MEASURING RETURNSS TO SCALE, DISTRIBUTION EFFICIENCY AND ESTIMATING WHEAT PRODUCTION FUNCTION IN DHI QAR PROVINCE

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ABSTRACT

The aim of this research was to estimate the production function to measure returns to scale and distribution efficiency of resources used in the production of wheat. Cross sectional data used of a random sample of 130 farmers in Dhi Qar Province. The results of the quantitative analysis of estimating production function showed that the double logarithmic form was the best estimated model based on economic and statistical indicators. However, that form suffered from heteroscedasticity and autocorrelation, so the robust regression technique was chosen. Value of returns to scale was 0.89 and this indicates decreasing returns to scale. This means that production function is in the second stage of the function. The results of the distributional efficiency study showed that the resources used in the production of the crop were not optimized as they amounted to 1.28 for the human labor resource and 20.6 for the capital. There was a shortage in the use of labor resource and capital for the optimal use that achieves economic efficiency and this caused low efficiency of crop production. Therefore, the research recommends the need to increase the amount of human labor in the wheat crop farms in Dhi Qar province, which would move the production function curve to a higher level in order to achieve the economic efficiency of the crop cultivation in the province on the one hand and return the farmers to production in the rational stage. Also, it is important to have the proper allocation of resources available by farmers, which has the effect of increasing the economic efficiency of those resources, which will in turn reflects on the efficiency of crop production.

Keywords: robust least squares method, cobb-douglas function, economic efficiency.

قياس عوائد السعة والكفاءة التوزيعية وتقدير دالة أنتاج محصول القمح في محافظة ذي قار

ضرغام سلمان برباز قيس طامي جسام اسراء نجم عبد الله
مدرس مدرس باحثة
قسم الاقتصاد الزراعي / كلية علوم الهندسة الزراعية / جامعة بغداد

المستخلص

أستهدف البحث تقدير دالة الانتاج الاقتصادية التي يتم بواسطتها قياس عوائد السعة والكفاءة التوزيعية للموارد المستخدمة في انتاج المحصول ، استخدمت بيانات مقطعية في ضوءعينة عشوائية اشتملت 130 مزارعاً من محافظة ذي قار. بينت نتائج التحليل الكمي لتقدير دالة ألانتاج الاقتصادية أن الأنموذج اللوغارتيمي المزدوج هو افضل النماذج المقدرة أستناداً للمؤشرات الاقتصادية والاحصائية وقد تم تحديد مشكلة عدم ثبات التباين ومشكلة الارتباط الذاتي ، لذا تم تقدير الدالة بطريقة الانحدار الحصين ، كما تبين من خلالها بأن قيمة عائد السعة بلغت 0.89 ، أي وجود عوائد سعة متناقصة، هذا يعني ان دالة الانتاج في المرحلة الثانية من مراحل الانتاج، كما بينت نتائج دراسة الكفاءة التوزيعية أن الموارد المستخدمة في أنتاج المحصول لم تستغل بشكل أمثل أذ بلغت 1.28 لمورد العمل البشري ، و20.6 لمورد راس المال، اذ ان هناك عجز في أستخدام مورد العمل وراس المال عن ألاستخدام ألامثل الذي يحقق الكفاءة الاقتصادية وهذا مايؤثر على تدني كفاءة أنتاج المحصول. لذا يوصي البحث بضرورة زيادة كمية العمل البشري في مزراع محصول القمح في محافظة ذي قار الامر الذي من شانه ان ينقل منحنى دالة الانتاج الى مستوى اعلى بشكل يحقق الكفاءة الاقتصادية من زراعة المحصول في المحافظة من جهة ويعيد المزارعين الى الانتاج في المرحلة الرشيدة من جهة اخرى، فضلا عن ضرورة التخصيص السليم للموارد المتاحة من قبل المزارعين لما لها من أثر في زيادة الكفاءة الاقتصادية لتلك الموارد التي ستنعكس بدورها على زيادة كفاءة انتاج المحصول.

الكلمات المفتاحية: طريقة المربعات الصغرى الحصينة، دالة كوب دوجلاس، الكفاءة الاقتصادية.

