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Spatial relationships of agricultural labor and grain production patterns in Al-Rifai district

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Abstract:
This research aims to analyze the spatial relationships between the characteristics of the agricultural workforce and grain production in Al-Rifai district. It examines the impact of demographic, educational, age, and gender variables on production variations among agricultural communities. The results reveal a clear spatial variation in grain production, primarily attributed to differences in the productive efficiency of the workforce. The active age group (15–64) was found to be the most influential variable, as it is the group responsible for carrying out actual agricultural work. Furthermore, the educational level of the workforce plays a significant role in determining production levels. The communities with the most educated workforce recorded higher productivity, reflecting the crucial role of knowledge and scientific expertise in improving farming methods. The study showed that gender (males) has a moderate to strong influence in a number of agricultural groups, as a result of agricultural activity being mainly dependent on physical labor, while the influence of marital structure was weak and ineffective in determining production. The results also showed the limited contribution of young age groups (0-14) and the elderly (65 and over) to agricultural operations, which was reflected in the low level of their connection to production. The main focus of this study is to analyze the spatial and statistical relationships between the characteristics of the agricultural workforce and the grain production pattern, using quantitative analysis tools to measure the strength and nature of the relationship, and to interpret the extent to which each variable contributes to the production variance, in order to identify the most important factors affecting the improvement of human resource utilization and the increase of agricultural productivity.
Keywords: Agricultural workforce, spatial relations, grains, human characteristics, Al-Rifai district

the introduction

The study of the spatial relationships between the agricultural workforce and grain production patterns is a crucial topic in agricultural geography, as it plays a significant role in explaining production variations and guiding agricultural policies toward the optimal use of resources. The Al-Rifai district is a key production area where workforce capabilities vary, leading to clear differences in grain production levels among the agricultural communities within the study area. Therefore, this study aims to analyze these relationships using quantitative analytical methods such as correlation coefficients* and coefficients of determination**, with the goal of revealing the strength and direction of the relationship between the characteristics of the agricultural workforce and grain crop production.

Research problem:

The problem was defined by the following questions:

1- Is there a spatial relationship between the demographic variables of the workforce and the grain production pattern?

2- What demographic characteristics of the workforce have an actual impact on grain production, and which of these characteristics has the greatest impact on increasing productivity?

3- What are the individual impacts of each demographic factor (age, education, gender, marital status) on grain production patterns in the various areas of Al-Rifai district?

Research hypothesis:

1- There is a statistically significant spatial relationship between the demographic variables of the workforce and grain patterns in Al-Rifai district.

2- The demographic characteristics of the workforce differ in their impact on agricultural production, such that some characteristics, such as education level, practical experience, and gender, have a greater impact on increasing grain productivity compared to others.

3- Each demographic factor has a specific individual effect on grain production patterns, as age, education, gender, and social status show different ways of influencing the spatial variation of production.

Research objective:

This research aims to study the spatial relationship between the characteristics of the agricultural workforce (demographic, educational, age, marital status, and gender) and grain production patterns in the Al-Rifai district, and to determine the impact of each of these variables on agricultural production. The research also seeks to statistically measure the strength of these relationships using correlation and determination coefficients, while identifying the variables that most influence production patterns. This will foster a scientific understanding that can contribute to improving the utilization of human resources in agriculture and increasing productivity.

Importance of the research:

The importance of this research stems from its contribution to clarifying the relationship between the characteristics of the agricultural workforce and grain production patterns in the Al-Rifai district. This supports agricultural planning, improves the utilization of human resources, and guides policies toward increasing productivity. Furthermore, the research provides a scientific basis for making agricultural decisions related to increasing grain production and ensuring its sustainability.

Fifth: Spatial and temporal limitations of the study:

LimitsSearchThe spatial aspect of Al-Rifai districtThe administrative units under its jurisdiction are located in the northern part of Dhi Qar Governorate, bordered by Maysan Governorate to the east, Wasit Governorate to the north, Qadisiyah Governorate to the northwest, Muthanna Governorate to the west, and the districts of Shatrah and Nasiriyah to the south. The area is 3,300 km². The Al-Rifai district comprises four sub-districts: Al-Fajr, Qalat Sukkar, the Al-Rifai district center, and Al-Nasr sub-district. The region lies astronomically between latitudes 31°20' and 32° North and longitudes 45°40' and 46°20' East.Map No. (1).The study covers a period of time spanning three consecutive growing seasons: 2021–2022, 2022–2023, and 2023–2024. The overall average production of cereal crops during these three seasons was adopted.

First topic

Grain patterns in Al-Rifai district

The study of grain production patterns is one of the fundamental topics in agricultural geography, given its importance in clarifying the nature of agricultural activity. Grain crops, especially wheat and barley, represent the main pillar of agricultural production in Al-Rifai district, due to their direct role in achieving food security and enhancing agricultural income for rural families.

