were recorded devoid of cultivated areas for the barley crop, they are (Kolh Kani/4, Kumh Yi/53). Sheikh Hawazi/54, Agha Mashhad/61, Lotfi Agha/68, Karamak/71,

Haidar Sur/71). Because some of them are exploited for wheat cultivation, others are not suitable for agriculture as they are rugged areas and extend through them are some of the main seasonal valleys, such as the Ak Su Valley.

3. Geographical distribution of wheat and barley production in Tuz Khurmatu district:

It is clear from Tables (4) and Maps (2) and (3) that the wheat crop recorded a production amount of (25007.25) tons, in the Touz district, distributed among (50) districts, which were distributed

In four levels, the highest production quantity was in (Chorau/1) province with a production quantity of (5602.5) tons, and in second place came (Sangor/2) province, which reached (3480) tons, and in third place came (Shah Siwan) provinces. /4, Bablan /8) amounting to (2179.5, 1448.25) tons, respectively, while the rest of the provinces came in fourth place, with production quantities ranging from (0 – 1400.6) tons. As a result of the influencing factors that will be detailed later.

Table (4) Area and production of wheat crop in Tuz Khurmatu District by province, for the year 2022

Production quantity/ton	Barley area/dunum	Production/ton	Wheat area/acre	County name	County number
36.73	93	207	276	Qalkhano is great	1
112.97	286	5602.5	7470	Shurao	1
40.68	103	471	628	Small Qalkhano	2
103.09	261	3480	4640	Sancor	2
124.42	315	1287.75	1717	Albu Sabah Al Gharbia	3
17.77	45	64.5	86	Mel Nasser	3
112.18	284	2179.5	2906	Shah Siwan	4
0	0	0	0	Call me Kanye	4
15.8	40	188.25	251	Touz	5
31.99	81	209.25	279	Bassas	6
36.34	92	218.25	291	Yinjah	7
33.97	86	1448.25	1931	Bablan	8
140.62	356	1194.75	1593	Big Eastern sweets	16
84.92	215	261.75	349	His little sweet	33
49.37	125	699.75	933	Southern Heliwa	38
24.09	61	134.25	179	Albu Sabah Al Sharqia	40
32.78	83	150.75	201	Khadr and me	47
26.46	67	312	416	Nogol	51
29.62	75	306	408	For you and Qashlan	52
0	0	42.75	57	Heap yea	53
0	0	0	0	Sheikh Hawazi	54

29.82	75	389.25	519	It's going to be great	60
0	0	209.25	279	A scene	61
6.71	17	0	0	Talao	62
11.06	28	3	4	Omar Sufi	63
16.19	41	159	212	In front of Muhammad Rashid	64
49.77	126	681	908	Make sure you don't mind	65
84.92	215	871.5	1162	Sefer Bayat	66
18.17	46	159	212	Take care of it	67
0	0	54	72	Big Kush (Lotfi Agha)	68
0	0	0	0	Your generosity	71
0	0	0	0	Haider Sur	71
50.16	127	673.5	898	cox	9
41.47	105	45	60	Especially Darlie	10
38.71	98	207	276	Suleiman Bey	14
20.4	51	138	184	Fossil	15
12.64	32	165	220	Brand new	23
33.97	86	69	92	Nahrawan	28
36.73	93	125.25	167	For people	36
8.69	22	0	0	He has a plain accent	46
18.56	47	186.75	249	spread	48
37.52	95	191.25	255	Bangs	49
5.53	14	0	0	He is safe	50
37.92	96	553.5	738	fort	55
59.64	151	1015.5	1354	Repent of your crime	56
24.88	63	99	132	Salehi is old	57
45.82	116	321	428	Dragee	58
20.4	51	131.25	175	Gory	59
12.64	32	39.75	53	And see me below	69
8.69	22	62.25	83	Zandana	70
1784.81	4517	25007.25	33343	the total	



Source: Organized by the researcher based on the Ministry of Agriculture/Saladin Agriculture Directorate - Tuz Agriculture Division (unpublished data), 2022.

