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Optimal allocation of Production Resources in Farms of Prolific Wheat Varieties: A study in Diyala Province - Iraq for the 2023 season

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Wheat, optimal allocation, productive resources, optimal productivity.

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Abstract: This research was carried out in the Iraqi province of Diyala by analyzing Financial of wheat producing farms that depend on high-yielding varieties. Among the wheat types were Barcelona, Wafih, Adna, Bora, and Ebaa 99. The study used a random sample of high-yielding wheat producers to determine the best possible distribution of economic resources. The sample consisted of 10.3% of the 388 farms in the study region. It approximated the Cobb-Douglas production function, which took into account variables including labor, capital, and agricultural area. Utilizing the best combination of (2) hectares and (15) workers, the Lagrange technique was used to get the optimal productivity of (15569) Kg. / ha. The expenses constraint was adopted to the short term, equal to (989) dollars / Hec. The best combination of (2) Hec. And (15) workers / Hec. On the other hand (1811) $/ha, was used to attain the maximum production, which came to (15569) K.g / ha. In the long term, the ideal combination of (1.4) hectares, (10) workers/ha, and (1276) $/ha was used to attain the optimal production, which was (14790) Kg. /ha. It discovered that raising labor numbers in return for lower capital costs increases marginal productivity by replacing the factors of production with area constant. It recommended that it be necessary to support the prices of agricultural inputs by regulating Price policies, as well as training farmers on to implement the recommendations of scientific research that dealt with achieving the optimal allocation of economic resources with the aim of maximizing producer's profits.

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التخصيص الأمثل للموارد الانتاجية في مزارع أصناف القمح غزيرة الإنتاج: دراسة في محافظة ديالى – العراق للموسم الإنتاجي 2023

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المستخلص

أجريت هذه الدراسة في محافظة ديالى – العراق، من خلال تحليل اقتصادي لمزارع انتاج القمح التي تعتمد البذور غزيرة الانتاج، شملت اصناف القمح (صنف إباء 99، صنف بورا، صنف وفيه، صنف ادنه، صنف برشلونة)، استهدفت الدراسة تحقيق التخصيص الامثل للموارد الاقتصادية باعتماد عينة عشوائية لمنتجي القمح غزير الإنتاج، شكلت العينة (10.3%) من مجتمع الدراسة البالغ (388) مزرعة في منطقة الدراسة، تم تقدير دالة الإنتاج (كوب – دوغلاس) والتي تضمنت متغيرات (العمل، رأس المال، مساحة المزرعة)، تم تطبيق طريقة لاغرانج باعتماد التكاليف المقيدة بالمدى القصير والتي بلغت (989) دولار/ هكتار، وتم التوصل للإنتاجية المثلى إذ بلغت (15569) كغم/ هكتار، وتحققت باستغلال التوليفة المثلى التي بلغت (2) هكتار، و(15) عامل/ هكتار، و(1811) دولار/ هكتار. اما بالمدى الطويل فقد بلغت الإنتاجية المثلى (14790) كغم/ هكتار والتي تتحقق باعتماد التوليفة المثلى التي تألفت من (1.4) هكتار، و(10) عامل/ هكتار، و(1276) دولار/ هكتار، ومن اجراء الاحلال بين عوامل الإنتاج بثبات المساحة اتضح ان زيادة عدد العمال مقابل خفض رأس المال يحقق زيادة بالإنتاجية الحدية، تمت التوصية بضرورة دعم أسعار المستلزمات الزراعية من خلال تنظيم السياسات السعرية الزراعية وكذلك تدريب الفلاحين على كيفية تطبيق توصيات البحوث العلمية التي تناولت تحقيق التخصيص الأمثل للموارد الاقتصادية بهدف تدنية التكاليف الإنتاجية وتعظيم أرباح المنتجين.

الكلمات المفتاحية: القمح، التخصيص الامثل، الموارد الإنتاجية، الإنتاجية المثلى.

Introduction:

Wheat is widely recognized as one of the most crucial and essential cereal crops globally. It holds the second position in economic significance after maize. Wheat plays a vital role in pastry production and is strategically valued at a political level as a key commodity and a potent tool in the food security strategies of wheat-producing and exporting nations. It is a cornerstone in ensuring food security for human populations, with its by-products also serving as animal feed. In the 2023 season, Diyala Province in Iraq harvested a total of 298,968 tons of various wheat varieties across 133,955 hectares, achieving an average yield of 2231 kg per hectare. Economically, agricultural producers have the liberty to harness natural resources to their full potential, leading to significant non-monetary gains. (Plant production Department, 2023) In economic literature, this concept it known as "open ownership," which implies that governmental intervention is necessary to manage economic resources like water reservoirs and extensive agricultural lands. These resources can be effectively utilized through regular exploitation. (Al al-Sheikh, 2007: 171) Local wheat varieties in Iraq have evolved to withstand drought and soil salinity, with varieties such as Abu Ghraib, Taqah, Tammuz, Entisar, Saber Beige, and Sham 6 being prominent. Some varieties are still cultivated due to their cost-effectiveness, like Ebaa 99, a prolific local strain, alongside imported foreign varieties like Bora (Italian), Barcelona (Spanish), Cihan, and Adana (Turkish). While various economic studies have analyzed wheat production, costs, and economies of scale, particularly in Iraq, there remains a gap in resource allocation for high-yield wheat varieties on farms. Studies have explored the economics of wheat cultivation under different irrigation methods, comparing spraying to traditional techniques in Salah al-Din Province, Iraq. (Al-Samarrai & Al- Zubaie, 2004) Additionally, research has focused on enhancing wheat agriculture through technical interventions like improved seeds, micronutrients, machinery, and fertilizers in Diyala Province. (Al- Tamimi, 2018: 42 - 51) Another study investigated the impact of irrigation systems on wheat production efficiency using stochastic frontier analysis in Salah-din Province - Iraq, comparing pivot sprinkler and fixed spray methods. (Ali, et. All, 2020) Furthermore, an economic study in Egypt highlighted the positive effects of technical factors like hybrid seeds, laser-leveling, unconventional irrigation, and improved fertilizers on wheat productivity, leading to a significant increase from 3300 kg/ha to 6500 kg/ha. There is a clear research gap in understanding how to allocate key economic resources (labor, capital, land) in the short and long term to optimize production within the constraints of limited resources. (Abdelmageed, et. All, 2018: 3-14)

