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The Spatial Variation of Predictive Value for Date Production in Thi Qar Governorate, Iraq

Hanan Yahya Muhammad[1], Munaf Muhammad Zrzor[2], Abdul Amir Juma Mahdi[3], Mahmoud Majeed Ibrahim[4], Qudos Osama Qawam[5]

Abstract

Geography studies the phenomena present on the Earth's surface, describing patterns and analyzing the processes that have created them. It aims to make more accurate and positive decisions supported by data databases, scientific models, applied studies, and analytical models. Recently, artificial intelligence (AI) has gained significant attention, especially in the academic field, particularly in geography and its connection to geographic information systems and remote sensing. This interest stems from the integration of geography and artificial intelligence (Geo AI), which provides various new methods for addressing a variety of problems through systematic modeling to monitor and predict geographic reality.

Keywords: *Dates, Regression Coefficient, Date, Thi Qar, Production.*

1. Introduction

Geographers sometimes tend to predict the occurrence of geographic patterns or future distributions, interpret, and determine the relationship between them and other surrounding phenomena. Prediction refers to the researcher's ability to create a future image of the phenomenon based on the current situation, representing the process of planning future plans or predicting agricultural production based on the production of previous years.

Here, a predictive and probabilistic value map for date palm crop production in the study area was developed using regression techniques. This was based on agricultural production data for forage and industrial crops from 2012 to 2022 in the study area, considering various aspects to draw research conclusions.

Research Problem and Hypothesis

The research problem revolves around the spatial variability of predictive values for date palm production in Thi Qar Governorate. Finding a solution to this problem and providing logical explanations requires understanding the spatial variability of predictive values for date palm production in Thi Qar Governorate.

The hypothesis of the research aims to interpret the spatial variability of agricultural production

[1] Aliraqia University, College of Arts, Department of Geography, Iraq. Email: hanan.al-khammas@aliraqia.edu.iq
[2] University of Baghdad - Ibn Rushd College of Education for Humanities, Department of Geography, Iraq
Email: munaf.m@ircoedu.uobaghdad.edu.iq
[3] Aliraqia University, College of Arts, Iraq. Email: abdulameer.j.mahdi@aliraqia.edu.iq
[4] Aliraqia University, College of Arts, Iraq. Email: mahmood.alzaidi@aliraqia.edu.iq
[5] University of Baghdad, College of Arts, Department of Geography, Iraq. Email: qods.hasan@coart.uobaghdad.edu.iq

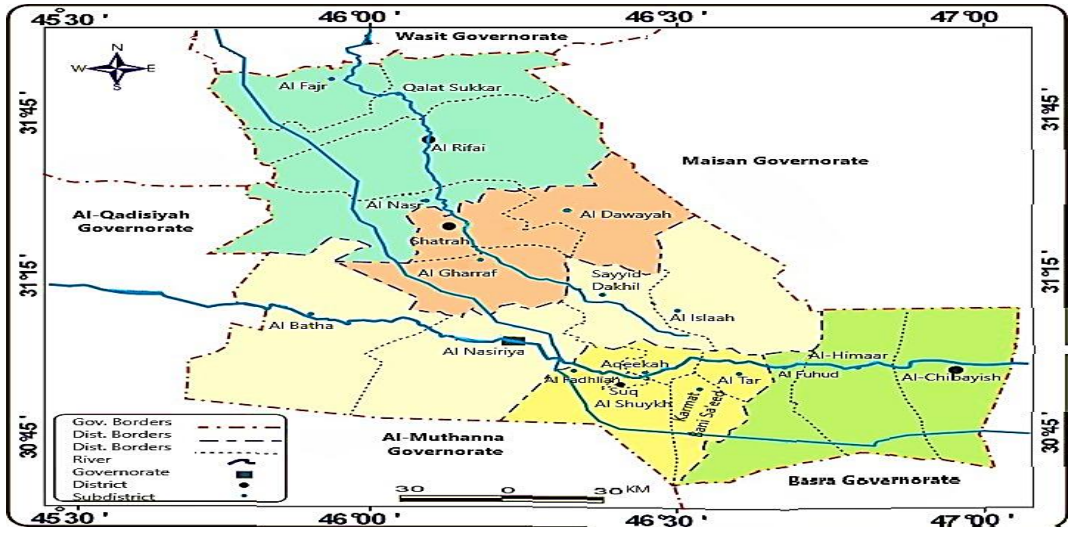
in Thi Qar Governorate in both its spatial and temporal dimensions, considering its future behavior reflected through the temporal series extending from 2012 to 2022 and its impact on crop behavior spatially**.**