As for the barley crop, there is also a discrepancy in the quantity of production of the barley crop in the Touz district, as the quantity of its production reached (1784.81) tons. In the district of Touz, there is a difference at the district level. It was divided into four categories, each of which is ranked first: the district of (Haliwa al-Sharqiya/16, Al-Bu Sabah al-Gharbiyya/3, Shoraw/1, and Shah Siwan/4) with a production of (140.62, 124.42, 112.97, 112.18) tons, respectively. In second place came the provinces (Sancor/2, Safar Bayat/66, and Helwa al-Saghira/33) with a production quantity of (103.09, 84.92, 84.92) tons respectively, and in third place came (Tabbah). Jarmak/56, Cox/9, Kojak Bash Tepe/65, Southern Halwa/38, Daraji/58, Khasa Darli/10, Qalkhano Saghir/2, Suleiman Bey/14, Qalaa/55, Gharra/49, Laqum/36, Qalakhano Kabir/1, Yenka/7) and with production (59.64, 50.16, 49.77, 49.37, 45.82, 41.47, 40.68, 38.71, 37.92, 37.52, 36.73, 36.73, 36.34) tons, respectively, and in fourth place came the rest of the provinces, and as In map (2-6), this discrepancy results from the nature of the soil at the base level and the availability of water resources, as the region is semi-arid and its rain is not guaranteed. This will be detailed in Chapter Three.

### 3. Spatial variation of wheat and barley crop production using statistical hot spots (Hot Spot Analysis (Getis - Ord Gi and Morans coefficient):

Geographic studies aim to analyze the spatial variation of geographical phenomena and link them with laws and spatial relationships in order to reveal the spatial connections of the studied phenomena. The processing and spatial analysis are statistical Spatial Statistics Tools in Geographic Information Systems are the ideal means in analysis processes to reveal spatial disparities and mutual relationships and correlations between different phenomena, using Mapping Clusters that indicate the formation of groups that are similar in the values of the characteristics of the spatial units resulting from entering the data table for the production of wheat and barley crops. We rely on calibrating statistical values using Moran's I method, which shows the degree of variation of each crop at the level of spatial units, and then knowing the geographical factors that led to the similarity in the values of each parameter in terms of values for high or low production (LH). In the current research, the districts of Al-Touz and Amerli in Salah Al-Din Governorate were chosen as a field of study by preparing maps of the spatial distribution of cultivated areas and the production of wheat and barley.

The statistical hot spot analysis tool distinguishes statistically significant spatial clusters of high values (hot spots) and low values (cold spots) and generates new outputs of the phenomenon with standard degree values (Z-Score, and Probability Values (P-Value), which indicate the observed spatial clustering of high or low values more clearly than expected in a normal distribution of the same values. This tool calculates the phenomenon in the selected data, and the results of the Z-Score and the probability values (Value) tell us where the phenomenon is clustered in a large spatial manner depending on the high or low values.

### 4. Interpretation of the standard score value (Z-Score and Probabilistic Values (P-Value):

Most statistical tests indicate whether or not to accept the null hypothesis (the null hypothesis). The null hypothesis for pattern analysis emphasizes the randomness of the spatial distribution, while the probability value (P-Value, which is called the level of significance. When it is very small, it means that (the probability is small) in observing a random spatial distribution in the results, and we can reject the null hypothesis.

The standard score (Z-Score) is a tool for managing results. For example, when the standard score (Z-Score) is (2.5), this means that the score is (2.5) for both values: the standard score (Z-Score). And the probability (P-Value) associated with a normal distribution.

To reject the null hypothesis, and accept the alternative hypothesis that emphasizes the non-randomness of spatial distribution in pattern analysis, we must make a judgment accepting the degree of risk, that is, we wish to (accept the error), that is, we incorrectly reject the null hypothesis. Accordingly, before we conduct the spatial census, we choose the level of confidence, The ideal confidence levels are: (90, 95, 99(%), and the confidence level (99)% would be the most acceptable in this case and indicates that we want to reject the null hypothesis unless there is in fact a possibility that this pattern was created randomly by chance, a probability less than (1)%, as in Table (5).