The analysis of grain production patterns relies on understanding the spatial distribution of cultivated areas and observing their variation among agricultural communities. The district exhibits a clear disparity in agricultural investment levels due to variations in human factors influencing production. Analyzing these patterns helps reveal levels of productive efficiency among the agricultural communities within the study area and helps understand the factors contributing to the concentration of grain production in certain regions. Furthermore, the analysis provides a

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knowledge base that can be used to develop strategies aimed at enhancing and sustaining grain production, thereby contributing to the governorate's food security and strengthening the agricultural sector in Al-Rifai district.

-Geographical variation in the distribution of grain production patterns:

Based on the statistical data available from the agricultural departments in the study area, a clear variation exists in the areas cultivated with cereal crops. This is due to the different geographical resources available in each region. In order to analyze this geographical variation more accurately, the standardized scoring method was adopted.Standard deviation technique, which allows for the classification of agricultural patterns and the identification of areas of concentration and dispersion in plant production.

Cereal production is the dominant agricultural pattern in the study area, accounting for a high percentage (64.7%) of the total cultivated land. The prevalence of this pattern is linked to a number of natural and human factors that have contributed to its established position compared to other agricultural patterns. From a natural perspective, the flat terrain of the region provides an ideal environment for cereal crops, particularly wheat, which requires large, uniform areas free of topographical obstacles. Furthermore, the relatively moderate climate, in terms of temperature and rainfall, has provided favorable conditions for its successful cultivation. From a human and economic perspective, the inherited agricultural expertise of farmers in cultivating wheat and barley has been a key factor in the continuity of this pattern. In addition, its importance as a strategic crop, supported by government initiatives through marketing programs via the Ministry of Trade's warehouses, its ease of marketing, and its direct link to food security have encouraged farmers to expand its cultivation at the expense of other agricultural patterns. Therefore, it can be said that the dominance of this pattern is the result of a confluence of natural, economic, and social factors that have made it the most stable and widespread in the region.

Furthermore, changes in wheat prices, coupled with government policies supporting its cultivation, have strengthened its position as a key crop, given its role as a cornerstone of national food security. However, grain cultivation remains limited to wheat and barley, excluding other crops from summer and winter agricultural plans. This reflects challenges, most notably water scarcity. Despite wheat's economic importance, the areas cultivated with it show a clear disparity among different agricultural communities. This disparity stems from a range of geographical factors, including variations in agricultural experience, landholding sizes, and infrastructure levels. The varying degree of engagement with agricultural policies and government support programs also contributes to the differences in cultivation levels among communities. The arithmetic mean reached 13,943.75 dunams, exceeding the standard deviation of 6,052.92, reflecting significant differences in the utilization of this crop across different agricultural communities. Table (1) and Map (2) reveal the distribution of agricultural communities into three main categories based on their standard scores..

Table (1) Average area in (dunums) and percentages and standard grade for grain crops in the study area for the seasons (2022-2023-2024)

the total	Victory	Al-Rifai	Sugar Castle	dawn	Division / crop
50671	8046	22822	9911	9892	wheat
100	15.9	45.0	19.6	19.5	%
	-0.782	1.718	-0.466	-0.470	Standard grade
5104	1150	1517	1180	1257	barley
100	22.5	29.7	23.1	24.6	%
	-0.872	1.668	-0.664	-0.131	Standard grade
55775	9196	24339	11091	11149	the total
100	16.5	43.6	19.9	20.0	%
	-0.784	1.717	-0.471	-0.462	Standard grade

Source: Researcher's work based on: Ministry of Agriculture, Dhi Qar Agriculture Directorate, Plant Production Department, unpublished data, 2024.

1- Agricultural divisions whose standard scores are (+0.500 - or more):

The Al-Rifai Agricultural Division ranked first with a standard score of (1.717), and a cultivated area of (24,339) dunams, representing (43.6%) of the total cultivated area in the region. This distinction is attributed to the vastness of its arable land, which constitutes approximately (46%) of the district's total area, thus providing a suitable spatial base for grain crop cultivation. Furthermore, the nature of wheat and barley, which are characterized by their high tolerance to drought and high temperatures, has contributed to making Al-Rifai an ideal environment for expanding their cultivation and achieving high productivity. These grains have received special governmental attention as strategic crops included in the priorities of the national agricultural plan, particularly in recent seasons where agricultural policies have focused on enhancing food grain production compared to other crop types. The division's spatial structure is represented by a central area within the Al-Rifai Agricultural Division, specifically the division's headquarters.