Research Problem: The allocation of major resources (labor, capital, and farm area) is one of the basic factors in achieving allocative and technical efficiency in agricultural production projects. The non- typical use of production requirements, including seeds, despite their high prices, is the main problem that it analyzed economically because it leads to higher variable production costs and thus lower producer profits.

Research Hypothesis: The adoption of improved seeds in wheat farms is one of the factors that lead to increased productivity, as they are considered highly productive varieties, in addition to the effect of agricultural

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mechanization and improved fertilizers. Therefore, it is necessary to achieve allocative efficiency with resources and technical efficiency in production to avoid high prices of production inputs.

Research objective: Conducting an economic analysis of wheat farms that rely on highly productive seeds, improved fertilizer techniques, and integrated mechanization with the aim of knowing the optimal allocation of productive resources, which in turn achieves optimal production, and comparing it to the actual use of resources.

Research Methodology: The research adopts the quantitative analysis method in explaining the relationship between production factors and the quantity of production through economic analysis of the estimated production function (Cobb - Douglas), in addition to using the descriptive analysis method in interpreting the results reached from estimating the production function.

Research Framework:

Production and production function: The production function represents a set of technically efficient relationships between productive factors and the quantity of production. This relationship it based on the use of production factors in their various forms, the most important of which are labor, capital, and farm area. For ease of knowing the changes that occur in production, the Cobb-Douglas production function can be estimated, which is characterized by ease of estimation, including the main factors of production, which are labor, capital, and area, as follows: (Badran, 2013: 86)

$Y = A\, L^{b1}\, K^{b2}\, N^{b3}$

Since:

Y = production quantity (K.g/ Hec.).

L = farm labor (Worker/ Hec.).

K = capital (Dollar/ Hec.)

N = farm area. (Hectare)

A = function constant. b3, b2, b1 = production elasticities of labor, capital, and area, respectively.

Product behavior in the short-run: The optimal quantities of production factors can be determined by adopting the Lagrange method, which consists of the production function in its exponential form and the total cost equation that includes the prices of production factors, then forming the objective function using the Lagrange multiplier with the aim of achieving the

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necessary condition to maximize production, as follows. (Al- Hayali, 2014: 169)

$C = WL + rK + aN \;\; \dots (1)$

$C^{\circ} - WL - rK - aN = 0 \;\; \dots (2)$ constact

$L = \left(A\, L^{b1}\, K^{b2}\, N^{b3}\right) + \lambda\,(C^{\circ} - WL - rK - aN) \dots (3)$ Aim function

Since:

(a) = a land rent. (W) = labor wages. (r) = the interest rate on capital. (C°)

(b) = Constant Cost.

Then the necessary condition it applied to find the maximum limit of the production function by performing the first partial differentiation for each production factor. (Nicholson & Snyder, 2008: 39)

Economic derivatives of the Cobb–Douglas production function: Marginal analysis is important in determining the producer's decisions to continue adding factors that are more productive or to stop, and from the estimated production function, the marginal product and the average product can found with the following relationships: (Debertin, 2012: 175)

Marginal product:

$$MPP_{Xi} = \frac{\partial Y}{\partial Xi} \dots . (4)$$

Average product:

$$APP_{Xi} = \frac{Y}{Xi} \dots . (5)$$

Production Elasticity: One of the characteristics of the Cobb-Douglas production function is that the set of partial elasticities of production factors represents the total elasticity of the function and represents the returns to capacity. In addition, the production elasticity can found by dividing the marginal product by the average product:

$$E_P = \frac{MPP_{Xi}}{APP_{Xi}} \dots . (6)$$

Long-run behavior of the product: The difference that distinguishes the long - run from the short - run conditions is that all factors of production are variable in quantity, so all production costs are also variable. Accordingly, the same steps that it performed in the short - run can adopted to achieve the maximum limit of the production function, and then form the objective function. However, the fundamental difference is the adoption of average total variable costs only, as well as the application of the idea of isoquant