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INTRODUCTION

Production in general means the process of converting inputs such as land, labor and capital into goods and services called outputs, and achieving optimal level of production with the least amount of resources possible is the primary goal targeted by communities around the world to reduce poverty and achieve high productivity. In order to achieve self-sufficiency, especially in developing countries, efficiency in the use of economic resources is an issue that is of big concern to economists recently as a precondition for achieving comprehensive economic development in society. This is obtained by minimizing the cost of production with a certain level of production or maximizing production with a certain level of cost.This requires proper allocation or redistribution of available resources to maximize production for many agricultural crops (10). Thus, one of the objectives of development is the fighting poverty and the optimal use of production resources, and agricultural projects are the basis for agricultural development in the economies of many countries (11). Agricultural production plays an important role in the economies of a country because it is linked to the lives of its people first and from the sources of economic activity, especially grain crops, which constitute 80% of the total plant foods (1). Although China has only 15% of arable land, it produces food for about 20% of the world's population and is the world's largest wheat producer (18) .In 2014, China's wheat production reached 126.2 million tons (13). Because Iraq is famous for the cultivation of wheat since ancient times, this crop occupies an important economic position in the Iraqi agriculture, both in terms of its contribution to farm income or to cultivated areas, where the cultivated areas of the crop 43% of the average cultivated land and about 50% of the cultivated areas of grain (7). Agricultural growth can be achieved through horizontal expansion by introducing new land into crop cultivation, or by vertical expansion by achieving higher rates of unit productivity (9). Achieving this depends to a large extent on how to deal with agricultural lands, with good management and scientific method that enables this efficiency (12). Therefore, studies on the economics of agricultural production need to be addressed through the optimal use of economic resources and achieving high rates of agricultural production and productivity because these studies illustrate the nature of the relationship between economic variables in agriculture (2). Therefore, the aim of this research was to identify the distribution efficiency of wheat cultivation in Dhi Qar governorate, as the cultivation of wheat crop in Dhi Qar governorate faces productivity and profitability problems, such as farmers' move away from the concept of optimization in the resources used, which reflected on the low economic efficiency in crop production. Farmers usually continue to grow wheat despite declining productivity and declining net farm income (6). This study assists farmers in the governorate and enables them to know the optimal use of resources that will in turn be reflected in production and thus increase the profits from crop production. The hypothesis of research is based on the existence of deviations in the use of resources from the best use of them, which reflected negatively on the economic efficiency of those resources, which in turn affected the low efficiency of production and profits from the production of the crop. The objective of this research is to estimate production function of wheat crop, to measure economies to scale in wheat production, as well as to measure the distribution efficiency of the resources used to produce the crop.

MATERIALS AND METHODS

This study was based on a questionnaire for a sample of wheat farmers in the province of Dhi Qar for the season 2017-2018 130 questionnaires were distributed to a random sample of the farmers of the crop. Cultivated areas were emptied and analyzed using the computer program of the statistical program Eviews11. For quantitative analysis, the ordinary least squares and robust regression methods were used.

Theoretical framework

First: economic production function of wheat crop: The economic production function generally means the relationship between the value of the gross product achieved on the one hand and the factors influencing the values of resources (costs) on the other hand (19).

By estimating the parameters, it was found that Cabb-Douglas function is the most suitable model in the study because of its compatibility with the logic of economic theory and statistical and standard tests(4).

$$Y = b_0 K^{B1} L^{B2} \ldots\ldots\ldots 1$$

The economic production function can be converted from the exponential model to the linear logarithmic model as follows:

$$LnY = Lnb_o + b_1 LnK + b_2 LnL + ui \ldots..2$$

So: Y: quantity of wheat crop production (tons), K: capital (IQD), L: number of hours worked (hours), b_o: constant limit, bi: regression coefficients, ui: random variable.

Measurement of wheat production function.

Second: Retun to scale (RTS) is the measure of the organization's success in producing the maximum output capacity from the available input range (17). Productivity elasticity is defined as the amount of relative change in output due to the relative change in the resource used (16). Productivity elasticity is calculated according to the following formula:

Where: EP: Elasticity of Production .MP: Marginal Product .AP: Average Product.

Return to scale takes the following values:

$\sum EP = 1, \sum EP > 1, \sum EP < 1$

If $\sum EP = 1$, returns to scale are constant.