2. Geographical Characteristics of the Study Area

The study area, represented by Thi Qar Governorate, extends over an area of approximately 12,900 km^2 (Ministry of Planning and Development Cooperation, 2011, p. 10) in southern Iraq. It is bordered by Wasit Governorate to the north, Maysan, and Basra Governorates to the east, and Qadisiyah and Muthanna Governorates to the west. The southern boundary of the governorate includes parts of Basra and Muthanna Governorates. Administratively, the governorate is divided into 19 districts, as shown in Map (1).

Methodology

Map (1) Administrative division of Thi Qar Governorate.



Source: Ministry of Planning and Development Cooperation, Central Statistical Organization, GIS Division, Administrative Map of Thi Qar Province, 2017.

The scientific approach should be multi-step, with its importance lying in understanding the study results and in saving time for researchers. Here, a descriptive-analytical method was adopted, utilizing quantitative and cartographic techniques in this field.

The scientific research method enables the attainment of accurate results through sequential logical steps to control the spatial behavior of agricultural production phenomena. Our study analyzed agricultural production data based on quantitative aspects, sourced from the Directorate and Agricultural Departments of Thi Qar Governorate for the years 2012-2022. The statistical program SPSS played a significant role in processing this data, while ArcGIS 10.5 was instrumental in mapping the research. Any phenomenon requires a precise description, including agricultural land uses. To avoid description based solely on verbal curves, we must adopt quantitative statistical techniques, which are the researcher's best tool for achieving valid and valuable results, leading decision-makers, and planners to the right

decisions (Ashwaq Musa Hussain, 2012, p. 41).

Prediction Technique

The general trend of a geographical phenomenon can be measured by estimating the general linear trend, as most geographical time series follow a linear trend by taking the following equation:

Y = B + b1x1

Where:

Y = Dependent variable

X = Independent variable value

B = Intersection points with coordinates (a, b)

Which represents the relationship between the y phenomenon and x time. Predicting the value of the studied phenomenon is achieved by finding a regression line (general trend line) of the phenomenon behavior mathematically, so that the sum of squares of the deviations of points from this line, representing the general trend, is minimized. When using this method in time series, the time element constitutes the independent variable and the values of the studied phenomenon represent the dependent variable (Sami Aziz, Iyad Ashour Al-Taie, , 2013, p. 106).

The prediction equation used here is the same as the simple regression equation.

Y = B + b1x1

Where:

Y = Value of the dependent variable (agricultural production)

X = Value of the independent variable (time)

B and b are the constants of the regression equation, and they are extracted through the following equations:

$$\hat{B}_1 = \frac{\sum XY - n\overline{x}\,\overline{y}}{\sum X^2 - n(\overline{x})^2}$$

$$\hat{B}_1 = \frac{\sum XY - \frac{\sum x \sum y}{n}}{\sum X^2 - \frac{(\sum x)^2}{n}}$$

$$\hat{B}_0 = \overline{Y} - \hat{B}\,\overline{X}$$

What is the Difference between Probability and Prediction?

Moving from descriptive geography to applied geography can only be achieved by uncovering the spatial behavior of phenomena and controlling this behavior. There are two techniques for this: probability, which relies on time series, and prediction, which also relies on time series.

If we want to know a certain magnitude of the dependent variable, it is determined by specifying a certain magnitude for the independent variable. This predicts what the magnitude of the independent variable could be if it is one variable, or the magnitudes of the independent variables if they are multiple. Thus, we move from the descriptive circle to the control of the phenomenon and draw its spatial future. Probability, on the other hand, is a branch of mathematics related to events and numerical descriptions of their likelihood of occurrence.