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curves with the aim of achieving long-run conditions to reach the optimal behavior of the product. (Al- Afandi, 2012: 278) As for production efficiency, it can achieved through economic derivatives of the estimated production function (Cobb-Douglas). (Andrew & W., 2013: 45)

Substitution between productive factors: In order to choose the optimal combination of productive factors, substitution can made between labor units and capital units on the same isoquant curve in order to achieve a point on the expansion path, and the marginal rate of substitution between productive factors can found with the following relationship: (Debertin, 2012: 96)

$$\mathrm{MRTS}_{\mathrm{X1\ for\ X2}} = \frac{\mathrm{MP}_{\mathrm{X1}}}{\mathrm{MP}_{\mathrm{X2}}} \ldots (7)$$

Material and Methods:

1. *A* questionnaire form designed to suit the research objectives.
2. Excel program for tabulating data and statistical analysis program (Eviews12).
3. The modern production function (Cobb-Douglas) and the Lagrange coefficient.

Results and Discussion:

Geographical boundaries of research and data collection: Diyala Province - Iraq it chosen as an area to study wheat production farms with high-yielding varieties because it produces wheat in abundance. (40) Prolific wheat producers were selected from a total of (388) producers to represent (10.3%) of the study population, the sample size depends on the size of the studied community and its homogeneity, so (10%) was determined to be appropriate for achieving the research objectives. (Al-Mahmoudi, 2019: 164)

Characteristics of the research sample: The characteristics of the research sample included the source of irrigation, the type of seeds, and the source of purchasing fertilizers and seeds, as shown in Table (1):

Table (1): Characteristics of the research sample farms in Diyala Province - Iraq for the 2023 season

Wheat seed variety	Number of producers	Percentage (%) of the sample	Country of origin of seeds	Seed supply source	Seed purchase price ($/kg)
Ebaa 99	14	35	Iraqi	Ministry Of Agriculture	0.941

Wheat seed variety	Number of producers	Percentage (%) of the sample	Country of origin of seeds	Seed supply source	Seed purchase price ($/kg)
Wafih	8	20	Turkish	Commercial companies	1.125
Adna	7	17.5	Turkish	Commercial companies	1.205
Barcelona	5	12.5	Spanish	Commercial companies	1.262
Bora	6	15	Italian	Commercial companies	1.836

Source: researcher based on the questionnaire form and the Diyala Governorate Agriculture Directorate.

Table 1 displays the seed types utilized in the research sample farms, comprising one domestic variety and four imported varieties sourced from various countries. Evidently, the imported varieties command higher prices, prompting farmers to opt for the local variety despite its perceived lower productivity, especially given the declining cost of local seed varieties.

Production cost structure: Production costs encompass all expenses incurred on the farm from the initiation of the production process until completion. These costs comprise of average fixed costs and average variable costs, as detailed in Table 2:

Table (2): Structure of total production costs for the sample of research farms

<table>
<tr><th colspan="2">Type of costs</th><th>items</th><th>the value (ha/$)</th><th>Relative importance%</th></tr>
<tr><td rowspan="10">Variable costs</td><td rowspan="5">Mechanical labor costs</td><td>Soil preparation</td><td>82</td><td>8.29</td></tr>
<tr><td>NPK fertilization</td><td>11</td><td>1.11</td></tr>
<tr><td>Seed</td><td>11</td><td>1.11</td></tr>
<tr><td>Urea fertilization</td><td>9</td><td>0.91</td></tr>
<tr><td>Insect control</td><td>8</td><td>0.81</td></tr>
<tr><td rowspan="5">Human labor costs</td><td>irrigation</td><td>67</td><td>6.77</td></tr>
<tr><td>Tinkering</td><td>5</td><td>0.51</td></tr>
<tr><td>Manual hoeing</td><td>7</td><td>0.71</td></tr>
<tr><td>maintenance</td><td>2</td><td>0.20</td></tr>
<tr><td>Transfer</td><td>6</td><td>0.61</td></tr>
</table>

Type of costs		items	the value (ha/$)	Relative importance%
	Production input costs	Cost of purchasing seeds	126	12.74
		NPK fertilizer	178	18
		urea fertilizer	137	13.85
		pesticide	18	1.82
		fuel	30	3.03
Total variable costs			697	(70.47)%
Fixed costs	Land rent		163	16.48
	Irrigation pump depreciation		3	0.30
	Irrigation pipes depreciation		2	0.20
	depreciation of work tools		1	0.10
	Interest on capital(%19)		123	12.45
Total fixed costs			292	(29.53)%
Total costs			989	100%

Reference: based on the questionnaire form. & (Agricultural Cooperative Bank, 2023)

* (1 $ = 1.148 Iraqi dinars) according to the average exchange rate for the year 2023.

Table (2) shows that variable costs constituted the largest proportion of the total costs per hectare, reaching (70.47%), while fixed costs constituted (29.53%) of the total costs.