Table (5): Ideal levels of trust

<b>z-score (Standard Deviations)</b> الدرجة المعيارية (الانحراف المعياري)	<b>p-value (Probability)</b> قيم الدرجة الإحصائية (مستوى المعنوية)	<b>Confidence level</b> درجة الثقة الإحصائية
< -1.65 or > +1.65	< 0.10	90%
< -1.96 or > +1.96	< 0.05	95%
< -2.58 or > +2.58	< 0.01	99%

Arc GIS Desktop 10.2 Help, Hot Spot Analysis (Getis-Ord Gi\*)

Therefore, the probability value is given (P-Value) with the given results to compare the given probability value (Value) with the significance level: (0.01, 0.05, 0.1).

If the probability value is (P-Value) is smaller than one of the three previous significant levels above, the null hypothesis is rejected, and the statistically significant alternative hypothesis is accepted.

If the probability value (P-Value) is greater than: (0.01, 0.05, 0.1), so the alternative hypothesis is rejected and the null hypothesis (1) is accepted, as shown in the figure (). Referring to the normal distribution table for the values of (P), we find that:

valueZ corresponding to 0.05 is 1.96

And valueZ corresponding to 0.01 is 2.58

Which means that he

$$P = (-1.96 < Z < 1.96) = 95\%$$

$$P = (-2.58 < Z < 2.58) = 99\%$$

When the significance level is chosen (0.05 or 0.1), this means the possibility of making the wrong decision regarding the results, and when the significance level is (0.05 or 0.01), that is, the lower the value (P) or the level of significance, this means increasing the probability of us making the correct decision regarding rejecting the null hypothesis. The value of (P) is calculated, which is the probability that the calculated value of (Z) falls outside the region of accepting the null hypothesis (null hypothesis) (2).

5. Spatial statistical analysis of wheat and barley crop production in Tuz Khurmato district using the hot spot model Hot Spot Analysis:

Based on the above, the hot spot analysis model method will be adopted in the processing processes and spatial analysis of agricultural investment for the wheat crop in the study area, which ranked first in production in relation to cultivated areas, as the amount of production in Al-Touz district for the year 2022 reached (25007.25) tons, while Production in Amerli district amounted to (9815.25) tons. With an average overall yield of (1,333) tons/dunum, and despite the spread of cereal crop cultivation in all provinces

of the study area, wheat crop production is not distributed uniformly, but rather varies from one province to another, as in Table (6) and Map (4) (5) ).

Table (6) valueGiZScore for wheat and barley crop production in Tuz Khurmato district

GiZScore barley production	GiZScore wheat production	County name	County number
-0.29959	-0.55082	For people	36
-0.961756	-0.623248	It's a new bronze	23
0.00205	-0.553062	Nahrawan	28
-0.646824	-0.661172	Fossil	15
-0.476494	-0.754031	Ghamas and Suleiman relaxed	48
0.177162	-0.566823	Bangs	49
0.053755	-0.367026	Especially Darlie	10
-0.712861	-0.682447	Suleiman Bey	14
0.01961	-0.548324	Dragee	58
-0.938703	-0.797608	Plain accent	46
-0.668277	-0.47832	Balkanah Salem	50
0.83441	0.263816	Bablan	8
0.28653	-0.353151	cox	9
0.932863	0.472552	Bassas	6
1.060253	0.560737	Little sweetie	33
1.087807	1.109143	Yinjah	7
-0.304753	-0.45593	My favor	57
-0.041204	-0.31698	Repent of your crime	56
-1.05159	-0.671329	Zandana	70
2.460173	1.022503	Siwan sheep	4
-0.760008	-0.508652	Gory	59
1.321201	-0.028989	Helwa Kabira South	38
-0.610253	-0.597348	Touz	5
0.314608	0.220472	fort	55
-0.28541	-0.370273	Take care of it	67
0.198543	-0.025963	Kojak bash repent	65
0.084214	-0.099732	In front of Muhammad Rashid	64
-0.217369	-0.298069	Sofarbiyyat	66
-1.008626	-0.803137	Lotfy Agha	68