The probability of an event occurring is a number between 0 and 1; the higher the probability, the higher the likelihood of the event occurring. (Alan Stuart and Keith Ord, 6th Ed, 2009)

Probability is the likelihood that agricultural production will be higher than it is in the years of the time series. Probability maps represent a new spatial form for the spatial variation of agricultural production probability, i.e., the spatial image of the probability of what the spatial form of agricultural production will be.

Prediction, on the other hand, gives us production in absolute numbers, which is the amount of production that will be in the future. (E.T. Jaynes, 2003).

Spatial Variation

Spatial variation occurs when the quantity being measured exhibits different values across different spatial locations. Spatial variation can be assessed using spatial descriptive statistics. Studying spatial variation of any phenomenon, including geographical phenomena, requires a classification process based on quantitative criteria, relying on spatial units.

Agricultural Land Use

Agricultural land use is a broad concept that geographers have been interested in studying as it represents human direct interest and activity, and the extent of interaction with the environment. Professor Vink defines land use as any permanent or periodic type of human intervention for the purpose of securing their needs, whether material or spiritual, from natural resources referred to as land. (Delhomme, J. P. 1979, pp. 269–280.)

Agricultural Production

Agricultural production represents the output or yield of a commodity resulting from adding a set of inputs or from the interaction of the production elements used. For the agricultural sector, production consists of the achievements realized in branches or fields of agriculture. Agricultural production can be expressed either physically or monetarily, with agricultural production being expressed physically using known measurement units such as tons.

3. Spatial Variation of Date Palm Production in Thi Qar Governorate for the Year 2022

The total date palm production in Thi Qar governorate for the year 2022 amounted to 73,883 tons, accounting for 8.84% of the total date palm production in Iraq for the same year, which was 835,253 tons. (Ministry of Planning, Report, 2022, p. 8.)

The district of Suq Al-Shuyoukh ranked first in date palm production in the study area, with a production of 26,354 tons, representing 35.66% of the total date palm production in the study area, which was 73,883 tons. Meanwhile, Al-Jabayish district ranked lowest in date palm cultivation in the study area, with a production of only 77 tons.

Map number (2) illustrates the spatial variation of the absolute importance of date palm production in Thi Qar governorate for the year 2022. The data were spatially classified using the logarithmic transformation technique. The highest rank in terms of production importance, ranging between 4,785 and 26,354 tons, was represented by four administrative centers: Suq Al-Shuyoukh, Nasiriyah, Shatrah, and Karmah Bani Said, extending their spatial entities in scattered areas in the central and southern parts of the study area.

The next rank, ranging between 1,841 and 4,784 tons, represented a wider spatial distribution covering a third of the study area's regions, including Al-Isslah, Al-Fahoud, and extending to the southeast part, including Al-Grafa, Al-Nasr, and Al-Bataha, additionally, Qalat Sukr district had a solitary presence in the north of the study area.

The lowest rank, ranging between 77 and 98 tons, was represented by only one district, Al-Jabayish, with its production extending singularly to the southeast part of the study area.

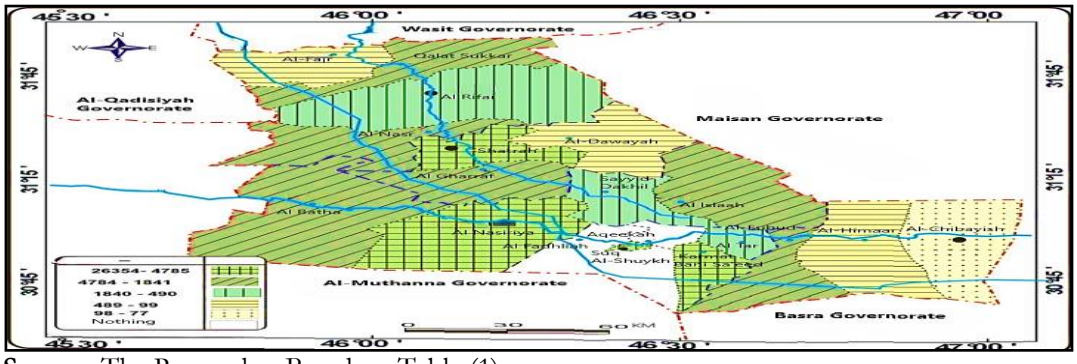
The fourth rank, ranging between 99 and 489 tons, included three districts: Al-Himar, Al-Dawiya, and Al-Fajr, with their spatial entities appearing in three regions, each containing one district, in the south, east, and northwest parts of the study area. The rank ranging between 490 and 1,840 tons included the Altar and Sayed Dakhil districts, extending widely across the central part of the study area and its south, while the Al-Rifai district had a solitary presence in the north of the study area. Date palm cultivation was not observed in the Akika and Al-Fadliya districts as they are marsh areas.