Statistical analysis of the Cobb-Douglas production function: Multiple regression analysis of the production function (Cobb-Douglas) it performed using the ordinary least squares method, and the results of the statistical analysis of the function were as shown in the equation (8)

$$\text{Ln}(Y) = 6.562 + 0.299\ \text{Ln}(L) + 0.338\ \text{Ln}(K) + 0.335\ \text{Ln}(N) \ldots. (8)$$

The statistical analysis showed the significance of the estimated production function parameters at a significance level (5%), as well as the existence of a positive relationship between the quantity of production and each of labor, capital, and farm area, where the production elasticities for these variables reached (0.299, 0.338, 0.335), respectively. This explains that increasing labor by (1%) leads to an increase in the marginal product of labor by (0.299) kg, and increasing capital by (1%) leads to an increase in marginal product

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by (0.338) kg, and increasing the farm area by (1%) leads to an increase the marginal product is (0.335) K.g.

Table (3): multiple regression analysis of the production function (Cobb-D-Glass)

Dependent Variable: Y				
Method: Least Squares				
Date: 09/27/23 Time: 06:54				
Sample: 1 40				
Included observations: 40				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	6.562042	0.755433	8.686470	0.0000
L	0.299848	0.125432	2.390517	0.0222
K	0.338723	0.130049	2.604573	0.0133
N	0.335196	0.116158	2.885687	0.0066
R-squared	0.912277	Mean dependent var		12.37441
Adjusted R-squared	0.904967	S.D. dependent var		0.897877
S.E. of regression	0.276792	Akaike info criterion		0.363540
Sum squared resid	2.758102	Schwarz criterion		0.532428
Log likelihood	-3.270809	Hannan-Quinn criter.		0.424605
F-statistic	124.7947	Durbin-Watson stat		2.430942
Prob(F-statistic)	0.000000			

Coefficient of determination (R^2): The statistical analysis showed, through the value of the coefficient of determination, that (91%) of the changes occurring in production were due to the production factors included in the estimated function. The remaining percentage (9%) is due to other factors that not measured by the function. The analysis also showed, through the Fisher test (F) value of (124.794), the significance of the function as a whole at a significance level of (5%), the number of observations (n=40) and the number of variables (k=3). To ensure that the estimated model is free of the problem of heteroscedasticity of variance, the (Park) test was conducted by performing multiple regression of the square of the logarithm of the least squares remainders as a dependent factor and the logarithm of the production factors (labor, capital, and farm area) as independent factors, and the results were as follows:

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Table (4): Park test to detect the problem of heterogeneity of variance

Dependent Variable: LOG(EISQ)				
Method: Least Squares				
Date: 09/24/23 Time: 15:48				
Sample: 1 40				
Included observations: 40				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	-18.96001	18.57427	-1.020767	0.3142
LOG(L)	-1.087866	6.082574	-0.178850	0.8591
LOG(K)	5.097360	10.19312	0.500078	0.6201
LOG(N)	0.223575	3.026325	0.073877	0.9415
R-squared	0.038147	Mean dependent var		-9.207795
Adjusted R-squared	-0.042008	S.D. dependent var		2.405864
S.E. of regression	2.455877	Akaike info criterion		4.729484
Sum squared resid	217.1279	Schwarz criterion		4.898372
Log likelihood	-90.58969	Hannan-Quinn criter.		4.790549
F-statistic	0.475914	Durbin-Watson stat		2.120514
Prob (F-statistic)	0.701012			

Log $(ei)^2$ = -18.960 - 1.0878 Log(L) + 5.097 Log(K) + 0.223 Log(N)… (9)

It was clear from the (t) test values that the estimated function parameters were not significant at different levels of significance, which means that there is no problem of heteroscedasticity of variance.

Econometric analysis: To detect the problem of autocorrelation between the least squares residuals, we can rely on the value of (d*), which is the value of the Durbin-Watson test. The statistical analysis showed that its value in Table (4) was (2). This means that there is no problem of autocorrelation based on the rule (4- du >d* > du) and at a significance level (5%) and the number of variables (K=3).

Economic Analysis:

First: The optimal behavior of the product in the short-run: The behavior of the product can be determined in the short - run by relying on the estimated production function with the aim of determining the optimal quantities of the main production factors to reach the optimal production volume and comparing it with the actual behavior of the product. This is possible by forming the objective function, which consists of the estimated

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production function after converting it to the exponential form, and the cost constraint equation, which consists of the prices of the productive factors included in the production function and using the Lagrange multiplier.

Factor prices and the level of total production costs in the short - run:

C° = 989 $/ha.

Labor wages = 20$/worker/day.

Interest on principal = 0.19 $ per 100 $.

Land rent = 163 $/ha.

Depending on the prices of production factors and the average costs per hectare in the research sample, the (cost constant) can formed as follows:

$989 - 20(L) - 0.19\,(K) - 200\,(N) = 0 \ldots (10)$

Then convert the estimated production function to the exponential form:

$Y = 707.685\ L^{0.299}\ K^{0.338}\ N^{0.335} \ldots.(11)$

To form the objective function, we can adopt equation (10) and equation (11) and use the Lagrange multiplier:

$$L = (707.685\ L^{0.299}\ K^{0.338}\ N^{0.335}) + \lambda(989 - 20L - 0.19K - 163N) = 0 \ldots (12)$$