4.067682	1.107716	Heliwa Kabira North	16
4.054364	1.518054	Albu Sayah Al Gharbia	3
-0.611379	-0.614353	Albu Sabah Al Sharqia	40
-1.637029	-0.900744	Your generosity	71
1.862172	1.435816	Khader Wali	47
-0.716222	-0.461316	Sheikh Hawazi	54
-1.998615	-1.049175	Haidra Sur	72
-0.931864	-0.721679	Omar Sufi	63
-0.87195	-0.726749	Nogol	51
0.347533	1.203071	Sancor	2
0.066156	0.751991	Sari Jam Bell	60
-1.393529	-0.853627	Talao	62
-1.264562	-0.681561	For you and Qushahlan	52
-1.343554	-0.866718	Kumhiye	53
-1.177774	-0.767796	Mel Nasser	3
1.564228	4.146012	Agha Mashhad	61
-0.206406	-0.467387	He said he was young	2
0.873362	3.595802	Shurao	1
-0.514404	-0.507162	He said, "Khanlou is great."	1
-0.728104	-0.592858	Kani's cola	4
-1.48641	-0.862357	He saw me below	69

Source: Depending on the tool application Hot Spot Analysis, using ARC MAP10.8 software.

The positive value of (GiZScore) is a statistical indicator or measurement of the normal distribution, given that the mean is zero and the standard deviation is one, and a high positive value of (Z) more than (2.96) at a significance level (0.00) makes the spatial units that produce wheat and barley crops outside the acceptance zone, i.e. in the region Rejection of the null hypothesis, which indicates that the distribution of these two crops is not random, but rather they form clusters (hot spots) of spatial units with high values for the production of wheat and barley crops, with a statistical significance of more than (99)%, which are spread in the northwestern parts of The study area is in red and brown for the wheat crop, as it includes the third and fourth categories with a standard deviation of (0.7 - 4.1), which are the provinces of (Shoraw 1, Aggeh Mashhad 61) as the highest provinces for hot spots. While the areas that constitute clusters (hot spots) for the barley crop were in the western parts in general, with a standard deviation ranging from (1.65 - 4.07) and came in four provinces represented in red and brown, they are the most

clustered according to production values, which are (Al-Bu Sabah Al-Gharbiyya, Helwa Kabira Al-Shamali, Khadr Wali, Swan Sheep).

#### 6. Spatial variance analysis

The study of spatial variation lies in geographic information systems. GIS represents the latest applied computer field that contributes to supporting contemporary geographic studies by providing a mechanism for analyzing spatial data and linking it to tabular information. Dealing with tabular data in geographic information systems is considered one of the aspects copied from database management systems (Database Management System). DBMS), and we can measure the spatial variation model in GIS techniques using Moran's method, through Mapping Clusters in GIS techniques. The method takes knowledge of the extent to which the studied features vary into consideration and is known as spatial models and measures their strength and then measures the adjacent features. (Similar) with their statistical values (3) Geographic information systems programs using Moran's I method through cluster analysis. This is what leads to advanced cluster analysis in geographic information systems techniques as a programmed statistical analysis that depends on calculating many and varied variables for many different models and then comparing those models containing on these variables in different proportions to each other depending on the variables they contain and the arrangement of their connections to each other in the form of clusters of graduated shapes (Dendrograms) and finding the percentage of similarity between the different variables and observations after comparing them to each other (4). Moran's I method is used to find the cluster variance when we study the variance based on The boundaries or areas of clustering of high and low values for the production of the two crops. When we use neighbors based on spatial similarity, we use the binary weight or the standard weight vector that results from processing the inputs of the cluster analysis using the Moran's I method, through the average value first, and then the difference from this value is calculated for each parameter of The neighborhood is multiplied by the weight of the dissimilar neighborhood, then these values are added and the sum is multiplied by the ratio of the difference from the average value of the original feature to the variance. As in the following equation (5).

$$I_i = \frac{(X_i - \bar{X})}{S^2} \sum_j w_{ij} (X_j - \bar{X})$$

I = clustering of positive or negative values.

$\bar{X}$  = the average value of the phenomenon.

$X_i$  = value of the teacher studied.