3- Agricultural divisions whose standard scores range between (-0.001 - -0.499):

The Al-Fajr agricultural division, with a standard score of (-0.462), comprised an area of (11,149) dunams, representing (20.0%) of the total area, while the Al-Qalaa agricultural division, with a standard score of (-0.471), comprised an area of (11,091) dunams, representing (19.9%). The combined area of these two divisions represents (22,240) dunams, or (39.9%) of the total area. The spatial configuration of this category is characterized by a longitudinal extension connecting the northeast to the southwest around the center of the Al-Rifai division, reflecting a partially balanced linear distribution surrounding the center on two opposite sides. The divisions in this category achieved average production due to limited labor availability, moderate rural density, medium-sized or irregular holdings, partial extension programs, and limited funding. This category adopted a spatial configuration extending from the northeast to the southwest of the Al-Rifai agricultural division, represented by the Qalaa Sukkar and Al-Fajr divisions.

4- Agricultural divisions whose standard scores are (-0.500_ or less): The Al-Nasr Agricultural Division, with a standard score of (-0.784) and an area of (9,196) dunams, representing (16.5%) of the total cultivated area, is a result of several specific factors. These include its limited arable land compared to other agricultural divisions, which restricts its ability to expand the cultivation of these strategic crops, and its low rural and agricultural density, with a rural density of (67) people/km². This reflects a limited trained workforce capable of intensive land use. Furthermore, it has the fewest drip irrigation systems (12) and a limited reliance on pumps and irrigation systems, which affects the regularity of crop irrigation and optimal growth. The spatial layout of this division is located in the southwestern peripheral area of the study region..

1- Wheat crop:

Wheat is a strategic crop of paramount importance in achieving food security. It belongs to the grass family and is an annual herbaceous plant cultivated during the winter season. Its importance is evident in its role as a staple food for humans, as its grains contain essential nutrients including sugars (70%), proteins (11.5%), oils (2%), and fiber (2%), in addition to vitamins and minerals necessary for the body's growth and

MSW MANAGEMENT -Multidisciplinary, Scientific Work and Management Journal
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Vol. 36 Issue 1s, 2026, Pages: 762-768

development. Bread made from wheat flour is the most common food among people worldwide, preferred by approximately 70% of the global population due to its energy content, which ranges from 2000 to 2500 calories per kilogram. (Arhim, 2002, p. 18).

Besides its nutritional value, wheat is of great economic importance; it is used as a raw material in many food industries, and its straw is used as animal feed. Furthermore, its high shelf life and ease of transport over long distances at low cost enhance its position in local and national markets. (Bashour, 1996, p. 72).

From an agricultural perspective, wheat is cultivated in the study area during the autumn season. Planting typically begins in early October and continues until late January, with a growing period of approximately six months, culminating in maturity in the first half of May (Al-Ansari, 1982, p. 7). The climatic conditions in Al-Rifai district are relatively suitable for its cultivation, given the moderate winter temperatures and the suitability of the alluvial soil, which retains sufficient moisture for seed germination..

Furthermore, wheat's ability to withstand relative drought and high temperatures during its later growth periods makes it an ideal crop for the district's environment, characterized by fluctuating surface water resources. In addition, its inclusion in the government's agricultural plan as a strategic crop receiving technical and financial support has contributed to its wider cultivation within the Al-Rifai agricultural units, particularly in highly fertile and productive lands.

The wheat cultivation pattern is evident across different agricultural divisions, but there is a clear variation in cultivated areas. The arithmetic mean reached (12667.75) dunams, exceeding the standard deviation of (5911.3), indicating a significant disparity in the utilization of this crop among the agricultural divisions. This disparity is illustrated in Table (1) and Map (3), where the agricultural divisions are classified into three main categories according to their standard scores..

1- Agricultural divisions whose standard scores are (+0.500_ or more):

The Al-Rifai Agricultural Division topped the list with a standard score of (1.711) and a cultivated area of (22,822) dunams, equivalent to (45.0%) of the total cultivated area in the study region. This is due to its possession of the highest percentage of arable land, providing a vast geographical area suitable for wheat, a strategic field crop that requires extensive land for economic viability. Furthermore, the stability of water resources and the abundance of irrigation networks and agricultural machinery in Al-Rifai have enhanced the sustainability of production. In addition, the high percentage of the working-age population (57.4%) has ensured a sufficient workforce capable of managing agricultural operations. All these factors have made Al-Rifai the leading producer of wheat, a key crop in the food security system and of high economic and agricultural importance. The geographical distribution of this demographic is concentrated in a central area within the Al-Rifai Agricultural Division, represented by the central agricultural division itself.