Depending on the objective function (Equation 12), partial differentiation of the factors of production (labor, capital, area) can performed in addition to the Lagrange multiplier as follows:

$$\frac{\partial L}{\partial L} = (707.685(0.299)L^{0.299-1}\ K^{0.338}\ N^{0.335}) + \lambda(989 - 20L - 0.19K - 163N) = 0$$

$$= (211.597)L^{-0.701}\ K^{0.338}\ N^{0.335}/20 = \lambda$$

$$= (10.579)L^{-0.701}\ K^{0.338}\ N^{0.335} = \lambda \ldots. (13)$$

$$\frac{\partial L}{\partial K} = (707.685(0.338)\ L^{0.299}\ K^{0.338-1}\ N^{0.335}) + \lambda(989 - 20L - 0.19K - 163N) = 0$$

$$= (239.197)L^{0.299}\ K^{-0.662}\ N^{0.335}/0.19 = \lambda$$

$$= (1258.931)L^{0.299}\ K^{-0.662}\ N^{0.335} = \lambda \ldots. (14)$$

$$\frac{\partial L}{\partial N} = (707.685(0.335)\ L^{0.299}\ K^{0.338}\ N^{0.335-1}) + \lambda(989 - 20L - 0.19K - 163N) = 0$$

$$= (237.074)L^{0.299}\ K^{0.338}\ N^{-0.665}/163 = \lambda$$

$$= (1.454)L^{0.299}\ K^{0.338}\ N^{-0.665} = \lambda \ldots. (15)$$

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$$\frac{\partial L}{\partial \lambda} = (989 - 20L - 0.19K - 163N) = 0 \ldots .(16)$$

The optimal size of the variable (Labor) in terms of the variable (capital) can found by dividing equation (13) by equation (14) as follows:

$$\frac{(10.579)L^{-0.701}\ K^{0.338}\ N^{0.335}}{(1258.931)L^{0.299}\ K^{-0.662}\ N^{0.335}} = \frac{\lambda}{\lambda}$$

$$\frac{(10.579)L^{-0.701}\ K^{0.338}\ N^{0.335}}{(1258.931)L^{0.299}\ K^{-0.662}\ N^{0.335}} = 1$$

$$\frac{0.008403\ K}{L} = 1$$

$$L = 0.008403\ K \ldots .(17)$$

The optimal size of the variable (farm area) can also found in terms of capital by dividing equation (15) by equation (14) as follows:

$$\frac{(1.454)L^{0.299}\ K^{0.338}\ N^{-0.665}}{(1258.931)L^{0.299}\ K^{-0.662}\ N^{0.335}} = \frac{\lambda}{\lambda}$$

$$\frac{0.001154\ K}{N} = 1$$

$$N = 0.001154\ K \ldots .(18)$$

To find the optimal size of capital, equation (17) and equation (18) can compensation by equation (16) as follows:

$$989 - 20L - 0.12K - 200N$$

$$989 - 20(0.008403\ K) - 0.19K - 163\ (0.001154\ K)$$

$$989 - 0.16806K - 0.19K - 0.1881\ K$$

$$989 - 0.546\ K$$

$$989 = 0.546\ K$$

$$K = \frac{989}{0.546} = 1811 \quad \text{Dolar/ Hectar}$$

Then we compensation the optimal size of capital with equation (17) to find the optimal size of labor:

$$L = 0.008403\ (1811) = 15 \quad \text{Worker/ Hectar}$$

In the same way, we find the optimal size of the farm area from equation (18):

$$N = 0.001154\ (1811) = 2 \quad \text{Hectar}$$

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To find the optimal production, it is possible by compensation the optimal quantities of productive factors with equation (11):

$$Y = 707.685\, L^{0.299}\, K^{0.338}\, N^{0.335}$$

$$Y = 707.685\ (15)^{0.299}\,(1811)^{0.338}\,(2)^{0.335}$$

$$Y = 707.685\,(2)(11)(1) = 15569 \quad \text{K.g./ Hetar}$$

The optimal size of production in the short- run was (15569) K.g/ha. To know the difference between the optimal behavior of the product in the short -run and the actual behavior, it is possible to compare the optimal combination that it reached with the combination of production factors actually used in the farms of the research sample, as in Table (4):

Table (5): optimal allocation and actual allocation of the product in the short-run on the farms of the research sample

Inputs and outputs	Actual allocation	Optimal allocation
Labor (Worker/ ha)	17	15
Capital ($/ha)	1944	1811
Area (ha)	2.3	2
Productivity	11200	15569

Reference/researcher based on the estimated production function and the questionnaire form.

It is clear from Table (5) that there is a difference between the actual behavior and the optimal behavior of the product. This means that the producers were unable to achieve efficiency in exploiting productive resources. These results are consistent with a study conducted by (F. et. All, 2023: 176-188) In (Baghdad) on wheat farms to measure the effect of improved seeds only on productivity, the researchers concluded that productivity by adopting traditional seeds amounted to (2932) K.g/ha, while with the adoption of improved seeds productivity reached (4100) K.g/ha.

Second: The optimal behavior of the product in the long-run: The maximum limit of the estimated production function can have achieved by adopting the derivation that was conducted in the short - run, but only by adopting the idea of isoquant curves and variable costs. All production factors, including farm area, are variable in the long - run, so production costs will all be variable. Depending on the prices of the prevailing factors of production in the input market, the cost constraint can be determined and used to form the objective function for arriving at the optimal combination of production factors.