$X_j$  = adjacent feature value.

$w_{ij}$  = juxtaposition weight.

$S^2$  = value of the studied teacher.

The value has been calculated. To know the degree of confidence enjoyed by the spatial variation model for wheat and barley crop production, the results of the analysis appear after the digital processing process after going through several statistical stages that show the value of crop variation.

When the tool is applied, three results appear: (LMiZScore, Lmindex, LmiP-value). It contains a low production value surrounded by other high values, while HL indicates a concentration of high production values surrounded by other low production values.

Wheat production varies at the level of agricultural provinces through visual or statistical analysis resulting from the use of inverse distance. Inverse Distance to detect typical spatial differences through the standard score represented by the LMiZScore value, which

begins by specifying the null hypothesis  $H_0$ , which states that there is no difference in spatial variation compared to the alternative hypothesis  $H_1$ , which indicates that there is a difference in the variation of statistical values spatially. The ZScore value extracted in the map indicates It is possible to reject the null hypothesis  $H_0$  since the discrepancy is large between the values of the LMiZScore cluster analysis outputs for the agricultural provinces that produce wheat.

The spatial variation map of spatial statistical values reveals the emergence of spatial variation between the agricultural provinces that were classified on the basis of the statistical value index process when Moran's I analysis of clustered clusters. For wheat and barley crops in Tuz Khurmatu and Amerli districts.

#### 7. Analysis of spatial variation for wheat and barley yields in Tuz Khurmatu District:

It is clear from applying the previously mentioned variation indicators to the wheat and barley crops in Tozerkhomato District, that there is a large variation at the district level, as shown in Table (7).

Table (7) Applying the values of spatial variation equations for wheat production in Tuz Khurmatu district

LMiPValue	LMiZScore	LMiIndex	County name	County number
0.376	0.398473	0.00004	For people	36
0.368	0.513852	0.000056	It's a new bronze	23
0.426	0.315803	0.000039	Nahrawan	28
0.328	0.559817	0.000067	Fossil	15
0.24	0.693102	0.000085	Ghamas and Suleiman relaxed	48
0.376	0.521295	0.00005	Bangs	49
0.34	0.12229	0.00002	Especially Darlie	10
0.136	0.647974	0.000056	Suleiman Bey	14
0.328	0.528491	0.000024	Dragee	58
0.154	0.608596	0.000132	Plain accent	46
0.428	0.427395	0.000093	Balkanah Salem	50
0.496	-0.350542	-0.000119	Bablan	8
0.292	-0.562392	-0.000029	cox	9
0.232	-0.442548	-0.000065	Bassas	6
0.102	-0.762211	-0.000058	Little sweetie	33
0.078	-1.695485	-0.000216	Yinjah	7
0.394	0.161242	0.000031	My favor	57
0.37	-0.550157	-0.000165	Repent of your crime	56
0.176	0.472224	0.000034	Zandana	70
0.264	0.144536	0.000072	Siwan sheep	4
0.496	0.336249	0.000055	Gory	59
0.36	-0.279503	-0.000014	Helwa Kabira South	38

0.352	0.508668	0.000042	Touz	5
0.188	0.293719	0.000004	fort	55
0.354	-0.072158	-0.000018	Take care of it	67
0.414	-0.176762	-0.000027	Kojak bash repent	65
0.34	-0.103027	-0.000039	In front of Muhammad Rashid	64
0.434	-0.458029	-0.000157	Sofarbiyyat	66
0.3	0.653405	0.000127	Lotfy Agha	68
0.082	0.875272	0.000104	Heliwa Kabira North	16
0.112	1.20026	0.000375	Albu Sayah Al Gharbia	3
0.424	0.490512	0.000051	Albu Sabah Al Sharqia	40
0.018	0.757357	0.000112	Your generosity	71
0.038	-2.298016	-0.000319	Khader Wali	47
0.436	0.273123	0.000044	Sheikh Hawazi	54
0.012	0.872001	0.000167	Haidra Sur	72
0.358	0.55482	0.000142	Omar Sufi	63
0.19	0.76629	0.000065	Nogol	51
0.398	-0.438516	-0.000521	Sancor	2
0.18	-0.756219	-0.000032	Sari Jam Bell	60
0.238	0.637227	0.000138	Talao	62
0.254	0.679953	0.000041	For you and Qushahlan	52
0.184	0.774096	0.00015	Kumhiye	53
0.348	0.517091	0.000092	Mel Nasser	3
0.01	-4.849385	-0.000437	Agha Mashhad	61
0.284	0.575125	0.000006	He said he was young	2
0.446	-0.321234	-0.000267	Shurao	1
0.484	0.386583	0.000032	He said, "Khanlou is great."	1
0.38	0.287895	0.00003	Kani's cola	4
0.04	0.721152	0.000087	He saw me below	69