Table (1): Geographic Distribution of dates production in Thi Qar Governorate for the Year 2022.

%	Dates production	Distract and subdistrict		%	Dates production	Distract and subdistrict	
6.73	4975	Karmat Bani Sa'eed	11	34	25364	Al Nasiriya	1
0	0	Al Fadhliah	12	1.02	750	Al Islaah	2
0.96	712	Al Tar	13	A.51	1851	Al Batha	3
0.1	77	Al-Chibayish	14	A.49	1840	Sayyid Dakhil	4
0.15	113	Al-Himaar	15	1.34	987	Al Rifai	5
1.02	754	Al-Fuhud	16	A.27	1675	Qalat Sukkar	6
6.74	4978	Al-Shatrah	17	1.Put	1351	Al Nasr	7
0.3	225	Al-Dawayah	18	0.57	421	Al-Fajr	8
1.97	1456	Al Gharraf	19	35.67	26354	Suq Al-Shuykh	9
100%	73883	the total	T	0	0	Aqeekah	10

Source: Ministry of Agriculture, Directorate of Agriculture in Thi Qar, Planning and Monitoring, Unpublished Data, 2022.

Map (2) Spatial Variation of Date Production in Thi Qar Governorate In 2022.



Source: The Researcher Based on Table (1).

4. Spatial Analysis of Predicted Date Palm Production in Thi Qar Governorate

Table (2) demonstrates that Al-Shikook District had the highest predicted value of date palm production, reaching 87,096 tons, constituting 35.79% of the total predicted value for date palm production in Thi Qar Governorate in 2026, which was 243,326 tons. Conversely, Al-Hammar District had the lowest predicted value for date palm production in 2026, amounting to 118 tons, representing only 0.04% of the total predicted date palm production for the same year.

The increase in date palm production in Al-Shikook District for 2026 amounted to 175.1% compared to 2012, while the increase for Al-Hammar District was 13.4%. The data for predicted date palm production in 2026 were classified into five ranks using logarithmic transformation, as depicted in Map (3). The highest rank, ranging from 23,068 to 87,096 tons, included Al-Shikook, Al-Nasiriyah, Al-Shatra, and Karmah Bani Sa'id districts, spreading spatially across the southern part of the study area.

The next rank, ranging from 6,167 to 23,017 tons, encompassed Al-Ghraaf and Al-Shatra districts, with values of 13,803 and 7,544 tons, respectively, extending spatially across the central part of the study area. Additionally, Al-Qala'a Sukkar and Karmah Bani Sa'id districts were represented as separate areas in the north and south of the study area, respectively, with values of 14,487 and 21,878 tons, respectively.

Districts with the lowest predicted values for date palm production in 2026, ranging from 118 to 441 tons, included Al-Hammar and Al-Jabayish, appearing spatially as a range in the southeast of the study area. Similarly, districts with values ranging from 242 to 1,648 tons, such as Al-Dawayah and Al-Fuhud, appeared spatially as two separate areas, extending in the southeast of the study area.