Factor prices and the level of total production costs in the long - run:

C° = 697 $/ha.

Labor wages = 20 $/worker/day.

Interest on principal = 0.19 $.

Land rent = 163 $/ha.

Depending on the prices of production factors and the total variable costs, the cost constraint can formed as follows:

$$697 - 20L - 0.12K - 163\ N$$

By adopting Equation (17) and Equation (18), the optimal combination of production factors that achieves optimal production in the long - run can reached as follows:

$$L = 0.008403\ K$$

$$N = 0.001154\ K$$

To find the optimal size of capital, equation (17) and equation (18) can compensation by equation (16) as follows:

$$697 - 20(0.008403\ K) - 0.19K - 163\ (0.001154\ K)$$

$$697 - 0.16806K - 0.19K - 0.1881\ K$$

$$697 - 0.546\ K$$

$$697 = 0.546\ K$$

$$K = \frac{697}{0.546} = 1276 \quad \text{Dolar/ Hectar}$$

We compensation the optimal size of capital with equation (17) to find the optimal size of labor:

$$L = 0.008403\ (1276) = 10 \quad \text{Worker/ Hectar}$$

In the same way, we find the optimal size of the farm area from equation (18):

$$N = 0.001154\ (1276) = 1.4 \quad \text{Hectar}$$

The optimal production in the long - run can found by compensation the optimal quantities of productive factors in the long - run into equation (11) as follows:

$$Y = 707.685\ L^{0.299}\ K^{0.338}\ N^{0.335}$$

$$Y = 707.685\ (10)^{0.299}\ (1276)^{0.338}\ (1.4)^{0.335}$$

$$Y = 707.685\ (1.9)(11)(1) = 14790 \quad \text{K.g./ Hetar}$$

The optimal size of production in the long - run. The research method is consistent with what it published by (Al-Timimi, 2018: 222-230), as the researchers used the production function (Cobb-Douglas) to determine the optimal size of fish farms in Salah al-Din Province - Iraq. The researchers concluded at the optimal allocation of labor, capital, and farm area in the long - run through the compensation method and then reaching the optimal production volume. In addition, the optimal farm size that it reached is lower than the optimal farm size in the short - run, and it gives an indicator of achieving efficiency in using farm capital. This result agreed with a study conducted by (Y., 2019: 196-204) on wheat production farms in Australia, which aimed to measure the effect of farm size and capital on productivity, as the researchers concluded that small wheat producers achieve efficiency in production and revenue.

Economic derivatives of the estimated long-run production function:
Depending on the estimated production function, the economic derivatives of the main production factors included in the production function can found as follows:

Marginal product and average product of labor:

$$MP_L = \frac{\partial y}{\partial L} = (0.299)\ 707.685\ L^{0.299-1}\ K^{0.338}\ N^{0.335} = 0$$

$$MP_L = \frac{(0.299)(7.374)\ L^{0.299-1}\ K^{0.338}\ N^{0.335}}{L} = 0$$

Since:

$$707.685\ L^{0.299}\ K^{0.338}\ N^{0.335} = Y$$

$$MP_L = (0.299)\frac{Y}{L}$$

$$MP_L = (0.299)(APL)\ \ldots.\ (19)$$

$$MP_L = (211.597)L^{-0.701}\ K^{0.338}\ N^{0.335}\ \ldots..(20)$$

The equation for the marginal product of labor.

By compensation, the optimal quantities of production factors into equation (20), we find the marginal product of labor:

$$MP_L = (211.597)(10)^{-0.701}\ (1276)^{0.338}\ (1.4)^{0.335}$$

$$MP_L = (211.597)(0.19906)(11.214)(1.119)$$

$$MP_L = 528.547 \quad \text{K.g./ Hectar}$$

The quantity t of marginal product of labor.

From equation (19), the average output of labor, can found:

$$MP_L = (0.299)(APL)$$

$$AP_L = \frac{MPL}{0.299}$$

$$AP_L = \frac{528.547}{0.299} = 1768 \quad K.g./\ Hectar$$

Labor share of productivity per hectare.

Marginal product and average product of capital:

$$MP_K = \frac{\partial y}{\partial K} = (0.338)\ 707.685\ L^{0.299}\ K^{0.338-1}\ N^{0.335} = 0$$

$$MP_K = \frac{(0.338)(707.685)\ L^{0.299}\ K^{0.338-1}\ N^{0.335}}{K} = 0$$

Since:

$$707.685\ L^{0.299}\ K^{0.338}\ N^{0.335} = Y$$

$$MP_K = (0.338)\frac{Y}{K}$$

$$MP_K = (0.338)(APK)\ \ldots.\ (21)$$

$$MP_K = (239.197)L^{0.299}\ K^{-0.662}\ N^{0.335}\ \ldots..(22)$$

The equation of marginal product of capital.

Compensation the optimal quantities of factors of production, we find the marginal product of capital as follows:

$$MP_K = (239.197)(10)^{0.299}\ (1276)^{-0.662}\ (1.4)^{0.335}$$

$$MP_K = (239.197)(1.9906)\ (0.008788)(1.119)$$

$$MP_K = 4.682 \quad K.g./\ Hectar$$

The quantity of marginal product of capital.