3- Agricultural divisions whose standard scores range between (-0.001 - -0.499):

The Al-Fajr and Al-Qalaa agricultural divisions comprise the former, which recorded a standard score of (-0.466) with an area of (9911) dunams, representing (19.6%) of the total, while Al-Qalaa recorded a standard score of (-0.470) with an area of (9892) dunams, equivalent to (19.5%). The combined area of these two divisions represents (19803) dunams, or (39.1%) of the total cultivated area. This category takes on a spatial form extending longitudinally between two opposite sides of the agricultural division, starting from the northeast where the Al-Qalaa agricultural division is located, and extending to the southwest where the Al-Fajr agricultural division is located.

4- Agricultural divisions whose standard scores are (-0.500_ or less): The Al-Nasr agricultural division, which recorded a standard score of -0.782, comprised 8,046 dunams, representing 15.9% of the total cultivated area. This division's productivity is limited by a combination of environmental, human, and technological factors. Specifically, Al-Nasr suffers from a limited number of pumps (540 pumps, or 11.1% of the total), directly impacting the regular supply of water necessary for grain crop growth. Furthermore, the rural and agricultural population density in both divisions is relatively low, at 67 people/km² in Al-Nasr and 32 people/km² in Al-Nasr, reflecting a limited skilled workforce and insufficient intensive land use. Additionally, arable land constitutes a low percentage. The spatial distribution of this group was concentrated in the southwestern part of the study area.

-crop barley:

It follows wheat in importance and its cultivation requires conditions similar to those of wheat, but it tolerates more temperature differences than wheat and tolerates drought and humidity more than wheat. Furthermore, good soil conditions are not necessary for the growth of barley as they are for wheat. (Al-Duwaikat, 1998, p. 213).

It is a winter grain crop and is more tolerant of different climatic conditions such as drought and salinity compared to other grain crops (Al-Barazi and Al-Mashhadani, 2000, p. 169).Barley is characterized by its ability to tolerate soil salinity and drought and resist agricultural pests. As for the soil, it can be grown in sandy or alkaline soils of low fertility with high salinity and poor drainage. It gives a higher yield in organic calcareous loam soils. Barley cultivation thrives in suitable climatic conditions, represented by minimum temperatures ranging between (3-4.5°C) and maximum temperatures between (28-30°C). Note that the temperature (25°C) is optimal for the growth of barley in Iraq. (Al-Fakhri, 1981, p. 312)

It is versatile, used in the manufacture of concentrated animal feed or as green fodder for animals. A portion is also used for human consumption after being mixed with yellow corn or wheat flour. Its grains contain 70% sugars, 11.5% protein, 2% oil, and 2% fiber, in addition to minerals and vitamins (Al-Saidi, 1978, p. 49). Barley cultivation in the study area begins in October and continues until it matures in the second half of April, with harvesting taking place in June. The climatic conditions suitable for its cultivation include minimum temperatures ranging from 3 to 5°C and maximum temperatures ranging from 28 to 30°C. A temperature of 25°C is considered optimal for its growth in the study area and Iraq. The crop requires 1858 heat units as accumulated heat throughout its growing season (Al-Saidi, 1978, p. 146).

Barley cultivation is widespread across all agricultural divisions within the study area. However, the distribution of cultivated land is characterized by significant variation, with the arithmetic mean of 1276 dunams exceeding the standard deviation of 144.51. This reflects a disparity in agricultural practices for this crop. This is illustrated in Table 1 and Map 3, which classify the agricultural divisions into three main categories.

1- Agricultural divisions whose standard scores are (+0.500_ or more):

The Al-Rifai Agricultural Division ranked in the first category, recording the highest standard score of (1.688), with an area of (1517) dunams, representing (29.7%) of the total cultivated area. Al-Rifai ranks first in barley cultivation due to this crop's ability to adapt to the prevailing environmental characteristics in the region, particularly the high temperatures and scarcity of irrigation water. The vastness of arable land, which constitutes (46%), also contributes to the widespread cultivation of this crop. Furthermore, the division has the highest number of farmers engaged in agriculture, in addition to a greater availability of harvesters and tractors than other agricultural divisions. This allows for the cultivation of large areas and provides an ideal environment for barley growth and high productivity. The spatial configuration of this category is located in an area central to the study region..

2- Agricultural divisions whose standard scores range between (-0.001 - -0.499):

MSW MANAGEMENT -Multidisciplinary, Scientific Work and Management Journal
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Vol. 36 Issue 1s, 2026, Pages: 762-768

The Al-Fajr Agriculture Division, which recorded a standard score of (-0.131), was represented by a cultivated area of (1257) dunams, representing (24.6%) of the total area. This division was located in the southwestern part of the study area and achieved average production due to partial availability of labor and limited funding and support.