Source: The work of the researcher based on a tool Cluster and Outlier Analysis (Anselin Local Morans I), using ARC GIS10.8 software.

The following facts can be observed from the table, maps and figure above:

- The spatial variation in the statistical values of wheat production indicates a difference in the pattern of spatial similarity of the crop, as we find the highest statistical value in the Western Albu Sayyah district, where this value reaches (0.000197-0.000375) for the value  $L_{min}$  index with a standard  $L_{miZ}$  Score score of (1.20026) compared to a probability of  $LMIP$  Value for production values of (0.112).

– The lowest value of spatial variation was reached  $L_{mi}$  index in the two provinces (Sinkor, Aghceh, Mashhad) with a value ranging between  $(-0.000521 \text{ _ } -0.000342)$  and a standard score  $L_{miZ}$  Score ranging between  $(-2.4788 \text{ _ } -1.3212)$  with a probability  $L_{miP}$  Value  $(0.398, 0.01)$  and reveals to us the spatial nature of this large discrepancy between the statistical values of the reciprocal of the distance resulting from the difference in the characteristics of neighboring features, and this is confirmed by the spatial statistics of neighboring features to reveal the pattern of variation of the value related to the features with the average value when using the Morens index. Moran's I for statistical values, if their distribution is clustered, but if the calculated average production is more, this means that the spatial variation of wheat crop production is different or dispersed, and as in the form of the distribution of statistical values  $L_{mi}$  index.

– Figure (2-5) indicates that the distribution pattern of wheat crop production in the district is random, meaning that the factors that affect the distribution of wheat production are also randomly distributed. Consequently, spatial variation is large among agricultural provinces.

As for the barley crop, there is also a large variation at the district level in the district, and this is proven by the results in Table (8)

Table (8) Applying the values of spatial variation equations for barley production in Tuz Khurmatu District

$L_{miP}$ Value	$L_{miZ}$ Score	$L_{mi}$ Index	County name	County number
0.352	-0.492406	-0.000004	For people	36
0.242	0.720636	0.000147	It's a new bronze	23
0.294	-0.107548	-0.000001	Nahrawan	28
0.404	0.435613	0.000058	Fossil	15
0.482	0.311249	0.000056	Ghamas and Suleiman relaxed	48
0.348	0.100071	0.000002	Bangs	49
0.398	-0.098688	-0.000006	Especialy Darlie	10
0.134	-0.986893	-0.000025	Suleiman Bey	14
0.44	-0.140167	-0.000013	Dragee	58
0.24	0.732112	0.00023	Plain accent	46
0.33	0.584357	0.000197	Balkanah Salem	50
0.19	-0.927813	-0.000013	Bablan	8
0.378	0.041239	0.000005	cox	9
0.21	-0.83554	-0.000041	Bassas	6
0.244	0.319969	0.000144	Little sweetie	33
0.092	1.434618	0.000013	Yinjah	7
0.44	0.070218	0.000011	My favor	57
0.412	-0.354161	-0.000138	Repent of your crime	56
0.246	0.705564	0.000082	Zandana	70
0.1	1.443175	0.001313	Siwan sheep	4
0.39	0.467337	0.000092	Gory	59
0.156	1.372937	0.000157	Helwa Kabira South	38
0.468	0.343142	0.000047	Touz	5
0.308	0.412034	0.000007	fort	55
0.232	-0.693647	-0.000292	Take care of it	67
0.422	0.047181	0.000029	Kojak bash repent	65
0.244	-0.616514	-0.000276	In front of Muhammad Rashid	64
0.292	-0.645597	-0.000903	Sofarbiyyat	66