The average output of capital can found from equation (21):

$$AP_K = \frac{4.682}{0.338} = 13.852 \quad K.g./\ Hectar$$

Capital's share of productivity per hectare.

Marginal product and average product of the farm area:

$$MP_N = \frac{\partial y}{\partial N} = (0.335)\ 707.685\ L^{0.299}\ K^{0.338}\ N^{0.335-1} = 0$$

$$MP_N = \frac{(0.335)(707.685)\ L^{0.299}\ K^{0.338}\ N^{0.335-1}}{N} = 0$$

Since:

$$707.685\ L^{0.299}\ K^{0.338}\ N^{0.335} = Y$$

$$MP_N = (0.335)\frac{Y}{N}$$

$$MP_N = (0.335)(AP_N)\ \ldots.\ (23)$$

$$MP_N = (237.074)L^{0.299}\ K^{0.338}\ N^{-0.665}\ \ldots..(24)$$

Equation of marginal product of farm area.

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The quantity of marginal product of area can it found by compensation the optimal quantities of production factors with equation (24):

$$MP_N = (237.074)(10)^{0.299}\,(1276)^{0.338}\,(1.4)^{-0.665}$$

$$MP_N = (237.074)(1.9906)\,(11.214)(0.799)$$

$$MP_N = 4228.392 \quad \text{K.g./ Hectar}$$

The amount of marginal product of area.

From equation (23), we find the average product of the area as follows:

$$AP_N = \frac{4228.392}{0.335} = 12622 \text{ K.g./ Hectar}$$

Share of farm area in productivity per hectare.

The economic analysis of the estimated production function showed that the marginal products of the factors of production were positive. This means that production is in the economic stage. Substitution can occur between both labor and capital with the farm area constant, with the aim of knowing the ability of producers to achieve a point on the path of expansion by moving along the same isoquant curve. By knowing the value of the marginal rate of substitution (MRTS).

Substitution between labor and capital: As long as long-run conditions allow changing all productive factors, including the farm area, the farmer is on the path of expansion and the process of substitution must occur between productive factors to achieve the optimal combination of those factors. From knowing, the ratio of substitution between labor and capital to knowing the possibility of achieving specialized efficiency of productive resources, the rate of substitution can it measured through the (MRTS) law. As the producer must work in the efficiency zone confined between the critical lines of the function (Ridge Line for Labor) and (Ridge Line for Capital), and this zone corresponds to the second productive stage of the law of diminishing returns. It achieves production maximization at the point where the marginal product of one of the factors of production reaches zero within the limits of a restricted cost and a specified area.

First: Increasing labor units in exchange for decreasing capital: Different combinations of production factors can it adopted in order to know the combination that achieves the allocative efficiency of productive resources based on the equation of marginal product for each production factor. To measure the marginal rate of substitution, the following relationship can it adopted:

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$$MRTS_{L,K} = \frac{\Delta K}{\Delta L}$$

Since: ΔK = change in capital. ΔL = change in labor element.

Table (6): Allocative efficiency of resources with increasing labor, decreasing capital, and constant area on the farms of the research sample

Combinations	Levels of quantities of production elements			Productivity	Marginal output level/ K.g			MRTS
	Number of Workers	Capital/ $	Farm area/ ha.		MP_L	MP_K	MP_N	
A	9	1176	1.4	14790	552.7	4.7	3984	---
B	10	1276	1.4	14790	528.5	4.6	4228.3	1
C	11	1376	1.4	14790	506.6	4.4	4358.2	1

Reference/researcher based on equations (11), (20), (22), (24) and the MRTS law.

$$Y = 707.685\, L^{0.299}\, K^{0.338}\, N^{0.335}$$
$$MP_L = (211.597)L^{-0.701}\, K^{0.338}\, N^{0.335}$$
$$MP_K = (239.197)L^{0.299}\, K^{-0.662}\, N^{0.335}$$
$$MP_N = (237.074)L^{0.299}\, K^{0.338}\, N^{-0.665}$$

We note from Table (6) that the marginal product of labor begins to decrease when units of labor increase and units of capital decrease, while the marginal product of both capital and area begins to increase, and the total product begins to decrease after combination (B).

Table (7): Allocative efficiency of resources with increasing capital, decreasing labor, and constant area on the farms of the research sample

Combinations	Levels of quantities of production elements			Productivity	Marginal output level/ K.g			MRTS
	Number of Workers	Capital/ $	Farm area/ ha.		MP_L	MP_K	MP_N	
A	9	1176	1.4	14790	552.7	4.7	3984	---
B	10	1276	1.4	14790	528.5	4.6	4228.3	1
C	11	1376	1.4	14790	506.6	4.4	4358.2	1

Reference/researcher based on equations (11), (20), (22), (24) and the MRTS law.

$$Y = 707.685\, L^{0.299}\, K^{0.338}\, N^{0.335}$$
$$MP_L = (211.597)L^{-0.701}\, K^{0.338}\, N^{0.335}$$

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$MP_K = (239.197)L^{0.299}\ K^{-0.662}\ N^{0.335}$
$MP_N = (237.074)L^{0.299}\ K^{0.338}\ N^{-0.665}$