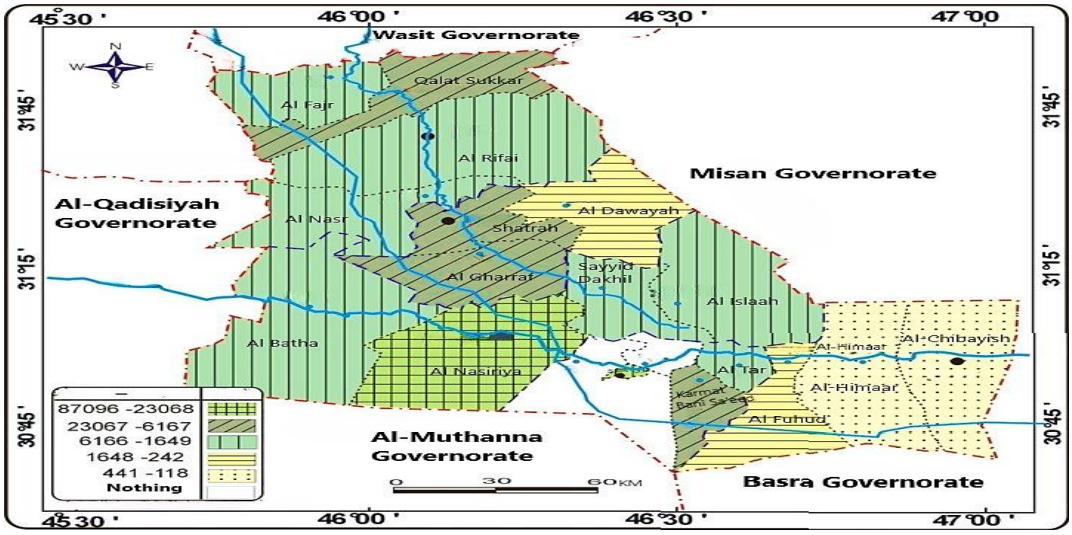
The third rank, ranging from 1,649 to 6,166 tons, included seven districts, appearing spatially as two ranges and one separate area. Al-Fajr appeared as a separate area in the northwest of the study area, while the first range extended in the east of the study area, including Al-Isslaah, Sayyid Duqayl, and Al-Taar districts, and the second range extended in the west of the study area, including Al-Rafaei, Al-Bataha, and Al-Nasr districts.

Comparing the absolute importance map for 2022 (Map 2) with the predictive importance for date palm production in 2026 (Map 3) reveals the following: Al-Fuhud, Al-Isslaah, Al-Rafaei, Karmah Bani Sa'id, Al-Fajr, Al-Shatra, and Al-Ghraaf districts have advanced to higher ranks in predictive value compared to their absolute importance in 2012. Conversely, Al-Dawayah District has occupied a lower rank in 2026 compared to 2012. The rest of the districts have maintained their positions in both years.

Statistical values in table (2) show that most districts in the study area exhibited statistical significance, with correlation coefficients exceeding 0.70, indicating a strong relationship. However, Al-Jabayish, Al-Hammar, and Al-Fuhud districts showed correlation coefficients below the acceptable level. Regarding the coefficient of determination (R2), it showed a similar trend to the correlation coefficients.

The calculated F value (5.12) at degrees of freedom (10-1) and a significance level of 95% indicates that the extracted F values for each district surpassed the critical F value, demonstrating the statistical significance of the model. The calculated t value (1.27) at a significant level of 95% was compared with the critical t value for each district, revealing that it exceeded the critical t value for all districts.

Map (3): Spatial Analysis of the Trend (Predictive) Value of Date Production in Thi Qar Governorate.



Source*:* The Researcher Based on on Table (2).

Table (2): Predicted Date Palm Crop (Tons) in Thi Qar Governorate by Districts for the Year 2026.