If $\sum EP > 1$, returns to scale are increasing.

If $\sum EP < 1$, returns to sclae are decreasing.

Third: Measuring the distribution efficiency of the resources used in the production of wheat: Allocative Efficiency (AE) means choosing a combination of inputs to achieve a certain level of output with minimal expenditure and reflecting the farm's ability to optimize inputs taking into account the prices of these inputs and available production techniques (8). According to the following formula (3):

$AE = MVP / MFC$

$MVP = MP \times Py$

$MP = Bi \times AP$

$AP = G(Y) / G(X)$

$MP = Bi \times G(Y) / G(X)$

$MFC = Px$

AE: Allocative efficiency, MVP: marginal value of product, MFC: marginal cost of the resource representing the resource price (Px), Py: output price of the unit produced, MP: marginal output,: AP: Average output of the resource, G (Y): Geometric mean of total return,G(X): Geometric mean of value resource .

Distributional efficiency takes values according to the following formula:

AE = MVP / MFC = 1 Efficient Used

AE = MVP / MFC > 1 Under Used

AE = MVP / MFC < 1 Over Used

If the value of AE=1 this means that quantities of the resource are used to achieve complete efficiency, then if the value of AE >1 this means using less of the resource, then if the value of AE <1 this means using more quantities than the supplier.

In order to know the amount of surplus or deficit in the use of the resource from the optimum level that achieves the distributional efficiency .

$D = [1 - (MFC / MVP)] \times 100.$

D: The absolute value of the relative change in the value of the marginal product of the resource.

RESULTS AND DISCUSSION

Descriptive analysis of the structure of the costs of wheat production.

Production costs are an important and fundamental issue in economic studies, because production decisions depend largely on the level of production costs, as the volume of production is always linked to production costs, because the importance of studying production costs is a key factor in determining the net income (5). Therefore, this aspect of importance is highlighted in the study. Table 1 shows that variable costs constitute 66% of total production costs, whereas fixed costs represent 27% of total production costs. As for variable cost items, chemical fertilizers costs came first with 24%. Fixed cost items came in first place with 14%. Descriptive analysis of revenue and rross profit from wheat production. Table 2 shows that the total revenues amounted to 4,137,040,000 dinar, an average of about 31,823,385 dinar at the farm level, while the total profit amounted to 2,000,888,143 dinar, with an average of about 16,431,937 dinar. The area cultivated in the research sample reached about 8562 dunums.

Economic, statistical and econom ctric analysis of the economic production function of wheat crop:

The parameters of the model variables were estimated using a econom ctric model in

several formulas (linear, semi logarithmic, inverse semi logarithmic and finally double logarithmic) to select the best by using statistical and standard tests with the economic logic and representation of the above productive relationship, especially passing the statistical and economctric tests and according to the tests of the first and second degree.

Table 1. Costs structure of wheat crop production.

Items	Cost per project (IQD)	Total cost in the research sample (IQD)	Relative importance
Seeds	**1686484.177**	**219242943**	**11%**
Fertilizers	**3730174.615**	**484922700**	**24%**
Pesticides	**76769.23077**	**9980000**	**0%**
Fuel	**734230.7692**	**95450000**	**5%**
Maintenance	**275269.2308**	**35785000**	**2%**
Mechanical Labor	**3597038.462**	**467615000**	**23%**
Variable Costs	**10099966.48**	**1312995643**	**66%**
Marketing Costs	**1108461.538**	**144100000**	**7%**
Land Rent	**228200.7692**	**29666100**	**1%**
Depreciation	**2163815.385**	**281296000**	**14%**
Interest on Capital	**1143464.615**	**148650400**	**7%**
Humen Labor	**647538.4615**	**84180000**	**4%**
Fixed Costs	**4183019.231**	**543792500**	**27%**
Total Costs	**15391447.25**	**2000888143**	**100%**

Source: Prepared by the researcher based on the questionnaire data.

Table 2. Total revenue and profit from wheat production.