3- Agricultural divisions whose standard scores are (-0.500_ or less):

The agricultural divisions of Qalaat Sukkar and Nasr were represented, with standard scores of (-0.644) and (-0.872), respectively. The cultivated area in Qalaat Sukkar reached 1,180 dunams (23.1%), and in Nasr, 1,150 dunams (22.5%). Both Qalaat Sukkar and Nasr ranked last in barley cultivation due to the poor suitability of their lands for this crop. Qalaat Sukkar suffers from soil salinity and fluctuating water resources, while Nasr faces a significant shortage of arable land and low rural and agricultural density. These factors combined resulted in limited barley production in these two divisions compared to the other agricultural divisions. The total cultivated area in these two divisions reached 2,330 dunams, equivalent to 45.6% of the total area in the study region.The spatial structure of this category extended in a longitudinal range starting from the northeast (Al-Qalaa Agriculture Division) and ending in the southwest (Al-Nasr Agriculture Division).

Second topic

Spatial relationships of agricultural labor and plant production patterns in the district

the introduction

This chapter aims to analyze the spatial relationships between the characteristics of the agricultural workforce (independent variables) and grain production patterns (dependent variable) in the study area, using quantitative statistical methods such as Pearson's simple linear correlation coefficient and the coefficient of determination (R^2).

The use of these tools contributes to determining the strength of the relationship between each variable of the agricultural workforce and the studied grain production patterns, as well as revealing the nature of this relationship, whether it is direct or inverse.

These analyses also allow us to explain the extent to which independent variables contribute to explaining the variance in the dependent variable, reflecting the statistical and real impact of these demographic and social characteristics in determining the grain production pattern.

The simple correlation coefficient was adopted (Pearson Correlation is considered one of the most effective statistical analysis tools for measuring linear relationships between variables. The analyses were performed using SPSS software, given its accuracy and reliability in extracting statistical indicators related to the strength and direction of the correlation.

The study relied on eleven independent variables representing the different aspects of the composition of the agricultural workforce in the district, as follows:

X1: Number of farmers
X2: Specific composition (males)
X3: Specific composition (females)
X4: Age structure of the age group (0–14 years)
X5: Age composition of the age group (15–64 years)
X6: Age composition of the age group (65 years and over)
X7: Educational Structure (Elementary and below)
X8: Educational Structure (Secondary and Vocational)
X9: Educational Structure (Diploma or higher)
X10: Marital structure (married)
X11: Marital structure (unmarried)

A correlation matrix between these variables and agricultural crops has been developed to determine the nature of the relationship and the effect of each variable on the level of production.

-Spatial relationships of the agricultural workforce with the grain crop production pattern in the district:

The analysis revealed the relationship between a set of independent variables related to the agricultural workforce and the production of wheat and barley crops as dependent variables. The results showed correlation coefficients (Pearson's R) exhibits varying degrees of influence, which we explain as follows:

First: Spatial relationships of agricultural labor in relation to the wheat crop production pattern in the district:

1- Using the link

The variables affecting wheat production can be classified into three main categories according to the strength of the correlation (Table 1 and Figure 1):

First: Variables with a strong correlation (0.70 or more): These variables indicate a strong positive relationship with wheat production and are key determinants that effectively influence production volume. This effect is clearly reflected inX10 (Marital Structure – Married Individuals), with a correlation coefficient of (0.92), indicates that family stability contributes to strengthening responsibility, distributing roles, and organizing effort within the family, reflecting the unity of the family as an integrated productive unit. This was followed by X9 (Educational Attainment – Diploma or Higher), with a correlation coefficient of (0.90), indicating that higher education contributes to the adoption of advanced agricultural technologies and improved agricultural management, thus increasing production efficiency. X8 and X7 (Secondary/Vocational and Primary or Less) had correlation coefficients of (0.87) and (0.84), respectively, demonstrating that education at all levels enhances the performance of agricultural workers, even at the lowest levels, as they possess a basic understanding of the fundamentals of agricultural work. As for X5 (the age group of 15–64 years), with a correlation coefficient of (0.84), this group represents the productive active force and is the backbone of the agricultural workforce. X1 (the number of farmers) shows a correlation coefficient of (0.79), which indicates a logical relationship, as the number of farmers increases, the productive capacity increases.

Second: Variables with a medium correlation (0.40)- 0.69):X6 (age group 65 and over): The correlation coefficient was (0.44), which shows the limited role of the elderly in agricultural work due to the decline in physical ability, but their accumulated experience cannot be ignored, which may contribute to improving agricultural productivity despite the lack of actual participation.

Third: Variables with weak correlation (0.40 and less): X2 (males) with a correlation coefficient of (0.32) indicates that gender alone is not a decisive factor in production, as the impact of males on wheat production does not appear to be strong, and the participation rates of females may be close to or could be indirect roles in the production process.