0.302	0.662467	0.000257	Lotfy Agha	68
0.016	3.09019	0.001402	Heliwa Kabira North	16
0.004	3.309024	0.0027	Albu Sayah Al Gharbia	3
0.364	0.518288	0.000049	Albu Sabah Al Sharqia	40
0.052	1.261743	0.000386	Your generosity	71
0.022	-2.478792	-0.000081	Khader Wali	47
0.498	0.261025	0.000095	Sheikh Hawazi	54
0.008	1.619724	0.000608	Haidra Sur	72
0.238	0.793341	0.000276	Omar Sufi	63
0.182	0.941855	0.000112	Nogol	51
0.276	-0.691765	-0.000484	Sancor	2
0.446	-0.067651	-0.000002	Sari Jam Bell	60
0.108	1.107322	0.000387	Talao	62
0.038	1.310758	0.000074	For you and Qushahlan	52
0.152	1.063703	0.00045	Kumhiye	53
0.178	0.873633	0.000177	Mel Nasser	3
0.028	-2.400869	-0.000746	Agha Mashhad	61
0.398	-0.42415	-0.00002	He said he was young	2
0.002	-1.08571	-0.000392	Shurao	1
0.34	-0.601067	-0.000005	He said, "Khanlou is great."	1
0.322	-0.081832	-0.000006	Kani's cola	4
0.026	1.314589	0.000231	He saw me below	69

Source: The work of the researcher based on a tool Cluster and Outlier Analysis (Anselin Local Morans I), using ARC GIS10.8 software.

- The lowest value of spatial variation was reached Lmindex in the provinces of (Safarbiyet, Agce Mashhad, Sankor, Choraw, Büyükbaştepe, Emam Muhammad Rashid) with a value ranging between (-0.000903\_ -0.000276) and a standard score of LmiZScore ranging between (-0.645597\_ -0.000276), as for the probability of variation and concentration. The lowest provinces were (Shorao, Albu Sayyah Al Gharbiya), with a probability of LMipValue of (0.02, 0.04), respectively.

- As for the distribution pattern of wheat crop production in the district, it is clustered (clustered), meaning that the factors that affect the distribution of barley production are concentrated in the districts and devoid of others.

### Conclusions:

1. The spatial analysis of the production of wheat and barley crops in the study area showed that production operations amounted to (25,007.25) tons of wheat in Tuz Khurmatu District, at a rate of (71.8)%, while the amount of wheat production in Amerli District amounted to (9,815.25) tons, at a rate of (28.2)%, of the total Production of the two judiciaries.

2. Its production also varied, as the quantity of its production reached (1784.81) tons in the Tuz district, at a rate of (63.3)%, while its quantity in the Amerli district reached (1036.82) tons, at a rate of (36.7)%.

3. Through the analysis of production and distribution impacts, it emerged that the economic impacts ranked first, at a rate of (70)%, since most farmers produce wheat and barley for economic purposes and not for food, followed by the social impacts, at a rate of (20%), and finally the environmental impacts, at a rate of (10%).

### **Recommendations:**

1. It is necessary to pay attention to the cultivation of wheat and barley crops in the study area, especially since the region has geographical capabilities that allow the cultivation of most types of crops, especially strategic grains, which contribute directly to the population's food and industrial raw materials, and to reduce imported quantities.
2. Managing and rationalizing water consumption using modern irrigation methods (sprinkler irrigation) and using a water management system, benefiting from groundwater to fill the shortage of surface water, with the necessity of analyzing the water to ensure the concentrations of dissolved salts in it and the extent of the tolerance of agricultural crops, and the necessity of relying on appropriate methods in collecting rainwater for exploitation. in agriculture.
3. The need for the state to contribute to reducing production costs by providing support to equip farmers with agricultural supplies (seeds, fertilizers, pesticides, etc.) to increase and improve the level of production in quantity and quality.

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