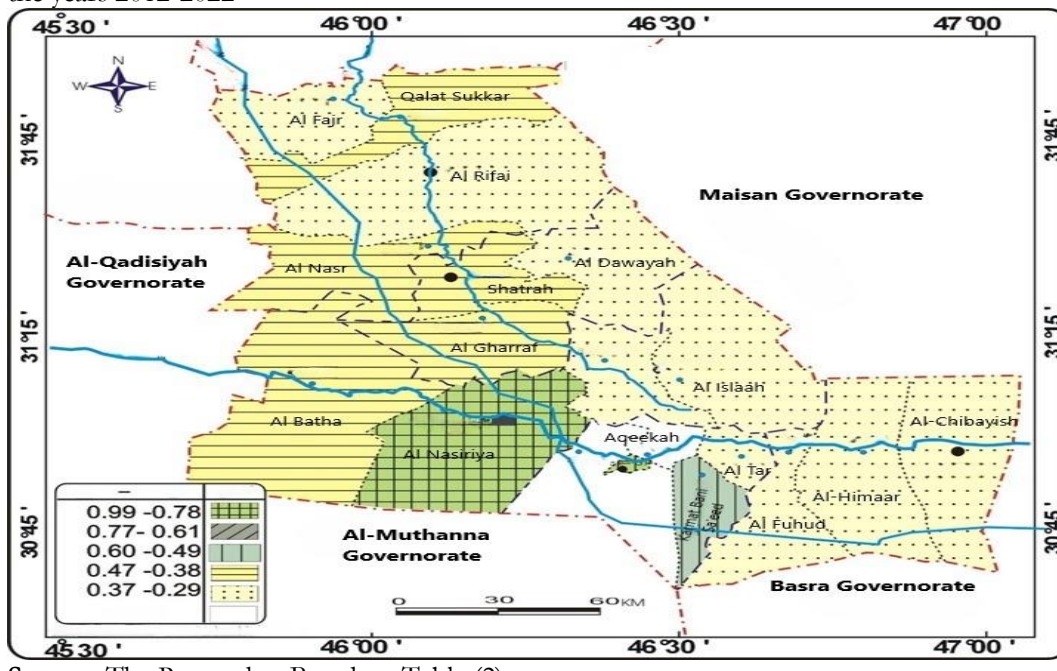
Predictive value	Sig	T	Sig	F	R2	R	District	
75162	0,00	Partial moral	0,00	Total morale	Coefficient of determination	Correlation coefficient	Al Nasiriya	1
1816	0,00	7,30	0,00	53,48	0,85	0,92	Al Islaah	2
3706	0,00	5,10	0,00	26,83	0,74	0,86	Al Batha	3
4289	0,00	4,55	0,00	20,76	0,69	0.83	Sayyid Dakhil	4
1929	0,00	7,32	0,00	53,60	0,85	0.92	Al Rifai	5
14487	0,005	6,21	0,005	38,59	0,81	0,90	Qalat Sukkar	6
3205	0,001	3,63	0,001	13,18	0,59	0.77	Al Nasr	7
2109	0,01	4,74	0,01	22,47	0,71	0,84	Al-Fajr	8
87096	0,00	4,59	0,00	21,15	0,70	0.83	Suq Al-Shuykh	9
-	-	7,03	-	49,54	0,84	0.92	Aqeekah	10
21878	0,004	-	0,004	-	-	-	Karmat Bani Sa'eed	11
-	-	3,87	-	15,04	0,62	0.79	Al Fadhliah	12
4073	0,003	-	0,003	-	-	-	Al Tar	13
123	0,005	4,10	0,005	16,83	0,65	0,80	Al-Chibayish	14
118	0,005	2,67	0,003	5,41	0,22	0,45	Al-Himaar	15
1343	0,03	2,47	0,03	6,13	0,40	0,63	Al-Fuhud	16
7544	0,00	2,57	0,00	6,61	0,42	0,65	Al-Shatrah	17
645	0,006	5,72	0,006	32,71	0,78	0,88	Al-Dawayah	18
13803	0,001	3,60	0,01	13,01	0,59	0,76	Al Gharraf	19

Source: The Researcher Based on the SPSS Software and Date Palm Data for the Period 2012-2022.

5. The Probability of Agricultural Production of Date Palms in Thi Qar Governorate for the Period from 2012 to 2022

The average production rate of the Dawaya district of dates, which approximates one-third of the production of the study area, amounted to 19,158 tons, indicating a probability that the production of this district would exceed its arithmetic mean of 2,887 tons by a probability ratio of 0.99, which is extremely high. Conversely, the Hamar district had the lowest probability that its production rate would exceed its arithmetic mean, amounting to 0.29.

Map (4) Potential Date Production in Thi Qar Governorate, According To. Sub-districts for the years 2012-2022



Source: The Researcher Based on Table (2).

The lowest probability of date palm crop production in the study area, ranging from 0.29 to 0.37, covered more than half of the districts in the study area and spatially extended from the north, through its eastern center, to its southeast. The Fajr district appeared as a singular area for the same rank in the northwest of the study area.