Items	The Average In Sample Level	Total	Relative Importance
Production (Tons)	**55.5**	**7219.05**	
Main Revenue (IQD)	**29,870,577**	**3,883,175,000**	**94%**
Secondary Revenue (IQD)	**1,952,808**	**253,865,000**	**6%**
Total Revenue (IQD)	**31,823,385**	**4,137,040,000**	
Total cost (IQD)	**15,391,447**	**2,000,888,143**	
Profit (IQD)	**16,431,937**	**2,136,151,857**	

Source: Prepared by the researcher based on the questionnaire data.

All coefficients of the estimated productive function were positive and consistent with what was expected according to the logic of economic theory. It may be noted through the analysis that the capital variable is more specific to the production of wheat crop, because the crop responds to the requirements of production of seeds and fertilizers and does not require a large amount of labour as wheat crop is one of the least need crops for agricultural labour. The f test showed that the overall model was significant at significant levels above 1%. The determination coefficient R^2 indicates that 91% of the variation in wheat production in Dhi Qar province was caused by independent variables (labor and capital), while 9% of these changes were due to other variables such as soil quality, climate and management, water sonrce, not included in the model. Its estimated effect has been absorbed by the random variable (Ui). economctric tests of the estimated model were carried out. The results indicate that the estimated model suffers from autocorrelation, according to the Breusch-Godfrey Serial Correlation LM Test. Multicolinearity has been solved because the estimated model is the logarithmic model is free from the problem of linear correlation. To detect heteroskedasticity, Breusch-Pagan-Godfrey test was used (14). It was found that the model estimated by the method of ordinary least-squares OLS suffers from heteroskedasticity. This requires appropriate

treatment to get rid of this problem of autocorrelation and heteroscedasticity. Therefore, the model was estimated using the robust regression method to treat the two problems. This method (Robust Least Squares) is one of the efficient methods to treat these two problems with it. The robust regression method was used, as showed in table 6. All the coefficients of the new production function, estimated by the robust regression, came with a positive and consistent signal with what was expected according to the logic of economic theory. The estimated function parameters were significant at the 1% level according to the t test and f test as a whole at significant levels above 1%. The Jargue-Bera test showed that the remainder of the estimated function is normally distributed. It proved that increasing the number of working hours by one unit when the amount of capital is stable at the average will lead to an increase in production by 14%, while the impact of capital on the amount of production is greater, as production will increase by 75% when the capital increase by one unit. Wheat yields are not highly dependent on labor, while production responds significantly to increased spending on seed and fertilizer inputs. Since the parameter value of the variable in the double logarithmic function represents the productive elasticity of that variable. The estimated function reflects that the production elasticity of the capital resource is 0.75, a positive value which is higher in value than the labor resource, indicating that wheat production depends mainly on the use of technology from improved seeds and the use of modern fertilizers, pesticides and agricultural mechanization. This is consistent with the economic reality of the sample farms as shown in the field survey, while the elasticity of the labor resource was about 0.14, which indicates that the crop weak response to the number of working hours if the crop does not require long hours of work. It reached 0.89, which is less than the correct one, indicating a decrease in the return on scale, meaning that the increase in production resources by 100% is accompanied by a decline in total output by 11%. This means that production function is in the second stage of the function and. The determination coefficient R^2 indicates that 70% of the variation in wheat production in Dhi Qar province was caused by independent variables (labor and capital).

Table 3. Estimated wheat production function by OLS method

Dependent Variable: LOG(Y)
Method: Least Squares
Date: 10/11/19 Time: 19:57
Sample: 1 130
Included observations: 130

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-9.346258	0.647448	-14.43553	0.0000
LOG(L)	0.142983	0.025860	5.529086	0.0000
LOG(K)	0.752065	0.050132	15.00175	0.0000

R-squared	0.916118	Mean dependent var	3.599699
Adjusted R-squared	0.914797	S.D. dependent var	0.745994
S.E. of regression	0.217753	Akaike info criterion	-0.188106
Sum squared resid	6.021867	Schwarz criterion	-0.121932
Log likelihood	15.22691	Hannan-Quinn criter.	-0.161218
F-statistic	693.5122	Durbin-Watson stat	1.316631
Prob(F-statistic)	0.000000		

Source: Prepared by the researcher based on the results of the statistical program eviews 11.