X3 (females), with a correlation coefficient of 0.20, shows a relatively weak contribution by women to wheat production. This can be attributed to the nature of this type of agriculture, which requires significant physical effort and strenuous work such as sowing and harvesting—tasks traditionally assigned to men by society, while women are relegated to less demanding or domestic roles. This gap is further widened by women's involvement in family responsibilities, such as caring for children and the elderly, which reduces their opportunities for dedicated fieldwork in agriculture.

MSW MANAGEMENT -Multidisciplinary, Scientific Work and Management Journal
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Table (1) Simple correlation coefficients between agricultural labor (independent variables) and cereal crop production pattern (dependent variable) and their coefficient of determination

X11	X10	X9	X8	X7	X6	X5	X4	X3	X2	X1	variable / crop	
0.85	0.92	0.90	0.87	0.89	0.84	0.07	0.06	0.02	0.02	0.79	Correlation coefficient (r)	wheat
0.73	0.85	0.81	0.76	0.78	0.71	0.00	0.0	0.0	0.00	0.62	Coefficient of determination (R^2)	
0.75	0.83	0.80	0.76	0.79	0.16	0.80	0.24	0.16	0.16	0.54	Correlation coefficient (r)	barley
0.56	0.69	0.64	0.58	0.62	0.03	0.64	0.06	0.03	0.03	0.29	Coefficient of determination (R^2)	

Source: The researcher's work based on Appendix (1) and Appendix (2) and the program SPSS.

Results of the simple correlation coefficient between the characteristics of the agricultural workforce and the wheat production pattern in Al-Rifai district

Second: Using the coefficient of determination (R^2):

The table of determination coefficients shows that the variable played the biggest role.X10 (married individuals), with a coefficient of determination of 0.85, means that 85% of the variation in wheat production can be explained by this variable, reflecting the crucial importance of family stability in wheat production. This is followed by X9 (diploma or higher), with a coefficient of determination of 0.81, indicating that higher education is one of the strongest factors influencing increased productivity. X7 and X8 (primary and secondary/vocational education), each with a coefficient of determination of 0.76, demonstrate that educational attainment at various levels contributes to the application of agricultural knowledge and improved workforce performance.

As for the variables with a weak effect,X2 (males) shows a coefficient of determination of (0.10), meaning that this variable explains only (10%) of the variation in wheat production, reflecting the weak direct qualitative effect of males. Similarly, X3 (females) shows a coefficient of determination of (0.04), meaning that only 4% of the variation in wheat production can be explained by this variable, indicating a very marginal effect in this aspect.

Second: Spatial relationships of agricultural labor in relation to the barley crop production pattern in the district:

Barley production shows a correlation with some variables and relatively different results from wheat, as the arrangement of the influential variables is similar, but to varying degrees. Table (1) and Figure (2):

1- Using the correlation coefficient

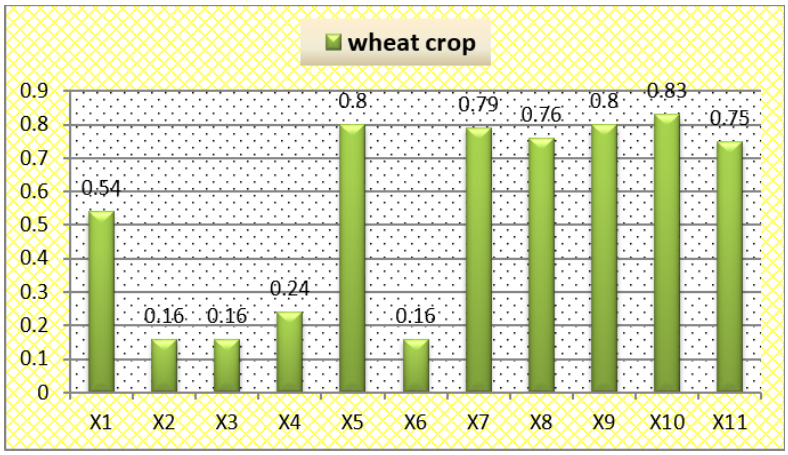
First: Variables with a strong correlation (0.70 or more): The variable related to married people occupied (X10 ranked first, registering the highest correlation value of 0.94, demonstrating the importance of social stability in organizing agricultural work and increasing barley production efficiency. This was followed by the producing class (X5) and the number of farmers (X1), with strong correlation levels of 0.76 and 0.73, respectively. The 15–64 age group represents the backbone of the agricultural workforce, and a higher number of farmers logically correlates with increased productivity. Secondary and vocational education levels (X8) contributed with a correlation coefficient of 0.74, as did the group with a diploma or higher (X9) with a coefficient of 0.69, underscoring the crucial role of education in improving agricultural skills and techniques and increasing barley productivity.