Table (7) shows that the marginal product of both capital and farm area decreases when capital units increase in exchange for a decrease in the number of workers, while the total product decreases after combination (B). The best decision for the producer is to follow the first case, which is (increasing the number of workers and decreases capital), because the marginal product of both the farm area and capital increases in the first case. While the marginal product for both the farm area and capital decreases in the second case, it will therefore be economically unfeasible. This is an indication that combination (B) in Tables (5) and (6) is the optimal combination that achieves contact between the isoquant curve and the Isocost line on same isoquant curve. Thus, it achieves a point on the expansion path, as it represents production in the economic efficiency zone, and this can it explained graphically as follows to figure (1):

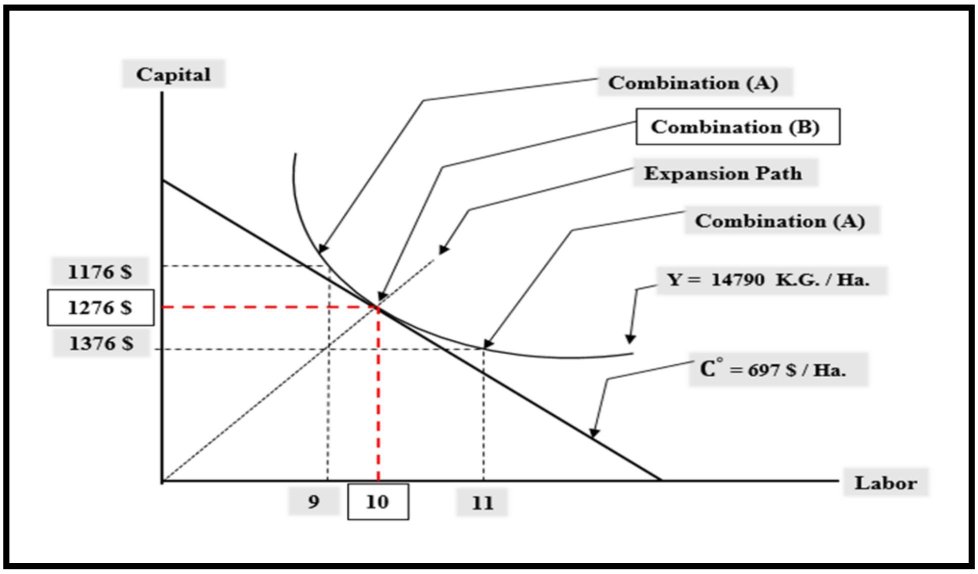

Figure (1): Achieving the allocative efficiency of productive resources and achieving optimal production in the research sample farms for the 2023 production season.

The graph (1) shows that maximizing production in the long - run it achieved at the point of economic efficiency, which is the point of tangency between the isoquant and the Isocost line, which it considered a point on the long - run expansion path.

Conclusions: Through the descriptive, quantitative and graphic economic analysis in this research, the following can concluded:

1. A percentage of (35%) of the sample producers adopted the local seed variety (Ebaa 99), whose price reached (0.941) dollars/K.g, while the remaining percentage adopted the seeds of imported varieties (Wafih, Adna, Barcelona, Bora), whose prices ranged from (1.125 –1.836) $/K.g. From this, we conclude that the price of seeds affects the producer's decision.
2. The proportion of variable production costs constituted (70.47%) of the total costs per hectare, and the highest proportion among its items was Urea fertilizer costs and NPK fertilizer costs, as they constituted (18%) and (13.85%), respectively, while fixed costs constituted (29.53%) of the total costs per hectare. We conclude from this that the increase in variable production costs was due to the increase in production requirements.
3. The statistical analysis of the production function (Cobb - Douglas) showed that there is a positive relationship between the quantity of production and the quantities of productive factors (labor, capital, farm area), where the production elasticities for these productive factors reached (0.299, 0.338, and 0.335), respectively.
4. The optimal volume of production in the short - run reached (15569) K.g/ha, which is achieved by using the optimal combination of productive factors that were reached, which amounted to (15) workers/ha, (1811) $/ ha, and (2) hectare.
5. The optimal volume of production in the long - run reached (14790) K.g/ha, which is achieved by adopting the optimal combination consisting of (10) workers/ha, capital (1276) dollars/ha, and area (1.4) hectare.

Recommendation: In light of the conclusions reached by the research, the following can it recommended:

1. Activating the role of agricultural extension to guide producers to adopt improved wheat seed varieties that help increase productivity.
2. Reorganizing the role of agricultural price policies with the aim of supporting the prices of agricultural production inputs, especially seeds and fertilizers, with the aim of encouraging producers to use improved seeds and improve productivity.
3. Implementing the recommendations of scientific research that dealt with achieving the optimal combination of productive resources with the aim of minimizing production costs and achieving economic efficiency.

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4. The need to train farmers on how to apply scientific research recommendations and use productive resources optimally, as this helps reduce production costs and maximize profits.
5. The study recommends following the quantitative analysis method by using the Lagrange coefficient to obtain more accurate results that can adopted to reach the optimum production volume in field crop farms, especially wheat.

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