Table 4. LM test

Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	**8.874872**	**Prob. F(2,125)**	**0.0002**
Obs*R-squared	**16.16442**	**Prob. Chi-Square(2)**	**0.0003**

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 10/11/19 Time: 20:05
Sample: 1 130
Included observations: 130
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.103671	0.627638	0.165177	0.8691
LOG(L)	0.013674	0.025036	0.546176	0.5859
LOG(K)	-0.012682	0.048654	-0.260663	0.7948
RESID(-1)	0.311252	0.090706	3.431431	0.0008
RESID(-2)	0.099539	0.093381	1.065941	0.2885

R-squared	**0.124342**	**Mean dependent var**	**3.30E-16**
Adjusted R-squared	**0.096321**	**S.D. dependent var**	**0.216058**
S.E. of regression	**0.205389**	**Akaike info criterion**	**-0.290116**
Sum squared resid	**5.273098**	**Schwarz criterion**	**-0.179827**
Log likelihood	**23.85756**	**Hannan-Quinn criter.**	**-0.245302**
F-statistic	**4.437436**	**Durbin-Watson stat**	**1.970895**
Prob(F-statistic)	**0.002183**		

Source: Prepared by the researcher based on the results of the statistical program eviews 11.

Table 5. Breusch-pagan-godfrey test

Heteroskedasticity Test: Breusch-Pagan-Godfrey			
F-statistic	**6.976877**	**Prob. F(2,127)**	**0.0013**
Obs*R-squared	**12.86938**	**Prob. Chi-Square(2)**	**0.0016**
Scaled explained SS	**15.29498**	**Prob. Chi-Square(2)**	**0.0005**

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 10/11/19 Time: 20:15
Sample: 1 130
Included observations: 130

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.732498	0.208743	-3.509084	0.0006
LOG(L)	-0.024277	0.008338	-2.911774	0.0042
LOG(K)	0.059989	0.016163	3.711503	0.0003

R-squared	**0.098995**	**Mean dependent var**	**0.046322**
Adjusted R-squared	**0.084806**	**S.D. dependent var**	**0.073386**
S.E. of regression	**0.070206**	**Akaike info criterion**	**-2.451973**
Sum squared resid	**0.625960**	**Schwarz criterion**	**-2.385799**
Log likelihood	**162.3782**	**Hannan-Quinn criter.**	**-2.425084**
F-statistic	**6.976877**	**Durbin-Watson stat**	**1.693581**
Prob(F-statistic)	**0.001334**		

Source: Prepared by the researcher based on the results of the statistical program eviews 11.

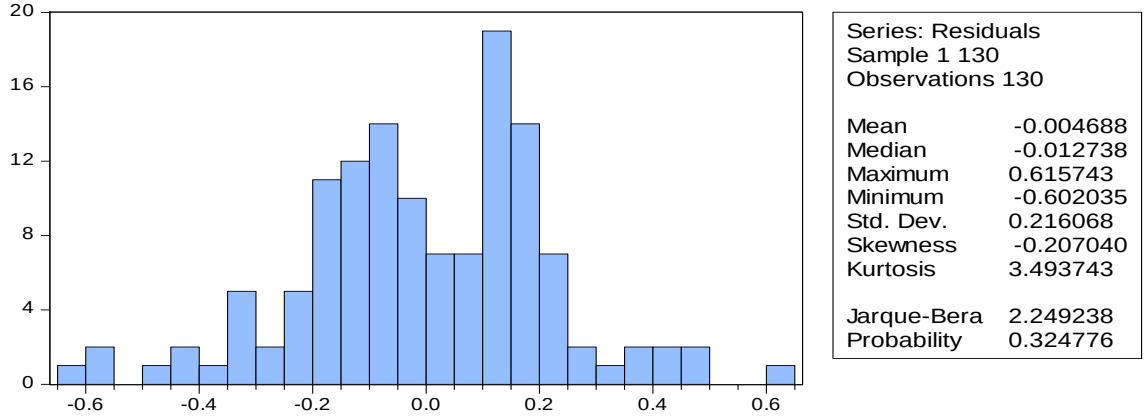
Table 6. The new production function of wheat byusing Robust Least Squares method