The fourth rank (0.38-0.47) showed spatial distribution following the previous rank, encompassing five districts. Four of them appeared as a western range in the study area, including Shatra, Al-Gharraf, Al-Nasr, and Al-Batha, while Qalat Sukkar extended as a singular area in the north of the study area. The highest rank in this classification (0.78-0.99) included the districts of Suq Al-Shuyukh and Al-Nasiriya, with probabilities of 0.99 and 0.97, respectively, and their spatial entities extended as separate regions. However, ranks (0.61-0.77) did not include any districts from the study area, limiting the third rank (0.49-0.60) to the Karmat Bani Sa'id district with a probability of 0.50.

Thus, two areas in the south of the study area had the highest probability of date palm production, which was lower in the rest of the study area.

A comparison between Map (2) of absolute importance and Map (4) of probability for date palm production reveals the following:

1. The rank of several districts in the study area, including Qalat Sukkar, Al-Dawaya, Shatra, Al-Nasr, Al-Gharraf, Al-Batha, Al-Rifai, Altar, and Sayid Dakhil, declined from higher ranks in absolute importance to lower ranks in production probability. However, the Fajr, Al-Jabayish, Hamar, Fahud, Al-Aslah, Suq Al-Shuyukh, and Al-Nasiriya districts maintained their positions on both maps.
2. The Karmat Bani Sa'id district, which showed date palm production in 2012, rose to higher ranks in production probability for the time series years.

Table (3): Probability of Agricultural Production for Dates in Thi Qar Governorate by District for the Years From 2012 to 2022.

Probability is less than average	Probability	Standard score	Production rate	District	
0,03	0.97	1,9	12604	Al Nasiriya	1
0,67	0,33	0,43-	656	Al Islaah	2
0,62	0,38	0,29-	1371	Al Batha	3
0,64	0,36	0,34-	1146	Sayyid Dakhil	4
0,65	0,35	0,38-	919	Al Rifai	5
0,56	0,44	0,15-	2075	Qalat Sukkar	6
0,61	0,39	0,26-	1515	Al Nasr	7
0,7	0,30	0.52-	231	Al-Fajr	8
0,01	0,99	3,19	19158	Suq Al-Shuykh	9
-	-	-	-	Aqeekah	10
0,05	0,5	0,07	3254	Karmat Bani Sa'eed	11
-	-	-	-	Al Fadhliah	12
0,67	0,33	0,44-	641	Al Tar	13
0,71	0,29	0,54-	115	Al-Chibayish	14
0,71	0,29	0,54-	97	Al-Himaar	15
0,65	0,35	0,38-	928	Al-Fuhud	16
0,54	0,46	0,09-	2400	Al-Shatrah	17
0,70	0,3	0.52-	213	Al-Dawayah	18
0,59	0,41	0,21-	1770	Al Gharraf	19
			2887	Arithmetic mean	
			5099	standard deviation	

Source: Based on the Researcher's Work Utilizing the Spss Software and Date Palm Data for the Period 2012-2022.

6. Conclusions

1. Parts of the central, eastern, and southern regions of the study area represented the highest extent of predictability for date palm production, which diminishes or disappears in the western and other parts of the study area. Regions such as Qal'at Sukkar, Al-Batahah, Al-Rifai, Al-Nasr, Al-Shatrah, Al-Dawaiyah, and Al-Gharaf showed strong correlation relationships.
2. The volume of date palm production for the year 2026 decreased significantly from the northern to the southwestern and southeastern parts of the study area. The correlation between the aforementioned crops for the time series and their production time exceeded the average in regions such as Al-Batahah, Al-Rifai, Al-Nasr, Al-Fajr, Sayid Dakhil, Qal'at Sukkar, Al-Fajr, Al-Jabayish, Al-Gharaf, Al-Dawaiyah, and Al-Shatrah.

3. The largest predicted value for date palm production in 2026 is evident in the northeastern and eastern parts of the study area, while it declines or disappears in other parts of the study area.
4. The highest probability of date palm production in Thi-Qar Province tends towards the south and southeast of the study area, with regions such as Karmah Bani Sa'id, Al-Fadaliyah, 'Akikah, Al-Nasiriya, Suq Al-Shuyukh, and Al-Shatrah showing prominence.

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