Second: Variables with a medium correlation (0.40 - 0.69): The younger age group came (X4 (0-14 years) with a correlation coefficient of (0.69), indicating the contribution of family members of different ages to agricultural activities, despite the limited roles of this group in terms of direct effort and productivity. As for X7 (primary education and less), it recorded a correlation coefficient of (0.58). This is because barley cultivation does not require a high level of awareness or knowledge of modern agricultural technologies compared to wheat, which explains the continued contribution of these groups with limited education to this agricultural activity with a moderate degree of influence.

Third: Variables with weak correlation (0.40 and less): The least influential variables included older adults (X6) recorded the lowest correlation level (0.16), reflecting a negligible effect due to advanced age and reduced ability to perform agricultural tasks. X2 (males) and X3 (females) also recorded low correlation coefficients of (0.21) and (0.17), respectively. These results reinforce the findings previously presented in the wheat yield analysis, demonstrating that gender alone is not a sufficient indicator to explain variation in production.

Figure (1)

Results of the simple correlation coefficient between the characteristics of the agricultural workforce and the barley production pattern in Al-Rifai district



Source: The researcher's work based on Table (1).

MSW MANAGEMENT -Multidisciplinary, Scientific Work and Management Journal
ISSN: 1053-7899
Vol. 36 Issue 1s, 2026, Pages: 762-768

Second: Using the coefficient of determination (R^2) For barley production:

The table of determination coefficients shows that the greatest effect in explaining the variance in barley production was due to the variableX10 (marital status – married), with a coefficient of determination of (0.69), meaning that approximately 69% of the variation in barley production can be attributed to this variable. This reflects the important role of the marital status of the agricultural workforce in promoting family stability and increasing participation in productive activities. Following closely in explanatory importance were variable X5 (age group 15–64 years) and variable X8 (secondary and vocational education level), which recorded coefficients of determination of (0.58) and (0.55) respectively. This indicates that (58%) and (55%) of the variance in barley production are attributable to these two variables, confirming the importance of the productive age group, which represents the backbone of the workforce, in addition to the relative role of secondary and vocational education in equipping farmers with practical skills that support their productive efficiency. As for the variables with a weak effect on barley production, the following variable appearedX3 (females) had a coefficient of determination of (0.02), meaning its contribution does not exceed (2%) of the changes in production, reflecting a limited impact of females on this agricultural activity. Similarly, variable X6 (age group 65 years and over) recorded a coefficient of determination of (0.03), indicating that (3%) of the variance in barley production can be explained by this variable, which is consistent with the expected nature of lower participation and productivity levels among older age groups who are less able to participate directly in agricultural work.

Conclusions:

1. Grain production in Al-Rifai district is characterized by a clear spatial variation among the agricultural populations. This variation is due to the different characteristics of the agricultural workforce in terms of gender, age, education level, and practical experience.
2. The characteristics of the agricultural workforce affect grain production to varying degrees. The 15–64 age group was found to be the most influential variable on production levels, as it is the group most actively involved in agricultural activity. This was reflected in a strong, positive correlation. Furthermore, the educational level of the workforce was found to be a significant factor, with populations with a more educated workforce exhibiting higher productivity. This indicates the role of agricultural knowledge in improving farming methods and input utilization.

It turns out that the male gender has a moderate to strong influence in a number of populations, as agricultural work in the district depends largely on manual labor, which is mostly done by males.

Marital status (married/unmarried) showed a weak or limited impact in most agricultural communities, indicating that the social status of agricultural workers is not a decisive factor in determining production quantity. The older age group (65 and over) and the younger age group (0–14) showed little or no impact on grain production, as they do not actively participate in basic agricultural operations. Taken together, these results suggest that the factors most strongly associated with production are those related to practical productivity and professional competence, while the importance of variables not directly related to labor effort in the fields diminishes. Educated workers tend to achieve higher productivity compared to communities with a predominantly primary or lower level of education.

Correlation coefficients indicate that some human variables have a greater influence than others; education level, age structure (15–64), and gender (males) often show a higher correlation with grain production compared to other variables.

Second: Suggestions:

1. Developing specialized extension programs for grain crops targeting farmers in low-productivity agricultural sectors, with a focus on disseminating modern agricultural practices and promoting awareness of the importance of scientific technologies in agriculture.
2. Raising the educational and professional level of the agricultural workforce by organizing seasonal training courses in the fields of sustainable agriculture and resource management, which contributes to increasing productivity and improving the efficiency of land use.
3. Enhancing spatial justice in the distribution of agricultural services by providing mobile guidance centers to meet the needs of people far from the center of the district, thereby reducing the spatial gap between production units.
4. Adopting spatial agricultural planning policies aimed at improving the investment of land suitable for grain cultivation, while identifying areas with high production potential and directing support and services to them in a concentrated manner.
5. Enhancing the participation of the active age group (15–64) in agricultural activity through training programs aimed at developing their practical skills, as they are the most influential group in production levels.
6. Developing agricultural knowledge among the workforce through specialized training workshops on modern technologies, which leads to improving farming methods and increasing productivity directly.
7. Achieving a balance in the participation of males and females in agricultural activity, taking advantage of the physical capabilities of males in field work, and enhancing the role of females in work that requires precision and organizational expertise, which will reflect on the efficiency of production.
8. Reducing reliance on marital structure as a productive factor due to its weak impact, and directing efforts towards developing the skills of the workforce regardless of their social status.
9. Investing in the untapped human potential of young people (0-14) and the elderly (65 and over) through educational programs for youth and advisory programs for the elderly, to benefit from accumulated agricultural expertise and promote the sustainability of local knowledge.

**Pearson's correlation coefficient was adopted (The Pearson Correlation coefficient was calculated using the SPSS statistical software to measure the strength and direction of the relationship between the variables under study, based on the established statistical formula for this coefficient. The coefficient of determination (R^2), which is obtained by squaring the correlation coefficient, was also calculated to indicate the proportion of variance in the dependent variable that can be explained by the independent variables. The importance of using these two indicators lies in determining the strength and accuracy of the statistical relationship, as well as understanding the explanatory impact of agricultural workforce characteristics on the variation in crop production patterns within the study area.

The correlation coefficient is calculated using the following equation.:

$$R = \frac{\sum y_i X_i - \frac{(\sum Y_i)(\sum X_i)}{N}}{\sqrt{\sum yi^2 - \frac{\sum (yi)^2}{N}}\sqrt{\sum Xi^2 - \frac{\sum (xi)^2}{N}}}$$

Whereas: R = Correlation coefficient between agricultural workforce characteristics and plant production patterns.

x = Individual values of agricultural labor force variables.

x- = the arithmetic mean of the agricultural labor force variables.

y = the individual values of the cultivated area for each crop of plant production.

y- = the arithmetic mean of the plant production variables.

The correlation coefficient ranges between (−1) and (+1), where (+1) represents a perfect positive relationship, (−1) a perfect negative relationship, and (0) indicates the absence of a relationship between the two variables. The closer the coefficient is to (+1), the stronger the

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positive relationship; the closer it is to (−1), the stronger the negative relationship; and the closer it is to (0), the weaker the relationship. These statistical indicators contribute to explaining the spatial variation in plant crop production within the district, reflecting differences in the characteristics and geographical distribution of the agricultural workforce.

****Coefficient of determination:**

It is calculated by squaring the value of the simple correlation coefficient (Pearson's coefficient), according to the following formula: $R^2 = r^2$

The value of the coefficient of determination ranges between (0-1), where values close to (1) express a high explanatory power of the independent variables in influencing the dependent variable. If the value of the coefficient of determination is close to (1), it means that a large proportion of the variance in grain production within the Al-Rifai district can be explained by the characteristics of the agricultural workforce. If it is close to (0), this indicates a weak ability of the independent variables to explain the variance in grain production in the district.

Appendix (1)

Dependent variables (X)				
femalesX3	MalesX2	Number of farmersX1		Agricultural people
50,499	51,113	556		Al-Rifai
29,543	29,902	2300		Sugar Castle
30353	30,722	1390		Victory
19837	20,078	3500		dawn
65- or moreX6	15-64X5	0-14X4		Agricultural people
2642	56191	42779		Al-Rifai
1605	34121	23719		Sugar Castle
1405	32431	27239		Victory
1437	21354	17124		dawn
Diploma or higher X9	Secondary and vocationalX8	Faqal Primary SchoolX7		The people
1318	5469	33128		Al-Rifai
2317	9155	47973		Sugar Castle
3455	12295	85862		Victory
1649	6535	52891		dawn
unmarried X11	married X10			The people
18161	21754			Al-Rifai
27057	32388			Sugar Castle
45724	55888			Victory
29937	31138			dawn

Source: Researcher's work based on: Republic of Iraq, Ministry of Agriculture, Dhi Qar Agriculture Directorate, Statistics Division, Unpublished Data, 2024.

Republic of Iraq, Ministry of Planning, Central Statistical Organization, Dhi Qar Statistics Directorate, 2024.

Republic of Iraq, Ministry of Planning, Central Statistical Organization, Rural Development Department in Dhi Qar Governorate, 2024.

Appendix (2) Dependent variablesY)

barleyy2	wheaty1	Agricultural people
1257	9892	Al-Rifai
1180	9911	Sugar Castle
1517	22822	Victory
1150	8046	dawn

Source:The researcher's work was based on: Ministry of Agriculture, Dhi Qar Agriculture Directorate, Plant Production Department, unpublished data, 2024.

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