Dependent Variable: LOG(Y)
Method: Robust Least Squares
Date: 10/11/19 Time: 20:17
Sample: 1 130
Included observations: 130
Method: MM-estimation
S settings: tuning=1.547645, breakdown=0.5, trials=200, subsmpl=3, refine=2, compare=5
M settings: weight=Bisquare, tuning=4.684
Random number generator: rng=kn, seed=56332944
Huber Type I Standard Errors & Covariance

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-9.401507	0.637911	-14.73796	0.0000
LOG(L)	0.140183	0.025479	5.501890	0.0000
LOG(K)	0.757099	0.049393	15.32796	0.0000
Robust Statistics				
R-squared	0.701290	Adjusted R-squared		0.696586
Rw-squared	0.930244	Adjust Rw-squared		0.930244
Akaike info criterion	121.7047	Schwarz criterion		131.6984
Deviance	5.089641	Scale		0.208484
Rn-squared statistic	1428.854	Prob(Rn-squared stat.)		0.000000
Non-robust Statistics				
Mean dependent var	3.599699	S.D. dependent var		0.745994
S.E. of regression	0.217815	Sum squared resid		6.025292

Source: Prepared by the researcher based on the results of the statistical program eviews 11.

Table 7. Jatque-bera test



Source: Prepared by the researcher based on the results of the statistical program eviews 11.

Measuring yield returns in wheat production: This shows that the yield value of the wheat yield was 0.89, smaller than the correct one, which indicates that there are decreasing capacity yields, this indicate that the yield of the crop is subject to decreasing yields based on economic theory. Production is done in the third stage of the production function. 100% of the resources considered will result in an 11% decrease in production. Measuring the distribution efficiency of resources used in wheat production: The results of the distributional efficiency of the labor and capital resource are shown in table 8, It reached 1.28 for the labor resource and about 20.6 for the capital. The allocative efficiency of the human labor resource is low compared to the capital allocative efficiency, which is greater than the correct one.This means that the marginal cost of one working hour by was 1.8 thousand will increase the value of the marginal output of the supplier by IQD 2.41 thousand. Wheat depends on mechanical labor. The human labor resource has not achieved the optimum level, the number of working hours was used below the required level that

achieves price efficiency. The decrease in the quantities of human labor is due to the high marginal cost, which means that the use of human labor should be increased with a decrease in its cost because This resource contributes to the increase in the marginal production value of the resource as it increased by about 22%. As for the capital resource, it has been shown that the distributional efficiency is high, reaching 20.6, which is also greater than the correct one. This means an increase in the cost of capital by 10%, which will lead to an increase of IQD 2.06 thousand in relation to the value of the marginal output of the resource, shown by the value of the capital efficiency, and the amount of change in the value of marginal product as a result of the use of capital amounted to 95%. It achieves an increase and therefore the use of capital must be increased in such a way that the resource achieves the price efficiency. It is evident from the distribution efficiency study that resources used in the production of wheat crop in the province of Dhi Qar achieve the optimal use of capital, and there was a surplus in the use of the resource capital, and therefore reflected on the profits from the production of wheat crop.

Table 8. Results of the distribution efficiency of the resources used in wheat production.

Variables	GM*	MVP	MFC	AE	D%
Total Revenue	**21086.65**	**-**	**-**	**-**	**-**
Human Labor	**1228.34**	**2.406**	**1.88**	**1.283**	**22.08**
Capital	**7736.61**	**2.064**	**0.10**	**20.635**	**95.15**

Source: Work of the researcher based on the questionnaire.

*** GM: Geometric mean (1000 dinars).**

Recommendations

In light of the results, the research found that by measuring the yield value of the capacity of 0.89, the production of wheat crop in Dhi Qar province yields decreasing returns to scale. The distribution efficiency study also showed that the resources used in the production of the crop were not optimized, as there is a shortage in the use of the labor resource for optimal use that achieves economic efficiency and this affects the low efficiency of crop production. Therefore, the research recommends the need to increase the amount of human labour in wheat production in the province of Dhi Qar. This would achieve economic efficiency of crop production in the province, as well as the need to allocate properly available resources by farmers because of its impact in increasing the economic efficiency of those resources which in turn will be reflected in increasing crop production efficiency.

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